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CEO'S FINANCIAL LITERACY AND TECHNOLOGICAL INNOVATION: THE ROLE OF RISK TAKING AND MANAGEMENT CONTROL SYSTEMS

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ABSTRACT: This study investigates how CEO financial literacy influences technological innovation in Indonesian MSMEs, with risk-taking and management control systems (MCS) as sequential mediators. The key contribution lies in advancing a dual-path mediation model that links individual financial competence to organizational innovation in emerging market contexts. Using PLS-SEM on data from 113 MSME CEOs across Java, findings reveal that CEO financial literacy directly promotes innovation, while risk-taking alone does not mediate this effect. However, MCS significantly mediates the relationship, and both variables jointly form a significant sequential path. These results highlight the importance of CEO financial literacy not only as a strategic resource but as a driver of internal capability development. For managers and policymakers, the findings emphasize that financial literacy must be paired with robust internal control systems to accelerate innovation and long-term competitiveness in MSMEs.

Keywords: CEO Financial Literacy; Technological Innovation; Risk-Taking; Management Control System

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INTRODUCTION

Indonesia, as one of Asia's largest economies, faces numerous challenges and opportunities in realizing the vision of Indonesia Emas 2045, which prioritizes economic transformation towards developed country status. The MSME sector plays a critical role in driving this growth (Tambunan, 2019), with technological innovation emerging as a key pillar for achieving inclusive and sustainable economic progress (Schot & Steinmueller, 2018). Strengthening the country's ability to promote technological innovation within MSMEs is vital for addressing challenges and fostering quality economic development (Al Aidhi et al., 2023; Zhang & Aumeboonsuke, 2022). However, challenges such as low financial literacy of business leaders (Hakim et al., 2018), lack of technology adoption (Rochmahwati, 2023), and limited access to funding (Liu et al., 2021) hinder this potential. Recent studies show that only 16% of MSMEs in Java use digital technology optimally (Sulaeman et al., 2024), even though technological innovation has been proven to increase productivity by up to 30% (Zhang et al., 2021). This research focuses on the CEOs or top leaders of MSMEs in Java, where the majority of Indonesia's MSMEs are concentrated, contributing 57.04% to the national GDP (Rasbin, 2019). Technological advancements in Java, particularly in the service and manufacturing sectors, have fueled significant regional economic growth (Yusuf & Sumner, 2015; Rochmahwati, 2023). However, despite their importance, MSMEs in Java continue to face various challenges (Tambunan, 2019), underscoring the need for targeted strategies to support their development towards achieving the Indonesia Emas 2045 vision.

Innovation is widely recognized as an important element that not only increases the prosperity of companies, but also drives the economic progress of a country (Townsend & Hunt, 2019). In particular, we emphasize on technological innovation as this is closely related to the organization's competitiveness, sustainability, growth and business success (Martínez-Alonso et al., 2022). In addition, technology plays a critical tasks in societal development and economic, both in academia and industry (Liu et al., 2021). Technology is one of the main components in the industry 4.0 era, which is characterized by the intensive use of technology in areas such as economy, health, education and others. The ease of technology in carrying out production processes, data processing, and information distribution makes many activities more efficient and easier (Premana et al., 2020).

Several studies have shown that entrepreneurs who adopt technology reap significant benefits. For example, the use of digital technology can improve market access and expand distribution reach, leading to increased sales volume and revenue (Rochmahwati, 2023). Another example is that the adoption of information technology can drive marketing improvements (Hartoyo et al., 2015), improve more efficient and effective communication (Adeola & David Oluseun, 2014), and enable organizations to achieve more, effective, efficient, innovative, and competitive growth at the global level (Rahayu & Day, 2015), Several studies reveal technological innovation as a key driver of environmental preservation practices (Ramírez-Orellana et al., 2021), market expansion, MSME capabilities and growth (García-Lopera et al., 2022). However, technological innovation in the MSME sector has received little attention in most of the existing literature (Arsawan et al., 2022). In fact, research on technological innovation in MSMEs is essential, because the capacity to innovate, the speed and frequency of innovation are critical factors for MSMEs, especially in a challenging and rapidly changing global context (Hilmersson & Hilmersson, 2021).

Moreover, the relevance of financial literacy in this context is scope, as technological innovations affect the way companies make investment decisions (Liu et al., 2021). Financial literacy in entrepreneurship is crucial as it helps reduce financial barriers and enhance organizational performance (Eniola & Entebang, 2017), and provide benefits in identifying opportunities (Anwar et al., 2020), attitudes, and managing entrepreneurial risks (Kulathunga et al., 2020; Riepe et al., 2022). Financial literacy plays a very important role in driving product and service innovation (Campos-Valenzuela et al., 2021). According to Dahmen & Rodríguez (2014) , learning finance makes it easier for companies to manage their business through budgeting, cost-saving strategies, and basic understanding of finance to achieve the company's financial goals.

CEOs with well financial literacy to be more innovative (Liu et al., 2021). Therefore, this study centralizes on the financial literacy of CEOs or owners (CFL) of MSMEs, which is an

important and relevant factor to consider in promoting development and innovation in the sector. CEO Financial Literacy (CFL) encompasses financial knowledge and skills in regard to the following areas: resources, markets, risk, managerial, legal and taxes, and the capacity to make option financial decisions (Tian et al., 2020). MSMEs that are financially literate can conduct effective financial control and planning, ensure the right source and use of funds, and the strategic decision-making process (Kulathunga et al., 2020). Besides, CEOs with high financial literacy can overcome financial barriers by leveraging broader access to financing, thereby increasing the company's capacity to innovate in technology (Duréndez et al., 2023). However, studies examining the relationship between CEO financial literacy and innovation capacity in the MSME sector are limited (Tian et al., 2020; Wahyono & Hutahayan, 2021). Moreover, this effect has not been comprehensively analyzed in past studies (Campos-Valenzuela et al., 2021). The limited literature shows that CEO financial literacy has a dual effect on MSMEs' technological innovation, both directly and indirectly through the reduction of financial barriers (García-Pérez-de-Lema et al., 2021). However, studies investigating the relationship between CEO financial literacy and innovation capacity in the MSME sector are limited (Eniola & Entebang, 2015). To fill this gap, this study goals to examine the role of financial literacy on innovation, with an emphasis on the knowledge perspective possessed by CEOs or MSME owners.

In the related of business technological innovation, information diversity is an essential element that enables effective communication, facilitates consensus building, and provides a perspective for CEOs to evaluate the subjective aspects of innovation projects (Henri & Wouters, 2019). Therefore, the present study considers of several mediating variables linking CEO financial literacy (CFL) with technological innovation, namely management control system (MCS) and CEO risk-taking. Along with increased investment in technology innovation, also followed by the risks and challenges faced by businesses. This is because entrepreneurial innovation activities are often characterized by high costs, significant risks and long payback cycles (Zhang & Aumeboonsuke, 2022). Furthermore, Zhang & Aumeboonsuke (2022) state that only 20% of innovation projects are feasible and effective, while the other 39% fail to achieve the expected goals. This suggests that around business investments in innovation do not succeed in creating better improvement opportunities, but rather cause significant losses in capital and resources. In an effort to rapidly increase enterprise value, leaders typically tend to take greater risks and pursue innovation as a strategy for long term growth (Hughes et al., 2018). However, in the process of innovation and development, companies need to assess risks carefully. Extreme approaches, such as avoiding risk altogether or taking excessive risks, are not the way to go. Fundamentally, business leaders need to consider risk aversion factors when making project decisions in order to maximize the benefits from innovation inputs (Zhou et al., 2021). However, studies examining the mediating influence of CEO risk-taking behavior on the relationship between financial literacy and technological innovation in MSMEs are still very limited (Molina-García et al., 2020). Therefore, the objective of this study is to contribute to the existing body of literature on this subject.

In addition to the relevance of today's technological innovations, their diversity and density make business management more complex and uncertain. To manage this phenomenon, MSMEs need to adjust their structure, operating methods and modify their information systems, making Management Control Systems (MCS) indispensable (Chegri et al., 2021). The link between management control systems (MCS) and innovation is significantly shaped by the way in which the control system is operationalized (Barros & Ferreira, 2023). The control system will be more effective in supporting the innovation process if MCS is implemented more interactively (Henri & Wouters, 2019). The development of management control systems (MCS) can facilitate the growth of SMSEs by helping them to achieve both short and long-term goals while maintaining flexibility, agility and adaptability to changing conditions (Pešalj et al., 2018). This is because the Management Control System (MCS) functions as a tool that management uses to shape the future of the organization (Rachman & Nuraeni, 2020). In addition, management control system (MCS) can serve as a routine mechanism to support innovation, enable learning from previous experiences, facilitate the coordination of geographically dispersed labor or activities within a given time period, and provide key milestones to support contracting with external partners (Wijayanti & Cahyadi, 2024).

Although the extant literature has separately addressed the significance of technological innovation and financial literacy, there is a paucity of studies that have examined the interrelationship between financial literacy and technological innovation in MSMEs. Therefore, this study carried out to fill this gap by investigating the linkage between financial literacy and technological innovation in MSMEs. A significant amount of research has focused on understanding how financial literacy affects personal financial choices and overall individual financial well-being. However, few studies have explored financial literacy within a business context, especially among CEOs, and its influence on strategic decision-making and organizational innovation (Hsiao & Tsai, 2018). Therefore, this study is also one of the studies that uses individual characteristics of CEOs (financial literacy of CEOs or top executives) As a deciding factor of technological innovation in MSMEs, which is expected to further develop theoretical perspectives. In addition, this study is very interesting because there are still few studies in Indonesia that discuss the mediating effect on the relationship between CEO financial literacy and technological innovation of Indonesian MSMEs.

A review of the available literature reveals significant gaps in the understanding of risk-taking (Campos-Valenzuela et al., 2021) and management control system (Duréndez et al., 2023) can act as a mediator between CEO financial literacy and technological innovation in MSMEs. Although a number of studies have explored the influence of financial literacy and risk-taking on innovation, the relationship of these two factors to innovation has not been thoroughly analyzed (Valenzuela et al., 2021). Therefore, this study contributes to the literature by examining two crucial factors that influence the relationship between financial literacy and technology innovation, that is CEOs risk-taking and MCS. In contrast to previous studies that focus on the direct effect or mediation effect of CEO financial literacy, this study uncovers a new sequential mediation model mechanism that has rarely been tested in emerging economy contexts. This study Helping to the developing of the literature linking CEO financial literacy with technological innovation and provides new insights into the interaction between risk-taking, MCS and technological innovation in the MSMEs. This is expected to provide guidance for more effective guidelines and strategies to drive growth of technological innovation in MSMEs, while strengthening the MSME sector as the main pillar of Indonesia's economic growth towards “Indonesia Emas 2045”.

THEORETICAL REVIEW AND HYPOTHESIS DEVELOPMENT

CEO Financial Literacy

CEO financial literacy is financial knowledge includes to markets, risk management, legal problems, taxes, resources and management business (Duréndez et al., 2023), and capacity to make appropriate financing decisions (Suresh, 2021). Marriott & Mellett (1996) define financial literacy as capacity of managers to comprehend, analyze and act on financial information. Function of financial literacy is of paramount importance for entrepreneurs, as it enables them to grasp fundamental financial and to cultivate the ability and confidence to managing their finances. This is evidenced by the implementation of prudent short-term decision-making strategies and a rational long term financial planning approach (Lusardi & Mitchell, 2014). Financial literacy enables MSMEs to create optimal decisions related cash management, investments, and the selection of financing sources (Toni et al., 2024). The greater the level of financial literacy, the more optimal the financial management and decision making, which in turn contributes to improved business performance (Bongomin et al., 2017). Financial literacy constitutes a critical skill for proprietors and administrators of MSMEs, these individuals must possess the capacity to comprehend and evaluate financial data, and subsequently take action based on the insights derived from this analysis. (Marriott & Mellett, 1996). This is important because MSME owners and managers need to have sufficient knowledge, supported by valid data, to make relevant and appropriate decision.

Risk-Taking

Risk-taking has a close relationship with business, demonstrating a business's commitment to retrieve opportunities although uncertainty about their successful (Woto et al., 2024). Risk taking referring to the capacity of a business to make strategic decisions and commit to actions that involve significant risk amid uncertainties related to investments and business activities. This ability is

commonly measured by various indicators such as sales, stock price fluctuations, R&D, capital expenditures, and debt ratios (Zhang & Aumeboonsuke, 2022). In Adim (2022) research, he states that entrepreneurial with moderate levels of risk-taking tend to achieve superior market performance compared to those that adopt either excessively high or extremely low risk-taking approaches.

An owner and CEO must have good risk-taking skills, as key business decisions are usually centered on their decision-making. Therefore, the strategic choices and initiatives undertaken by CEO are profoundly shaped by their analysis of available strategic, then are influenced by their personalities and experiences (Calabrò et al., 2019). Risk-taking MSME CEOs tend to be more innovative and agile, which can help them capitalize on new opportunities and remain competitive in the market (Dahlan et al., 2023). This is due to the belief that risk-taking has the potential to result in increased sales, heightened profits and expanded market share, in turn, can contribute to the long-term growth and success of MSMEs (Franczak & Weinzimmer, 2022). This is supported by Kort (2017), who states that successful leaders and entrepreneurs who are adept at taking risks have developed a mindset and systematic approach to managing risk. This allows them to regulate their emotions when faced with uncertainty, capitalize on opportunities, and maximize profits when taking risks to achieve progress and growth.

Management Control System

Management control systems (MCS), conceptualized by Anthony (1965) as tools to align organizational activities with strategic goals, evolve dynamically in MSMEs. Management control systems become very important in the organization decision-making process, It has the potential to as sustainable source of sustainable competitive advantage if properly developed and implemented (Pešalj et al., 2018). According to Jukka (2023), management control system is a process and mechanism carried out by managers to influence organizational members to implement the established strategy. Therefore, a management control system facilitates the dissemination of pertinent information to managers, thereby improving their capacity to perform their duties effectively and make well-informed decisions (Itohan & Mbaya, 2024). With an effective control system, the organization can ensure that the planned strategy can be consistently implemented to achieve the organization's goals. According to Simons et al. (1990), the management control system serves as a tool for monitoring organizational activities, this system is used for regulation, supervision of activities, performance evaluation and as an integrative component that ensures optimal use of resources to achieve organizational goals. The system also acts as a formal methodology and framework that uses data to guide patterns of business activity based on available information (Simons et al., 1990).

In principle, MCS are not only relevant for large companies, but are also very useful for MSMEs (Chegri et al., 2021). The application of MCS in MSMEs can provide optimal results because MSMEs have advantages over large corporations, namely the closeness between the top leader/CEO and the employees. This reduces organizational complexity and makes it easier to manage and lead smaller, well-organized teams (Chegri et al., 2021). Therefore, CEOs must be able to implement effective MCS in order to boost employee motivation, encourage teamwork, optimize decision-making procedures, and provide necessary feedback, among other objectives (Itohan & Mbaya, 2024). Management control systems can guide businesses to grow and develop with strong management, planning, action, and proper control (Wong et al., 2021), MCS focuses not only on monitoring results, but also on monitoring relevant action plans to achieve business goals.

Technological Innovation

Technological innovation, in the Schumpeterian perspective (1934), is the motor of economic growth through the process of creative destruction. According to Teece (2018), technological innovation can be understood as an effort by business actors to adapt to technological changes that occur in their respective business environments. Dynamic capabilities such as the ability to adapt technology are the main determinants of competitiveness (Teece et al., 1997). Additionally, Kallmuenzer et al. (2024) revealed that the application of technology innovations, such as e-commerce platforms, big data, and artificial intelligence, enables SMEs to enhance efficiency, expanding market, and create unique customer experiences, ultimately

providing a competitive advantage. Technological innovation enables companies to offer products that are more efficient, innovative, and relevant to the evolving request of the marketplace. In addition, the effective use of technology can open up new opportunities that were previously out of reach, while expanding market access for MSMEs and playing an important role in increasing MSME competitiveness in increasingly competitive local and global markets (Cunningham et al., 2023). Technology enables MSMEs to improve their operational efficiency and make better use of limited resources, giving them an edge in productivity and cost management. Surya et al (2021), found that the application of technology by MSMEs can open up opportunities to develop a more dynamic and thriving local business ecosystem. By adopting technology, MSME's not only improve their competitiveness, but also help strengthen the local economic structure. Anatan (2023), adds that technology-adopting MSMEs are poised to assume a more significant role in job creation and economic growth at the local level. This shows that adopting technology is not only beneficial to the company itself, but also has a positive economic impact on the surrounding community.

Hypothesis Development

Financial literacy, defined as the ability to process economic information and make informed decisions (Lusardi & Mitchell, 2011), is a critical determinant of entrepreneurial behavior. Foundational studies demonstrate its role in enhancing investment decisions (Rooij et al., 2011), a mechanism central to technological innovation in MSMEs. Further, Pellegrina et al. (2017) argues that firms that actively adopt technology are likely to face fewer financial constraints, as the readiness to innovate through technology reflects a commitment to business development. Therefore, CEOs or business owners with high levels of financial literacy are better able to engage in risky financial practices such as investing in technology (Izwan et al., 2024). This is supported by the Resource-Based View theory, which explains that executive financial competence is a strategic resource that enables companies to identify and optimally allocate funds for technology development (García-Pérez-de-Lema et al., 2021). They form this hypothesis.
H1: CEO Financial Literacy Has a Significant Positive Effect on Technological Innovation

Adequate financial literacy empowers entrepreneurs to manage financial resources in a more effective manner (Abdul Rashid et al., 2024), including in making investments in technology that supports their business. According to Von Gaudecker (2015) who supports Behavioral Finance theory, a thorough understanding of financial instruments reduces cognitive biases in assessing risk, thereby enabling bolder yet measured decisions. This financial knowledge serves as a foundation to assist individuals in evaluating various financial options and selecting the most appropriate one (Hussain et al., 2018). In Wei et al. (2025) found that a CEO with a financial background tends to adopt a higher level of corporate risk taking. CEOs with high financial literacy have a better ability to calculate the risk-return tradeoff, so they are more courageous in making risky strategic decisions (Mishra, 2015). Financial literacy development can improve leaders' understanding of finance and reduce investment risk (Lusardi & Mitchell, 2014), as hypothesized.
H2: CEO Financial Literacy Has a Significant Positive Effect on Risk Taking

Substantial research from various fields shows a close relationship between risk-taking and innovation in the organizational context (March and Shapira, 1987), and research by Campos-Valenzuela et al. (2021) has highlighted that innovation demands risk-taking in all dimensions of the company. The main theoretical basis for this relationship comes from the perspective of real options theory (McGrath, 1999) which explains that strategic risk-taking capacity creates growth options for future technological development (Santos & Qin, 2019). Because risk-taking behavior at the CEO level facilitates experimentation, exploration, and rapid adoption of technological discontinuity (García-Granero et al., 2015). In Chen & Zhou's (2023) study of 420 CEOs in the manufacturing industry, they state that risk-oriented CEOs are more likely to adopt disruptive technology, hence, altogether they form hypothesis.
H3: Risk-Taking Has a Significant Positive Effect on Technological Innovation

Financial literacy is a very important aspect of everyday life, as it provides the basis for individuals to make wiser and more informed financial decisions (Balasubramnian & Sargent,

2020). Consequently, individuals who possess a comprehensive understanding of financial principles are better equipped to make deliberate and calculated decisions, increasing their likelihood of deriving benefits from risky investments (Von Gaudecker, 2015). In this regard, a solid understanding of financial literacy is essential for effective risk management and to facilitate more informed decision-making in technology investments (Suresh, 2021).

Risk-taking has a significant impact on technology innovation and business growth, especially in MSMEs, where innovation is a Important factor in the long-term success of the business (Dahlan et al., 2023). Innovation not only contributes to improve competitiveness and creating value for customers, but also opens up opportunities to create new sources of revenue (Farida & Setiawan, 2022). In order to achieve success, it is essential that entrepreneurship implement a well-organized approach that encompasses the planning, development, testing, and continuous improvement of their processes (Wellalage & Fernandez, 2019). Various studies in entrepreneurship and leadership (Hossain et al., 2022; Owino & Namusonge, 2023), and in the realm of creativity (Wellalage & Fernandez, 2019), have investigated the relationship between risk taking and innovation. From a managerial point of view, risk management includes the Determination of substantial resources to potentially profitable innovation activities, although the outcome cannot be ensured, so it remains risky. Along with increasing investment in technology innovation, so do the uncertainties, risks and challenges faced by organization, given that entrepreneurial innovation activities generally involve high costs, significant risks and long benefit cycles (Zhang & Aumeboonsuke, 2022). While financial literacy of entrepreneurs generally has a positive relationship with innovation outcomes, Liu et al. (2021) emphasize the importance of considering risk-taking dynamics in the context of innovation. The undertaking of innovative projects frequently entails a considerable degree of risk, with lengthy cycles, uncertain durations, and a substantial possible failure (Egorova & Dubkov, 2016).

Individuals who possess a high degree of financial literacy are better equipped to identify and assess risk at an early stage. This is because they have a more sophisticated understanding of the potential outcomes of risky, innovative activities in contexts where the expected returns are uncertain (Engström & McKelvie, 2017; Hsiao & Tsai, 2018). Furthermore, a number of studies have shown that risk-taking CEOs tend to produce more technological innovations of superior quality (Bsoul et al., 2022; Kim & Koo, 2018). Additionally, the extant literature suggests that financial literacy is a significant antecedent in understanding the risk-taking behavior of CEOs. In addition, evidence from previous studies suggests that CEO risk-taking propensity positively influences a firm's technological innovation (García-Granero et al., 2015), and thus it establish the rationale for hypothesis.

H4: Risk-taking positively mediates the relationship between CEO Financial Literacy and technological innovation.

Based on the Upper Echelons theory (Hambrick & Mason, 1984), individual characteristics at the CEO level, including financial competence, significantly influence the organizational decision-making process. CEOs with high levels of financial literacy tend to have a more comprehensive understanding of the importance of management control systems in managing company resources (Lusardi & Mitchell, 2014). The study by Duréndez et al. (2023) shows that leaders who have strong financial analysis skills are better able to design and implement effective MCS, such as strategic budgeting systems, cash flow monitoring, and financial performance evaluation. Financial literacy enables CEOs to identify the need for more structured control mechanisms to mitigate operational and financial risks (Kulathunga et al., 2020). Empirical study by Kulathunga et al. (2020) on the MSME sector in Southeast Asia shows that CEO financial understanding significantly affects the implementation of four key components of MCS such as budgeting systems, cost control, performance evaluation, and risk management. This finding is reinforced by the research of Grana-Alvarez et al. (2024) who found that CEOs with a formal financial background tend to adopt technology-based MCS 1.8 times higher than CEOs without such a background.

H5: CEO Financial Literacy Has a Significant Positive Effect on Management Control System

The implementation of MCS is a dynamic capability (Teece et al., 1997) that enables MSMEs to react quickly to technological change. Research by Henri and Wouters (2019) revealed that a well-designed MCS serves as a framework that facilitates the innovation process through

efficient resource allocation mechanisms and systematic project monitoring. This is in line with the Resource-Based View Theory (Barney, 1991) which states that organizational capabilities such as MCS can be a source of sustainable competitive advantage. Effective MCS implementation provides real-time information needed to evaluate the feasibility of innovation projects, identify potential risks, and ensure alignment between innovation activities and business strategy (Bedford, 2015). Empirical study by Feranita et al. (2021) on MSMEs found that firms with mature MCS exhibit higher technology adoption rates, as hypothesized.

H6: Management Control System Has a Significant Positive Effect on Technological Innovation

Recent research reveals a significant relationship between the CEO's financial literacy level and implementation of a management control system, this is particularly evident in the context of business risk management practice and system (Kulathunga et al., 2020). CEOs with high financial literacy are able to evaluate the advantages and disadvantages of financial decisions more accurately, thanks to their deep understanding and skills in financial products and processes (Lusardi & Mitchell, 2014). Financial literacy acts as a tool that enhances the risk assessment capabilities affected by the application of MCS, thereby enabling more effective risk management, especially with regard to high levels of financial leverage (Grana-Alvarez et al., 2024).

Research in the literature relating to innovation and management control suggests that widespread implementation of management control systems can encourage innovation (Wijayanti & Cahyadi, 2024), including technological innovation. However, a key challenge in implementing effective innovation is managing the balance between achieving set goals and the freedom to innovate, which requires a alignment between controlling and flexibility (Simons, 1994). The proper implementation of controls through the MCS, encompassing management, organizing, and administrative controls, allows companies to get alignment between efficiency and flexibility (Duréndez et al., 2016). The effective implementation of MCS is of critical importance in driving technological innovation. This is because such competencies are not easily imitated and serve as a source of competitive advantage, as postulated by the perspective of Resource-Based View (RBV) (Le et al., 2023). Specifically, Bedford (2015) revealed that interactive use of MCS can improve technological innovation performance in SMEs, especially in the context of explorative innovation, which requires simpler diagnostic systems and fewer resources than exploitative innovation. Therefore, management control exercised by the CEO or owner plays an important role in enhancing technological innovation potential (Duréndez et al., 2023; Feranita et al., 2021). However, according to Henri & Wouters (2019), the existing literature reveals a lack of research examining the link between MCS and technological innovation. Prior research has investigated the correlation between formal MCS and product innovation (Abernethy & Brownell, 1997), nevertheless, the utilization of formal MCS at the leader level and product innovation from a business aspect has not been as extensively investigated (Lopez-Valeiras et al., 2016). Based on the above arguments, we propose the following hypothesis:

H7: Management control systems positively mediate the relationship between CEO financial literacy and technological innovation.

As the main leader, the CEO has the responsibility to make strategic decisions, including in terms of innovation (Kashmiri et al., 2019). Empirical evidence shows that business decisions and performance are often influenced by the actions of top executives. This view is explained in echelon theory (Hambrick & Mason, 1984), which states that organizations reflect the cognitions, values, and personal characteristics of their top leaders. The essence of this approach is that the way top leaders assess opportunities and risks, as well as the way they process and evaluate information, is strongly influenced by their personal characteristics. As a result, it will affect the CEO's propensity to take risks and the implementation of management control systems (MCS) that support technological innovation in the organization (Cannella & Monroe, 1997).

Previous research has examined separately the role of organizational factors and CEO characteristics in influencing innovation performance (Jukka, 2023). In the context of organizational innovation, the interdependence approach suggests that CEO characteristics, such as CEO financial literacy and risk-taking propensity, play an important role in driving changes in organizational resources and capabilities, particularly those related to management control systems (Duréndez et al., 2023). Therefore, it can be concluded that organizational factors and

CEO capabilities are interrelated and both have greater potential to improve the understanding of technological innovation in MSMEs. Therefore, we hypothesize as follows:
H8: The effect of CFL on technological innovation is sequentially mediated by risk taking and MCS.

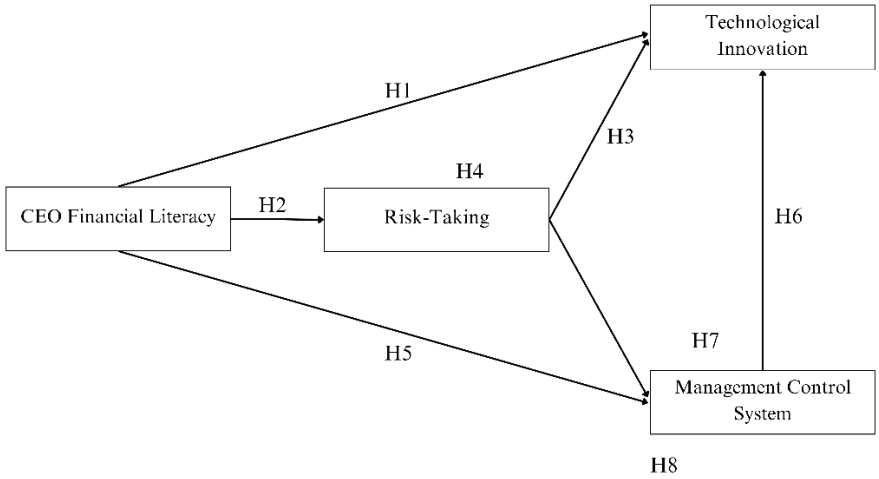

Figure 1. Conceptual Framework

RESEARCH METHOD

Sample and Data Collection

A quantitative approach was used to examine the factors influencing financial literacy on technological innovation, with risk taking and management control system as mediating variables. The questionnaire was developed by incorporating pre-tested items and based on previous literature. The population in this study were CEOs or owners of MSMEs operating in 6 provinces on the island of Java. With the respondent criteria, the position as leader, CEO or business owner, the business has at least 2 employees and has been operating for at least 1 year. CFL scale was based on (García-Pérez-de-Lema et al., 2021). This variable is measured as a reflective composite in the estimation process, following the suggested methodology García-Pérez-de-Lema et al. (2021), It considers various interrelated condition, such as managers' level of understanding of economic development, access to alternative sources of financing, financial assets for investment, and corporate financial information. MCS refers to the model developed by (Duréndez et al., 2016), following modifications to the original concept Simons et al. (1990). The MCS consist of 7 items, and is classified as a reflective composite, which is based on the inclusion of elements such as ERP system usage, financial accounting, budgetary control, Financial Research, strategical planning, internal auditing, and quality control. We refer to Covin & Slevin (1988) and Yang (2012) measure risk-taking tendencies, takes into account factor constructs that contain 4 items. In this study, technological innovation outputs were subjectively evaluated using a scale from Madrid-Guijarro et al. (2021). The CEOs were requested to provide a description of the business's position in relation to its competitors, with particular emphasis on the number of new products launched and implemented processes, the degree of innovative activity exhibited by the organization in introducing new products and processes, and the speed with which the company responds to product, service, and process innovations initiated by competitors.

Measurement

The sample for this research was determined using a non-probability sampling method, determined using purposive sampling. Data was collected using survey research methods, which involves administering an online questionnaire to CEOs of MSMEs in Indonesia. All questionnaire items were created with covered-ended questions that followed a Likert scale to measure the participants' level of suitability. To test the hypotheses, this research uses SEM-PLS, supported by previous research. (Duréndez et al., 2023). The number of samples follows the criteria of Hair

et al. (2021), who recommend a minimum of 100 samples to use PLS-SEM. A total of 113 respondents from six provinces in Java participated in this study. Generalization of results based on a deductive approach method that employs the use of a survey questionnaire.

RESULTS

Data Analysis

Reliability testing in this study follows a general guideline (rule of thumb). An initial check was conducted to examine the measurement model to ensure that the instruments used were valid and reliable. The validity test includes an examination of the indicator loadings. Factor loadings above 0.70 are recommended as this indicates that the construct can explain more than 50% of the variance of the indicators (Hair et al., 2021). However, according to (Hulland, 1999), Reflective indicator factor loading can be considered good for latent variables if it is more than 0.50. Therefore, in this study, the outer loading acceptance limit was set at 0.60, because this value is still acceptable (Ghozali & Latan, 2015). All measurement items for each variable have a loading value above 0.70, except for the risk-taking item (RT 1) with a value of 0.686. Nevertheless, RT item 1 is still used, because the loading value of 0.60 is still considered acceptable according to Cohen (See Table 1).

Table 1. Outer Model Criteria

Constructs	Items	Outer Loading	Cronbach Alpha	Rho	AVE
CEO Financial Literacy	CFL 1	0.896	0.904	0.914	0.775
	CFL 2	0.908			
	CFL 3	0.879			
	CFL 4	0.837			
Risk-Taking	RT 1	0.686	0.907	0.918	0.644
	RT 2	0.788			
	RT 3	0.877			
	RT 4	0.839			
Management Control System	MCS 1	0.804	0.800	0.802	0.624
	MCS 2	0.791			
	MCS 3	0.821			
	MCS 4	0.766			
	MCS 5	0.773			
	MCS 6	0.843			
	MCS 7	0.775			
Technological Innovation	TI 1	0.811	0.940	0.954	0.769
	TI 2	0.841			
	TI 3	0.872			
	TI 4	0.918			
	TI 5	0.914			
	TI 6	0.901			

Source: Processed Primary Data

The evaluation of discriminant validity aims to ensure that each construct in the model is theoretically distinct and can be proven empirically distinct through statistical tests. To strengthen this evaluation, two main approaches are used, namely the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT) (Fornell & Larcker, 1981). According on the Fornell-Larcker criterion, discriminant validity is considered achieved if the square root of the Average Variance Extracted (AVE) of each construct exceeds its correlation with other constructs. This indicates that the construct has more variance explained by its own indicators than the variance explained by other constructs. The test results confirm, discriminant validity in this study is met, because each construct has a root AVE value that is greater than its correlation with other constructs (Table 2). In addition, HTMT is used as a more sensitive alternative for measuring discriminant validity.

Henseler et al. (2016), suggests that the HTMT value should be below 0.90 to ensure that the constructs tested are truly significantly different (See Table 3). Taking into account the test results based on the Fornell-Larcker and HTMT criteria, it can be concluded that this research model demonstrates strong discriminant validity, as each construct is distinctly different, ensuring the model's validity in terms of discriminant measurement.

Table 2. Discriminant validity (Fornell-Larcker Criterion)

Constructs	CFL	MCS	RT	TI
CEO Financial Literacy (CFL	0.881	-	-	-
Risk-Taking (RT)	0.530	0.803	-	-
Management Control System (MSC)	0.420	0.424	0.790	-
Technological Innovation (TI)	0.478	0.554	0.334	0.877

Source: Processed Primary Data

Table 3. Discriminant validity Heterotrait-Montrait Ratio (HTMT)

	FL	MCS	RT	TI
CEO Financial Literacy (CFL)	-	-	-	-
Management Control System (MCS)	0.566	-	-	-
Risk-Taking (RT)	0.481	0.480	-	-
Technological Innovation (TI)	0.497	0.582	0.365	-

Source: Processed Primary Data

Path analysis testing using SmartPLS 4.0 Hypothesis testing between variables is carried out, with the criteria for accepting the hypothesis if the p value at the significance level is less than 0.05 (Ghozali & Latan, 2015; Hair et al., 2021). The results of hypotheses testing are presented in table 4, and displayed in Figure 2.

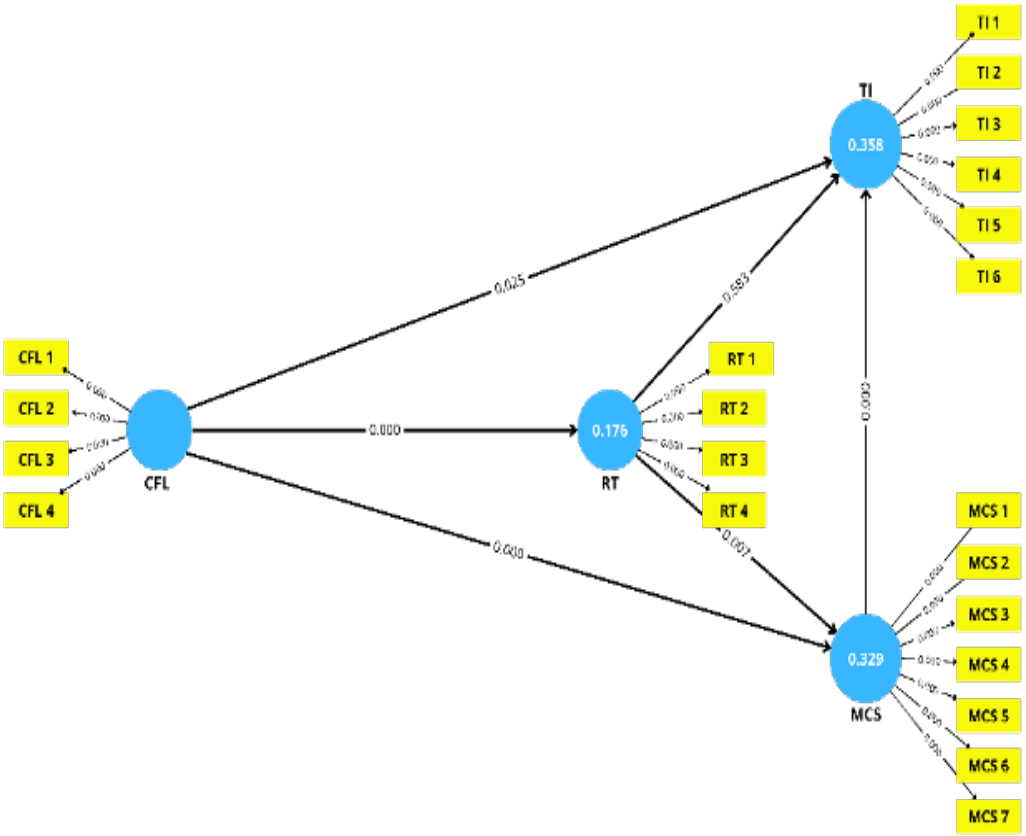

Figure 2. Testing Results
Source: Processed Primary Data

Table 4. Hypothesis Testing Results

Paths	Effect	P-values	Hypothesis
H1. CFL → TI	0.242	0.025	Supported
H2. CFL → RT	0.419	0.000	Supported
H3. RT → TI	0.062	0.583	Rejected
H5. CFL → MCS	0.419	0.000	Supported
H6. MCS →TI	0.400	0.000	Supported
Indirect Effects			
H4. CFL → RT → TI	0.026	0.600	Rejected
H7. CFL → MCS → TI	0.167	0.008	Supported
H8. CFL→RT→MCS→TI	0.043	0.037	Supported

Source: Processed Primary Data

DISCUSSION

The findings of this study confirm that CFL positively influence on technological innovation. This finding is in line with a study García-Pérez-de-Lema et al. (2021) which asserts that CFL positively contributes to technological innovation. Innovation in the enterprise is a process that relies heavily on knowledge, both individual and organizational; therefore, without a planned and sustained effort to acquire knowledge, it will be difficult to achieve innovation (Graham & Moore, 2021). Duréndez et al, (2023), stated that CEOs with good financial literacy can overcome financial difficulties by obtaining broader opportunities to funding and financing sources, this further enhances the enterprise's capacity for technological innovation. This study reinforces the argument that financial literacy is not only an individual skill, but also an organizational asset that encourages the innovative capabilities of MSMEs.

The results of the H2 analysis show a strong and significant influence between the CEO's financial literacy and the tendency to take risks. This finding confirms that CEOs with better financial competence tend to be more courageous in making risky strategic decisions. The high path coefficient shows that financial literacy not only functions as a risk control tool, but also as an enabler for measured risk-taking behavior. This is in line with the behavioral finance perspective which states that comprehensive financial understanding reduces loss aversion through more objective risk analysis capabilities (Kahneman & Tversky, 1979). This finding is consistent with the research of Bsoul et al. (2022) on family businesses in the Middle East, but it gives a higher coefficient value, perhaps because of the unique characteristics of MSMEs in Java, which tend to depend more on the individual decisions of the owners.

Contrary to the initial hypothesis, risk-taking does not show a significant effect on technological innovation, so hypothesis H3 is not supported. Consequently, mediation through risk-taking H4 is also insignificant. This finding is in line with research (Duréndez et al., 2023), which found similar results. However, this result contradicts previous research, although Campos-Valenzuela et al. (2021) found risk-taking to be a strong mediator, their study focused on MSMEs in Spain that have more stable market access. This may not be the case in Indonesia where economic risk is higher. In the context of MSMEs in developing countries, CEOs or business owners tend to prioritize business stability over taking big risks, due to limited resources including restricted access to technology, capital and markets (Koentjoro & Gunawan, 2020). Another opinion is that CEOs often prioritize the financial stability of the company to protect the organization's assets, employees, and reputation (Kahneman & Tversky', 1979). In addition, the unique characteristics of MSMEs in Java tend to be more conservative in implementing radical innovations (Rochmahwati, 2023). This results aligns with finance behavioral theory, which is states that CEOs are generally more risk-averse, especially in situations that involve high uncertainty, such as long-term innovation decisions.

The Research Results for H5 prove the strong positive influence of CEO financial literacy on MCS implementation. This finding is in line with research by Kulathunga et al. (2020) which found that CEOs with financial competence tend to be better able to design comprehensive control systems, especially in terms of strategic budgeting and risk management. Financial literacy enables CEOs to understand the importance of formal control mechanisms in managing business complexity and environmental uncertainty. This finding is consistent with previous research by Duréndez et al. (2023) but makes a new contribution by demonstrating the strength

of the relationship in the context of growing MSMEs. This may be due to the dual role of MSME CEOs, who often double as business owners, so their financial literacy has a more direct impact on the design of control systems.

The results of H6 show that the implementation of MCS has been proven to have a strong positive influence on technological innovation. This finding supports the argument of Henri and Wouters (2019) that an effective MCS functions as a framework for managing the innovation process through the proper allocation of resources, monitoring of project progress, and evaluation of performance. A good control system allows companies to reduce uncertainty in the innovation process while increasing the efficient use of resources. This finding supports Bedford's (2015) research but adds nuance by showing a stronger relationship in the context of MSMEs than in large companies. This may be due to the flexibility of the MCS in small organizations, which allows for faster adaptation to innovation needs.

The results of testing H7 suggest that the MCS exerts a positive mediation effect on the relationship between CFL and technological innovation. This finding is consistent with research (Duréndez et al., 2023) which states that MCS acts as a full mediator in the relationship between CFL and technological innovation. These results indicate that MSME CEOs who have adequate financial literacy and decision-making skills related to funding and investment are better equipped to implement a budgeting-based management control system (Rostamkalaei et al., 2022), and other control mechanisms within the business (Kulathunga et al., 2020). In addition, according to Duréndez et al. (2023) CEOs who have expertise in finance, including planning, accounting, analysis and investment, are more likely to successfully integrate MCS, which plays a crucial role in driving innovation.

The results of testing H8 show that risk taking and MCS sequentially mediate the relationship between CFL and technological innovation. The effect of CEO financial literacy on innovation is channeled through the firm's risk attitude and MCS implementation. This finding is consistent with previous research which independently shows that CEO financial literacy acts as a key driver of risk-taking. (Campos-Valenzuela et al., 2021), that risk taking has a significant influence on the implementation of MCS (Hiebl, 2024), and that MCS has a significant influence on innovation (Feranita et al., 2021). This finding supports the view proposed by (Zhou et al., 2021), which states that the combination of controlled risk-taking and effective implementation of MCS can reduce innovation project failure and improve resource use efficiency. This suggests that both variables are essential in supporting the application of technological innovations in MSMEs.

CEOs' financial literacy is expected to increase their motivation to take risks and influence decision-making related to risk management (Liu et al., 2021). This risk-taking attitude is consistent, but can change over time, as CEOs constantly face dynamic decision-making processes. The implementation of organizational control systems, such as the Management Control System, has the potential to influence the risk-taking behaviors exhibited by CEOs. This is due to the fact that such systems tend to focus attention on a multitude of aspects associated with the decision-making process (Giaccone & Magnusson, 2022). MCS assists CEOs in making more informed decisions, which in turn affects their propensity towards risk-taking. In this case, the controls implemented through MCS, such as administrative planning and management, allow companies to achieve stability between efficiency and flexibility, which in turn encourages technological innovation (Ahrens & Chapman, 2004).

CONCLUSION AND FURTHER STUDY

This study reinforces the pivotal role of CEO financial literacy in driving technological innovation within Indonesian MSMEs, particularly through the effective deployment of management control systems (MCS). While financial literacy is shown to directly enhance innovation, its influence is not transmitted via risk-taking alone—a finding that challenges assumptions based on Western-centric behavioral finance. Instead, the integration of MCS emerges as a critical conduit, underscoring the strategic function of internal controls in environments marked by resource constraints and cultural conservatism. Theoretically, this study advances the Upper Echelons Theory and Resource-Based View by validating a sequential mediation model in a developing economy context, while also offering a contextual counterpoint to the universal claims of Prospect Theory.

Despite its contributions, the study is limited by its cross-sectional design, potential response bias, and geographically concentrated sample. Future research should employ longitudinal approaches, explore sectoral variations, or examine additional mediators such as digital readiness or leadership orientation. Practically, the findings imply that improving financial literacy among MSME leaders must be paired with structured control systems—not just entrepreneurial daring—to yield innovation outcomes. Policymakers and business development agencies should prioritize programs that integrate financial training with implementation support for MCS, ensuring that financial acumen translates into real technological advancement on the ground.

ETHICAL DISCLOSURE

This study ensures the protection of participants' rights, privacy, and confidentiality. All participants involved in the research voluntarily provided written informed consent after being clearly informed about the objectives of the study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article. All authors have contributed significantly to the research and preparation of the manuscript, and there is no financial, institutional, or personal relationship that might influence the content or outcome of this study.

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