

Empowering Entrepreneurs: The Mediation Role of AI Adoption in Cognitive Skill and Product Innovation

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Abstract

The rapid increase in the incorporation of artificial intelligence (AI) into entrepreneurial environments is altering the adoption of cognitive skills and innovative products by entrepreneurs. In spite of the increasing popularization of the field of digital entrepreneurship, there is a lack of empirical data on the way cognitive skill development is transformed into product innovation via AI-based processes. In this study, the authors explore the mediating effect of the adoption of AI on the correlation between the development of cognitive skills and product innovation in entrepreneurs. A 7-point Likert-scale survey was carried out on 201 entrepreneurs working in a variety of industries using a positivist research philosophy and a quantitative cross-sectional design to collect the required data. The hypothesized relationships were tested using structural equation modeling and mediation analysis. The results show that cognitive skill development has a significant effect on the adoption of AI and product innovation. Further, the role of AI in mediating the relationship between cognitive skills and product innovation shows that AI is used by entrepreneurs to apply analytical, problem-solving, and decision-making skills to innovative product results. The research will contribute to the existing literature on entrepreneurial cognition and digital innovation, as it provides empirical evidence of the mediating role of AI and highlights the synergistic relationship between cognitive competence and the adoption of technologies. Practical implications highlight the importance of AI literacy courses, cognitive skill-building policies, and policy frameworks that drive innovation in order to enable entrepreneurs to thrive in digitally active settings.

Categories: Accounting, Innovation Economics, International financial markets and institutions

Keywords: artificial intelligence (ai), cognitive skills, product innovation entrepreneurship, mediation analysis, marketing

JEL Classifications: F20, M20, N80, O32, Q55, O35

Introduction

A rapidly growing pace of artificial intelligence (AI) technologies has radically altered the ways entrepreneurs learn, make decisions, innovate, and compete in the contemporary digital markets. With the world economy becoming more data-driven and knowledge-intensive in terms of organization, businesspeople are increasingly turning to AI to improve their decision-making, discover new opportunities, and streamline the product development process ([Dwivedi et al., 2021](#)). The entrepreneur is now assisted by AI-powered systems, like predictive analytics, recommendation engines, generative models, and intelligent automation, to get to the next stage of efficiency in innovation and strategic agility ([Giuggioli and Pellegrini, 2023](#)). Cognitive skills are now indispensable in entrepreneurial performance in this fast-changing environment, which includes critical thinking, analysis, adaptability, and problem-solving ([Melisa et al., 2025](#)). Although there is much literature on digital entrepreneurship, very little has been done on how the cognitive skill development of

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entrepreneurs interacts with AI adoption to determine product innovation outcomes. The development of cognitive skills is commonly known as a pillar of entrepreneurial behavior, which determines the opportunity recognition, strategic decision-making, and creativity (Baron, 2006) (Macnamara et al., 2024).

This co-evolution of machine intelligence and human expertise allows entrepreneurs to transcend bounded rationality by leveraging AI's analytical precision while retaining the intuitive leaps essential for groundbreaking innovation (Cristofaro et al., 2025). This integration enables a hybrid decision architecture, where algorithmic reasoning and human cognition recursively interact to shape organizational routines and strategic choices within startups (Cord et al., 2026). This dynamic interplay extends beyond mere efficiency, fundamentally reshaping entrepreneurial identity and creative processes (Jeremiah, 2024). This symbiotic relationship, where humans and machines collaborate rather than compete, is becoming a mainstream practice in business and management, offering a promising avenue for entrepreneurship (Obschonka and Audretsch, 2024). This integration is particularly valuable in contexts characterized by profound uncertainty, as AI systems enhance pattern recognition and predictive capabilities, thereby expanding the cognitive bandwidth of individual entrepreneurs and enabling them to manage complexity that previously required extensive organizational infrastructure (Wadkar and Patil, 2025). This paradigm shift necessitates a re-evaluation of entrepreneurial competencies, emphasizing the ability to effectively collaborate with AI systems and interpret their outputs rather than solely relying on traditional human-centric skills. This requires a heightened focus on "cognitive agility," enabling entrepreneurs to engage effectively with AI-provided insights and avoid misinterpretations that could arise from misaligned human-AI communication (Knox et al., 2023). Such cognitive agility is crucial for entrepreneurs to effectively integrate AI into their operational frameworks, ensuring that algorithmic actions align with strategic objectives and foster sustained innovation (Chaudhary et al., 2025).

Furthermore, this evolving landscape necessitates a deep understanding of how AI-driven insights interact with entrepreneurial cognition to influence strategic decision-making and venture performance (Mostafiz et al., 2025). This redefines the entrepreneurial dynamics, allowing individual entrepreneurs to achieve scalability and sustainability traditionally associated with larger organizations, fostering lean models for value creation. This redefinition stems from AI's capacity to augment individual capabilities through mechanisms like skill enhancement, capital accessibility, and risk mitigation, thereby transforming the entrepreneurial environment (Wadkar and Patil, 2025). This shift necessitates a detailed examination of how AI adoption impacts the cognitive skill development of entrepreneurs, influencing their capacity for opportunity recognition, strategic decision-making, and creativity, especially concerning product innovation outcomes (Cristofaro et al., 2025). This integrated perspective is critical for understanding how AI can assist entrepreneurs in navigating uncertainty and effectively seizing new market opportunities (Truong et al., 2023). Given the nascent stage of this technological convergence, it is crucial to investigate the specific mechanisms through which AI influences entrepreneurial cognitive processes and subsequently impacts product innovation. The efficacy of this integration largely depends on the entrepreneur's ability to develop a nuanced understanding of AI's capabilities and limitations, cultivating a skill set that includes evaluating AI-generated insights and understanding the implications of AI design decisions (Knox et al., 2023).

Nevertheless, with the growing adoption of AI technologies in the workflow of entrepreneurs, it is essential to learn whether it is cognitive abilities that make people innovative or whether AI is merely a technological channel that reinforces the cognitive innovation relationship (Al-Mamary, 2025). According to recent studies, entrepreneurs who can successfully use AI have a better chance of detecting untapped market demands, understanding customer behavior, and reducing the time from ideation-to-launch (Chatterjee et al., 2021) (Wamba et al., 2017). The combination of AI and human cognitive abilities is also consistent with the rest of the literature on human-technology symbiosis. The emerging literature shows that AI can support entrepreneurs in managing cognitive loads, increasing cognitive bandwidth, and supporting higher-order thinking, i.e., by automating routine tasks (Gerlich, 2025) (Lee et al., 2025).

This shows the need to explore how cognitive skill development and the adoption of AI interact in entrepreneurial situations. With these theoretical and empirical gaps in place, the present research explores the role of cognitive skill development in product innovation and evaluates the mediating role of AI adoption among entrepreneurs. Using a quantitative design and mediation analysis, the study provides evidence on whether the relationship between cognitive

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abilities and innovation is direct or whether AI is a technological mediator. The results can be integrated into the current debate on digital entrepreneurship, entrepreneurial cognition, and innovation management, providing a sophisticated insight into the interplay of cognitive and technological capabilities in influencing entrepreneurial activity. By doing so, the present study addresses recent calls for research examining AI-facilitated cognitive processes in entrepreneurial activity (Khanfar et al., 2024) (Uriarte et al., 2025).

This study makes several important contributions to the existing literature. First, it extends the field of entrepreneurial cognition by empirically examining how cognitive skill development influences product innovation in the context of artificial intelligence adoption. Second, it contributes to digital entrepreneurship research by introducing AI adoption as a mediating mechanism that explains how cognitive abilities are transformed into innovation outcomes. Third, unlike prior studies that primarily focus on developed economies or large firms, this research provides empirical evidence based on entrepreneurs across diverse sectors, enhancing the generalizability of the findings. Finally, the study offers practical insights by highlighting the importance of integrating cognitive skill development with AI literacy to foster innovation, thereby bridging the gap between human capabilities and technological advancement. This study aims to examine the role of cognitive skill development in enhancing product innovation among entrepreneurs. It investigates how AI adoption influences entrepreneurial decision-making and innovation processes. The research further explores the relationship between cognitive skills and product innovation outcomes. Additionally, it evaluates the mediating role of AI adoption in linking cognitive abilities with innovation. Overall, the study aims to understand how the integration of human cognition and AI technologies drives entrepreneurial innovation.

Despite the growing body of literature on digital entrepreneurship and AI, several gaps remain. Existing studies largely examine AI adoption and innovation separately, with limited focus on how cognitive skill development interacts with AI to influence product innovation. Moreover, prior research has predominantly concentrated on developed economies and large organizations, leaving entrepreneurial contexts underexplored. In addition, the mediating role of AI adoption in transforming cognitive capabilities into innovation outcomes remains insufficiently examined. Therefore, this study addresses these gaps by integrating cognitive skills, AI adoption, and product innovation within a unified framework.

Literature review

Over the past few years, the nature of entrepreneurship has witnessed an incredible revolution as digital technologies, specifically, AI, have changed how people think, work, and create. Cognitive skills and critical thinking, analytical thinking, adaptability, and complex problem solving are broadly understood as key entrepreneurial capabilities. These are the skills that help an entrepreneur to read market signals, see opportunities, and formulate new solutions within fast-changing environments. According to scholars, the more dynamic and data-intensive entrepreneurial ecosystems are, the more cognitive competence becomes the core component of successful decision-making and innovation performance. Recent research indicates that entrepreneurs who possess more pronounced cognitive abilities are able to cope with uncertainty more effectively, and with the cognitive load of operating in digital business environments (Melisa et al., 2025) (Lee et al., 2025). AI has become one of the most important technological facilitating factors in cognitive performance and innovation procedures. AI technologies, including machine learning, predictive analytics, natural language processing, and generative AI, assist entrepreneurs by enhancing the process of decision-making, increasing recognition of opportunities, and expediting the process of experimentation. Studies conducted between 2020 and 2025 have continued to demonstrate that the adoption of AI has led to increased innovation outcomes, increased productivity, and market responsiveness (Dwivedi et al., 2021) (Giuggioli and Pellegrini, 2023).

AI helps entrepreneurs by automating their routines, processing large volumes of data, and creating actionable insights, freeing their cognitive resources to work on more productive and creative problems (Gerlich, 2025). AI, in this manner, acts as an extension and an escalator of the cognitive abilities of entrepreneurs. An increasing body of literature indicates that the development of cognitive skills is a key determinant of the adoption of AI. The more entrepreneurs have a high level of cognitive preparedness, digitalization, and analytical judgment, the higher their likelihood of comprehending the potential of AI, assessing risks, and embracing smart technologies in their operations. This trend can be attributed to the theories of technology adoption, such as the Technology Acceptance Model and the Unified Theory of Acceptance and

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Use of Technology, which present the perceived usefulness, ease of use, and cognitive beliefs as the key predictors of adoption behavior (Venkatesh et al., 2003). The empirical data prove that cognitive abilities have a positive impact on AI preparedness, readiness to experiment with AI-based solutions, and the ability to process AI-generated information (Khanfar et al., 2024).

Therefore, the development of cognitive skills responds not only to entrepreneurial thinking but also makes an entrepreneur more inclined to accept technological innovations. Innovation of the product is one of the key sources of entrepreneurial competitiveness, especially in industries where technology is changing at a rapid rate. Innovation performance is not only about creativity and strategic thinking, but also about how entrepreneurs can use digital technologies. Product innovation is assisted by AI-based tools to enhance ideation, customer needs analysis, product design optimization, and speed up time-to-market. Research indicates that companies that embrace AI are more efficient in their innovation processes, come up with more new features of their products, and react more quickly to demands in the market (Wamba et al., 2017) (Chatterjee et al., 2021).

According to recent studies, AI is a mediating factor between the outcomes of innovation and cognitive skills. Highly cognitive entrepreneurs would tend to embrace AI technology, and when they embrace it, AI makes a big difference in enhancing the conversion of cognitive skills into innovative output. Empirical research shows that cognitive capabilities facilitate the adoption of AI, and AI adoption, in turn, increases creativity, opportunity recognition, and innovative behavior (Uriarte et al., 2025). This intermediate process demonstrates the change in the entrepreneurship literature toward hybrid models in which human cognition and AI systems cooperate in generating innovation. Additionally, AI-based cognitive enhancement allows entrepreneurs to reduce bias, detect anomalies in market data, consider alternative strategies more accurately, and develop more successful and innovative products in the end. Although this is emerging evidence, researchers note that further empirical research is required to investigate the role of AI in mediating the relationship between cognitive factors and innovation performance, especially among entrepreneurs and small business owners in developing countries. This nuanced point of view strives to clarify how AI capabilities, including improved decision-making, automation, and customer experience, can be converted into real entrepreneurial outcomes and new product proposals (Al-Mamary, 2025). It will also look at the ways AI integration can help eliminate risks and provide a unique competitive edge, which is essential in the case of entrepreneurs in dynamic and multifaceted market environments (Al-Mamary, 2025).

Additionally, the tactical integration of AI serves as a turning-point facilitator, greatly enhancing the opportunities in entrepreneurial decision-making and expanding the range of opportunities explored (Truong et al., 2023). This is in line with the current literature that highlights the significant potential of AI in the field of entrepreneurship, especially its beneficial effect on opportunity identification and business model reinvention (Mugunzva and Manchidi, 2024). The revolutionary nature of AI is applicable to the different aspects of entrepreneurial activities, including decision-making, automation, and customer experience, which, in combination, bring about innovation and competitive advantage (Al-Mamary, 2025). This can be seen especially in emerging economies, where AI implementation can contribute to the significant improvement of firm operations and create data-driven products and services regardless of resource availability (Mostafiz et al., 2025). The growing process of digitalizing business activities, which is even boosted by the Industry 4.0 paradigm, lies behind the importance of AI in defining the future of entrepreneurial activities and promoting responsiveness in dynamically changing markets (Giuggioli and Pellegrini, 2023) (Khalid et al., 2025). The paper synthesizes the AI, innovation, and entrepreneurship literature to provide a coherent analysis of the AI-entrepreneurship nexus by assessing the role of AI in enhancing opportunity recognition, business model reinvention, and socio-economic dynamics (Mugunzva and Manchidi, 2024). It provides an in-depth understanding of the role of AI as an intermediary, converting cognitive abilities into real product innovations in an entrepreneurial ecosystem. Moreover, the holistic approach will attempt to fill existing research gaps by comprehensively analyzing the ways in which AI capabilities can be used to transform cognitive abilities into innovative outputs, and thereby generate sustainable growth and help create an innovative entrepreneurial environment (Al-Mamary, 2025).

In particular, this paper will explore how predictive AI capabilities can decrease uncertainty in business activities and improve strategic decision-making, which, in turn, affects the evolution and growth of new businesses (Truong et al., 2023) (Uriarte et al., 2025). It involves finding a way to enhance human ingenuity using AI, not to substitute it, but to augment the capabilities of entrepreneurs to detect and use new trends and opportunities in the market (Giuggioli and Pellegrini, 2023) (Mumi et al., 2025). The capability of AI to process large amounts of data can enable entrepreneurs to fine-tune their strategic position and allocate resources more efficiently, which will result in more resilient and responsive business models (Mumi et al., 2025). Not only does this integration create an environment that supports continuous innovation and allows entrepreneurs to quickly adapt depending on changes in the market and customer satisfaction, but it also streamlines the work processes to a level where operational efficiencies are enhanced (Julie et al., 2024) (Mumi et al., 2025). In addition, the interaction between entrepreneurial bricolage and AI use can beneficially increase opportunity awareness as the interaction is synergistic and enhanced by the intermediating role played by entrepreneurial expertise (Kang et al., 2023). The given viewpoint focuses on the way that the clever use of finite resources, combined with the use of highly developed AI tools, enables entrepreneurs to see and exploit new opportunities, resulting in improved business model innovation and a long-lasting competitive edge (Kang et al., 2023).

While psychomotor and behavioral skills such as action orientation, manual execution, and risk-taking have traditionally been associated with entrepreneurial success, contemporary research increasingly emphasizes the centrality of cognitive skills in shaping entrepreneurial outcomes. Cognitive skills, including analytical thinking, problem-solving, information processing, and strategic decision-making, are particularly critical in technology-driven environments where entrepreneurs are required to interpret large volumes of complex data and interact with intelligent systems.

In the context of AI, the importance of cognitive skills becomes even more pronounced. AI systems provide data-driven insights; however, the effectiveness of these systems depends largely on the entrepreneur's ability to critically evaluate, interpret, and apply such insights in decision-making processes. Therefore, while psychomotor skills contribute to execution, cognitive skills form the foundation for leveraging AI technologies effectively and translating technological capabilities into meaningful innovation outcomes.

Hypotheses

H1: Cognitive skill development positively influences product innovation.

H2: Cognitive skill development positively influences AI adoption.

H3: AI adoption positively influences product innovation.

H4: AI adoption mediates the relationship between cognitive skill development and product innovation.

Conceptual framework

The theoretical framework of the proposed research is based on the premise that cognitive skill formation is a core source of entrepreneurial performance and innovation within technology-intensive settings (Figure 1). When strong cognitive capabilities are present in an entrepreneur, i.e., analytical reasoning, complex problem-solving, and critical thinking, such an entrepreneur is in a better position to comprehend market information, assess opportunities, and make strategic decisions. These mental capabilities not only contribute to creative thinking but also augment the capability of an entrepreneur to work with and embrace new technology. AI is placed as one of the important mediating mechanisms in this framework. Previous studies indicate that people with high cognitive preparedness also tend to accept, adopt, and successfully use AI tools. By adopting AI, entrepreneurs will be able to expand their mental capacity, automate their analytical functions, create insights out of big data, and speed up the innovation process. Thus, the development of cognitive skills is predicted to impact AI adoption directly, as well as for AI adoption to improve product innovation. The main outcome variable in this model is product innovation. It involves the creation of new or improved products, which is driven by the use of data-informed decision-making and improved creative processes. The framework suggests that cognitive skills influence product innovation directly and indirectly via the adoption of AI. The role of AI is thus to multiply

and direct the advantages of cognitive abilities into greater innovation outcomes. The conceptual framework collectively describes a mediated model where the development of cognitive skills has a direct and indirect effect on product innovation via AI adoption (Figure 1).

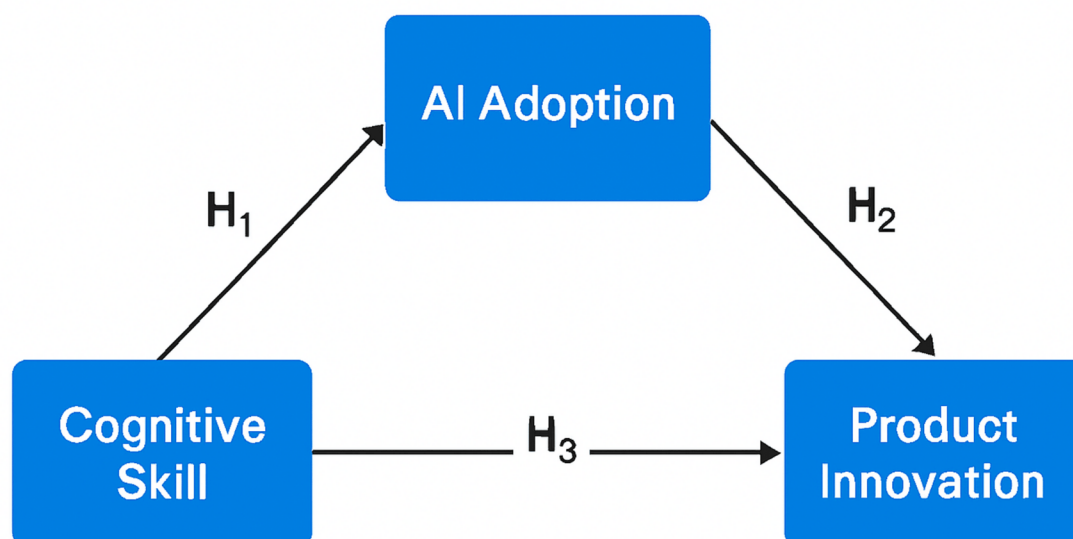


FIGURE 1: Conceptual framework diagram

AI, artificial intelligence

Research Method

Methodology

Philosophy and Approach to Research

The research philosophy in this study was positivism because the study sought to empirically examine the association between cognitive skill development, adoption of AI, and product innovation in the entrepreneurial setting. A deductive research approach was used since the hypotheses were based on the existing theories and previous empirical research in the respective areas of entrepreneurial cognition, digital entrepreneurship, and technology adoption.

Research Design

The quantitative cross-sectional research design was applied to obtain the perceptions and practices of the entrepreneurs at one time. This study design was suitable for investigating the structural relationships among cognitive skills, AI adoption, product innovation, and mediation effects. Cross-sectional designs are popular in entrepreneurship and innovation studies as they are efficient and appropriate for theory-based validation of empirical studies.

Population and Sampling

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The target group was entrepreneurs who were engaged in strategic decision-making and innovation activities in different industries. The number of entrepreneurs who participated in the survey was 201, and the sampling technique employed was convenience sampling. This sampling method was deemed suitable as there was no complete sampling frame of entrepreneurs available and it has been frequently used in entrepreneurship research (Saunders et al., 2023). In addition, the sample size was deemed sufficient to conduct mediation analysis and provide the required statistical power to identify significant relationships between the study variables (Hair et al., 2022) (Chirico et al., 2026).

The study sample consists of entrepreneurs operating across a diverse range of industries, including both technology-oriented and traditional business sectors. This diversity ensures that the findings are not limited to highly technical environments but instead reflect a broader entrepreneurial ecosystem where varying levels of technological adoption exist. Although a significant proportion of respondents possess higher educational qualifications, including undergraduate, postgraduate, and doctoral degrees, the study does not exclusively focus on highly educated individuals. Entrepreneurs with different educational backgrounds were included to capture a more realistic and inclusive representation of entrepreneurial practice. The use of convenience sampling allowed for efficient data collection; however, efforts were made to include participants with diverse demographic and professional characteristics, thereby enhancing the overall relevance and applicability of the findings. This approach enables the study to provide meaningful insights into how entrepreneurs from different sectors and backgrounds engage with AI technologies.

Data Collection Procedure

A structured self-administered questionnaire was used to collect primary data by means of professional and entrepreneurial networks through electronic transmission. The study involved volunteering, and the respondents were advised of the academic objective of the study before filling out the survey. Anonymity and confidentiality were observed at all times during data collection in order to reduce bias in responses and promote honesty among participants in the process.

Measurement of Variables

A seven-point Likert scale was used to measure all constructs, from strongly disagree to strongly agree. Cognitive skill development was evaluated by items that reflected analytical thinking, problem-solving skills, adaptability, learning skills, and decision-making skills. The adoption of AI was assessed by determining the use of AI-based applications, such as data analytics, automation, predictive technologies, and intelligent decision-support systems, in the business activities of entrepreneurs. The product innovation scale was assessed using a scale that included items that expressed the innovation of new or improved products, improvements in product features, speed of innovation, and sensitivity to customer and market demands. The measurement items were adapted from previously validated scales reported in the entrepreneurship, innovation, and technology adoption literature, ensuring content validity and construct relevance (Hakeem, 2026) (Hair et al., 2022).

Data Analysis

To analyze the data, IBM SPSS Statistics Version 29 and PROCESS Macro Version 4.2 were used, both of which were developed by Hayes (Hayes, 2022). Descriptive statistics were first calculated to summarize the characteristics of the respondents and analyze the distribution of the responses. Exploratory factor analysis was used to assess the construct validity of the measurements and confirm the dimensionality of the measurement items. Reliability and convergent validity were assessed by utilizing Cronbach's alpha, composite reliability, and average variance extracted (AVE). To test the mediation hypotheses, mediation analysis using PROCESS Macro Model 4 was performed. Bootstrapping techniques were used to produce bias-corrected confidence intervals for the indirect effects without requiring the normality assumption of the data. Studies on innovation adoption and SMEs' operational performance recently employed similar mediation and analysis techniques (Çelik et al., 2024) (Saifulina et al., 2024). Data were analyzed to establish the robustness and credibility of the findings by using multiple analytical techniques in addition to performing reliability/validity assessments. Attention was also paid to reducing the potential for common method bias, which is a significant concern in survey-based research, by implementing several procedural remedies for data collection. Some of these remedies included: respondent anonymity to remove the potential for social desirability bias; a structured, clear

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questionnaire was created to reduce ambiguity; respondents were assured that their answers would be used for academic purposes only, thereby reducing evaluation apprehension/concerns about responsibility. The use of established measurement scales and careful data screening procedures further established the overall quality of the dataset. Recent research specific to AI adoption, operational performance, supply chain innovation, and SMEs has implemented several of the same methodological procedures (Bravo et al., 2023) (Pillai et al., 2021) (Rosecká et al., 2023). The use of these procedural methods supports the validity and reliability of the study's results, as well as enhances the researcher's confidence in the conclusions.

Ethical Considerations

They adhered to ethical standards during the research. Participation was voluntary, and informed consent was obtained before participation, after which no personally identifiable information was gathered. Data were only utilized for academic purposes, and they were confidential, anonymous, and adhered to accepted ethical research principles.

Results And Discussion

Results

This section presents the empirical findings of the study based on data collected from 201 entrepreneurs across multiple industries. The results are organized into five main components: demographic analysis, descriptive statistics, assessment of the measurement model, evaluation of the structural model, and mediation analysis.

Demographic Characteristics of Respondents

The demographic analysis of the 201 entrepreneurs reveals important insights into the composition of the study sample (Table 7). A majority of the respondents were male (56.7%), while females accounted for 43.3%, indicating a relatively balanced gender representation with a slight dominance of male entrepreneurs. In terms of age distribution, the largest proportion of respondents belonged to the 35-44 years age group (35.8%), followed by those aged 25-34 years (26.9%). This suggests that most participants were in their prime working and decision-making years, which is often associated with higher levels of professional maturity and innovation potential. Smaller percentages were observed among younger entrepreneurs aged 18-24 years (10.9%) and older participants aged 55-64 years (7.5%). Regarding educational qualifications, the sample demonstrated a high level of academic attainment, with 41.8% of respondents holding a university degree, 34.8% possessing postgraduate qualifications, and 23.4% having earned doctoral degrees. This indicates that the entrepreneurial population examined in this study is highly educated, which may positively influence their cognitive skills and ability to adopt advanced technologies such as artificial intelligence. With respect to entrepreneurial experience, nearly half of the respondents (46.8%) reported having more than five years of experience, while 30.8% had between three and four years of experience, and 22.4% had one to two years of experience. This distribution reflects a diverse mix of emerging and seasoned entrepreneurs, enhancing the representativeness of the findings.

Category	Classification	Frequency (N = 201)	Percentage
Age	18–24	22	10.9%
	25–34	54	26.9%
	35–44	72	35.8%
	45–54	38	18.9%
	55–64	15	7.5%
Gender	Male	114	56.7%
	Female	87	43.3%
Education	University Graduate	84	41.8%
	Post Graduate	70	34.8%
	Doctorate Degree	47	23.4%
Experience	1–2 Years	45	22.4%
	3–4 Years	62	30.8%
	5+ Years	94	46.8%

TABLE 1: This table presents the demographic characteristics of the respondents, including age, gender, education level, and entrepreneurial experience (N = 201)

Descriptive Statistics

Descriptive statistics were used to assess the respondents' perceptions of cognitive skills, AI adoption, and product innovation (Table 2). The results indicated that most of the study constructs were able to elicit mostly positive responses. Regarding the cognitive skills construct, the items ranged from 3.98 to 4.18, with a standard deviation ranging from 0.76 to 0.88, which indicated that the respondents had high analytical thinking, problem-solving skills, adaptability, and decision-making skills. The adoption of AI ranged between 3.68 and 3.91, indicating moderate adoption of AI in entrepreneurial processes across the items. With item means ranging from 4.03 to 4.20, product innovation showed a high degree of interest and was the highest-scoring construct of the three. In general, the relatively low standard deviations indicated the uniformity of participants' responses and suggested that the measurement items did not differ greatly from one another.

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Variable	Items	Mean	Std. Dev.
Cognitive Skills (IV)	Q6–Q10	4.08	0.82
AI Adoption (MED)	Q11–Q15	3.79	0.88
Product Innovation (DV)	Q16–Q20	4.12	0.76
Construct	Item	Mean	Std. Dev.
Cognitive Skills	Q6	3.98	0.88
	Q7	4.05	0.84
	Q8	4.10	0.79
	Q9	4.09	0.82
	Q10	4.18	0.76
	Overall Mean	4.08	0.82
AI Adoption	Q11	3.68	0.94
	Q12	3.74	0.89
	Q13	3.81	0.86
	Q14	3.82	0.87
	Q15	3.91	0.84
	Overall Mean	3.79	0.88
Product Innovation	Q16	4.03	0.81
	Q17	4.08	0.78
	Q18	4.15	0.74
	Q19	4.14	0.72
	Q20	4.20	0.75
	Overall Mean	4.12	0.76

TABLE 2: This table reports the descriptive statistics (mean and standard deviation) for cognitive skills, AI adoption, and

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product innovation

AI, artificial intelligence

Exploratory Factor Analysis

Construct validity was assessed using Exploratory Factor Analysis (EFA), which was used to identify the factor structure of the items measured. The Kaiser - Meyer - Olkin value was very good ($KMO = 0.874$), and the Bartlett's Test of Sphericity was significant ($\chi^2 = 2145.32$, $df = 105$, $p < .001$), indicating that the data were suitable for factor analysis. The three factors, namely Product Innovation, AI Adoption, and Cognitive Skills, accounted for a total of 71.50% of the total variance. Convergent validity was good, as all the factor loadings were > 0.70 , and this factor structure was supported by the three factors.

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Construct	Item	Factor Loading
Product Innovation	Q16	0.812
Product Innovation	Q17	0.826
Product Innovation	Q18	0.844
Product Innovation	Q19	0.867
Product Innovation	Q20	0.885
AI Adoption	Q11	0.795
AI Adoption	Q12	0.814
AI Adoption	Q13	0.836
AI Adoption	Q14	0.854
AI Adoption	Q15	0.872
Cognitive Skills	Q6	0.782
Cognitive Skills	Q7	0.801
Cognitive Skills	Q8	0.823
Cognitive Skills	Q9	0.839
Cognitive Skills	Q10	0.854

TABLE 3: This table shows the results of the exploratory factor analysis, including factor loadings and construct structure for the study variables

Reliability and Convergent Validity

The reliability and convergent validity of the measurement scales were assessed using Cronbach’s alpha, composite reliability, and average variance extracted (Table 4). The results demonstrate high internal consistency across all constructs. Cronbach’s alpha values ranged from 0.902 to 0.925, indicating excellent reliability and suggesting that the items within each construct were highly correlated and measured the same underlying concept. Composite reliability values, which provide a more robust estimate of internal consistency in multivariate analysis, ranged from 0.924 to 0.941

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and exceeded the recommended threshold of 0.70. Furthermore, the average variance extracted values ranged from 0.710 to 0.763, surpassing the minimum criterion of 0.50 and confirming strong convergent validity. These findings indicate that each construct accounted for a substantial proportion of the variance in its indicators and that the measurement instrument was both reliable and valid for further hypothesis testing.

Construct	Cronbach's Alpha (α)	Composite Reliability (CR)	Average Variance Extracted (AVE)
Cognitive Skills	0.902	0.924	0.710
AI Adoption	0.914	0.935	0.742
Product Innovation	0.925	0.941	0.763

TABLE 4: This table summarizes the reliability and convergent validity results using Cronbach's alpha, composite reliability, and average variance extracted

AI, artificial intelligence

Structural Model Results

The findings from the study strongly support the proposed model and show that there is a statistically significant relationship between all constructs in the model (Table 5). The results showed that cognitive skill development had a strong positive effect on product innovation ($\beta = 0.742$, $t = 10.25$, $p < .001$), which supports H1. This suggests that those who have greater analytical skills, problem-solving skills, and decision-making skills are more successful in creating innovative products. Also, the analysis revealed a strong positive relationship between cognitive skills and AI adoption ($\beta = 0.658$, $t = 9.12$, $p < .001$), thus substantiating H2. Individuals with greater cognitive abilities seem to have a better ability to grasp, assess, and adopt AI tools in their business practices.

The results further indicated that AI adoption had a significant positive association with product innovation ($\beta = 0.534$, $t = 7.45$, $p < .001$), supporting H3. This discovery suggests that AI technologies can play a role in creating innovative product outcomes in ways that boost decision-making, product development efficiencies, and market responsiveness. In conclusion, the results of the structural modeling confirm that cognitive skills positively influence the adoption of AI and product innovation, while the adoption of AI, in turn, positively influences product innovation, with AI adoption mediating the relationship between cognitive skills and product innovation.

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Hypothesis	Path	β	t-value	p-value	Decision
H1	Cognitive Skills → Product Innovation	0.742	10.25	<0.001	Supported
H2	Cognitive Skills → AI Adoption	0.658	9.12	<0.001	Supported
H3	AI Adoption → Product Innovation	0.534	7.45	<0.001	Supported

TABLE 5: Structural model results

AI, artificial intelligence

Mediation Analysis

A bootstrapping procedure was used to verify whether AI adoption mediated the relationship between cognitive skill development and product innovation, with 5,000 replications. An indirect effect of cognitive skills on product innovation through AI adoption was found to be positive and statistically significant. The indirect effect coefficient was $\beta = 0.351$, with $t = 5.87$ and $p < .001$. The 95% bootstrap confidence interval (CI) did not contain 0 (0.236-0.471), which suggests that there is a significant mediation effect (Table 6). The findings support H4 and indicate that AI's influence on product innovation is partially mediated by cognitive skill development.

Hypothesis	Indirect Path	Indirect Effect (β)	t-value	p-value	95% Bootstrapped Confidence Interval	Result
H4	Cognitive Skills → AI Adoption → Product Innovation	0.351	5.87	< .001	LL = 0.236, UL = 0.471	Supported

TABLE 6: Mediation analysis

AI, artificial intelligence

Discussion

The results of this study indicate that cognitive skills have a positive relationship with entrepreneurs' product innovation and entrepreneurs' AI adoption, and that AI adoption is a mediator in the relationship between cognitive skills and product innovation. This positive correlation between cognitive skills and product innovation aligns with the findings of previous studies, which suggest that analytical thinking, adaptability, and problem-solving skills are linked to the creative

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and innovative aspects of entrepreneurship, particularly in recognizing opportunities in the market (Melisa et al., 2025) (Macnamara et al., 2024). The importance of cognitive flexibility in coping with uncertainty and in fostering innovation in analogous research has received emphasis. The findings of the present study add to this literature because entrepreneurs with higher cognitive capacities are more likely to convert their ideas and insights into new products. The results also corroborate the research carried out by Maroufkhani et al. (Maroufkhani et al., 2023), who suggested that cognitive-related abilities impact innovation performance. The results also show that cognitive skills positively relate to the adoption of AI. This conclusion is consistent with the results obtained in a previous study conducted by Khanfar et al. (Khanfar et al., 2024), who found a correlation between cognitive readiness, analytical judgment, and digital literacy and greater acceptance of AI technologies. Likewise, the theories of technology adoption, like the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), stress the cognitive belief in technology acceptance (Venkatesh et al., 2003). According to the current results, cognitive skills might help entrepreneurs assess, comprehend, and incorporate AI tools into their business operations. The positive correlation between the use of AI and product innovation is similar to the results of the previous studies that have highlighted the influence of AI tools on the ideation process, understanding of customers, productivity in product development, and meeting customer demand (Chatterjee et al., 2021), (Wamba et al., 2017), and (Giuggioli and Pellegrini, 2023). Previous studies have found that AI-powered companies tend to have better abilities to recognize market opportunities and accelerate product development. Based on the results of the present study, the benefits might apply to entrepreneurial businesses in other industries. One of the significant findings of this study is that AI adoption mediates its effect. The results indicate that the relationship between cognitive skills and product innovation is partially mediated by AI adoption, consistent with the current trends in human-AI augmentation. The findings also confirm to some degree the partial mediation effect of AI adoption between cognitive skills and product innovation, consistent with new perspectives regarding human-AI augmentation. Previous researchers Gerlich (Gerlich, 2025) and Lee et al. (Lee et al., 2025) have found that AI reduces mental workload and allows entrepreneurs to concentrate on more complex cognitive functions, such as thinking and creativity. In the same way, Zhang et al. (Zhang et al., 2022) suggested that AI application can enhance the utilization of cognitive ability in innovation output. The results of previous studies were found mainly in large businesses or developed economies, while the current study results indicate that similar patterns may exist in other industry sectors and in other countries as well as among entrepreneurs, which increases the value of the results of the current study. To briefly summarize, the outcomes suggest that cognitive skills have the potential to play a crucial role in entrepreneurial innovation, and that using AI can amplify this impact by utilizing data for decision-making, increasing analytical efficiency, and managing innovation. The results add to the body of knowledge on the importance of integrated cognitive capability and AI adoption strategies in improving entrepreneurial innovation in digital economies (Dwivedi et al., 2021) (Al-Mamary, 2025). Based on the results of this study, the hypothesis is supported that the interaction of human cognitive ability and AI can lead to more entrepreneurial innovations, but further research is needed to substantiate the relationship between them in various situations.

Practical, theoretical, and policy implications

Theoretical Implications

This study makes several important contributions to the existing body of knowledge in entrepreneurship, innovation, and digital transformation. First, it extends the literature on entrepreneurial cognition by empirically demonstrating that cognitive skills are not only directly linked to innovation outcomes but also indirectly influence innovation through technological mechanisms such as AI adoption. This supports the evolving perspective that cognitive capabilities remain central even in highly automated environments. Second, the study advances the understanding of artificial intelligence within entrepreneurship by conceptualizing AI as a mediating construct rather than merely an independent technological variable. This provides a more nuanced explanation of how innovation is generated in digital ecosystems, emphasizing that AI acts as a bridge between human capabilities and innovation performance. Third, the findings contribute to established theoretical models such as the TAM and the UTAUT by integrating cognitive skill development as a key antecedent of AI adoption. This highlights that beyond perceived usefulness and ease of use, internal cognitive readiness plays a critical role in technology acceptance. Finally, the study contributes to the emerging paradigm of

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human-AI collaboration by providing empirical evidence that innovation is increasingly co-created through the interaction between human intelligence and artificial systems. This shifts the theoretical narrative from technology replacing humans to technology augmenting human cognitive capabilities.

Practical Implications

Implications for Entrepreneurs: The findings suggest that entrepreneurs should not rely solely on AI technologies but must actively develop their cognitive skills, including analytical thinking, adaptability, and problem-solving abilities. AI tools are most effective when entrepreneurs are capable of interpreting outputs, questioning results, and making strategic decisions based on insights. Entrepreneurs should therefore invest in continuous learning and skill development to remain competitive in rapidly evolving digital markets. Additionally, entrepreneurs should adopt a balanced approach to AI integration. Over-reliance on AI may reduce critical thinking and lead to poor decision-making if systems are flawed or biased. Therefore, human judgment should always complement AI-driven insights.

Implications for Organizations and Firms: Organizations should focus on building a culture that supports both technological adoption and cognitive development. Firms should invest in employee training programs that enhance AI literacy alongside critical thinking and decision-making skills. Furthermore, organizations should establish internal governance mechanisms to monitor AI usage, ensuring transparency, accountability, and ethical compliance. Integrating AI into business processes should be aligned with organizational strategy rather than implemented as a standalone technological solution.

Implications for Policymakers: Policymakers play a crucial role in facilitating AI adoption within entrepreneurial ecosystems. Governments should develop policies that promote access to AI technologies, particularly for small and medium enterprises that may face financial and technical barriers. In addition, regulatory frameworks should be designed to address ethical concerns such as data privacy, algorithmic bias, and accountability. Supporting innovation hubs, funding AI-based start-ups, and promoting digital infrastructure can further strengthen entrepreneurial ecosystems.

Future research directions

While this study provides important insights into the relationship between cognitive skills, AI adoption, and product innovation, it also opens several avenues for future research. Given the rapidly evolving nature of artificial intelligence and entrepreneurial ecosystems, further investigation is necessary to deepen understanding and enhance the robustness of the findings.

Longitudinal and Causal Research Designs

One of the primary limitations of this study is its cross-sectional design, which restricts the ability to establish causal relationships between variables. Future research should adopt longitudinal approaches to examine how cognitive skills, AI adoption, and innovation evolve over time. Longitudinal studies would allow researchers to track changes in entrepreneurial behavior, technological adoption patterns, and innovation outcomes across different stages of business development. Such approaches would provide stronger evidence of causality and offer insights into whether AI adoption leads to sustained innovation or only short-term improvements.

Additionally, experimental or quasi-experimental designs could be employed to establish clearer cause-and-effect relationships, particularly in controlled environments where variables can be systematically manipulated.

Cross-Country and Cross-Cultural Comparisons

Future studies should explore the role of cultural, institutional, and economic differences in shaping AI adoption and entrepreneurial innovation. The current study is limited to a specific regional context, which may influence the generalizability of the findings. Cross-country comparative research would provide valuable insights into how factors such as technological infrastructure, regulatory environments, cultural attitudes toward innovation, and education systems impact the relationship between cognitive skills and AI adoption.

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For example, entrepreneurs in developed economies with advanced digital ecosystems may experience different challenges and opportunities compared to those in developing countries. Understanding these variations would contribute to a more comprehensive and globally relevant theoretical framework.

Industry-Specific Analysis

Another promising direction for future research is the examination of industry-specific dynamics. Different industries vary significantly in terms of technological intensity, innovation requirements, and AI applicability. Future studies could investigate how the role of cognitive skills and AI adoption differs across sectors such as manufacturing, healthcare, finance, retail, and information technology. For instance, AI may play a more critical role in data-intensive industries, whereas human creativity and intuition may remain dominant in creative sectors. Such industry-level analysis would provide more nuanced insights and enable researchers to develop tailored models that account for sector-specific characteristics.

Moderating and Mediating Variables

While this study focuses on AI adoption as a mediating variable, future research should explore additional mediators and moderators that may influence the relationship between cognitive skills and innovation. Potential moderating variables include organizational culture, leadership style, technological readiness, environmental uncertainty, and resource availability. These factors may strengthen or weaken the impact of cognitive skills and AI adoption on innovation outcomes.

Additionally, other mediating mechanisms such as knowledge management practices, digital transformation strategies, and organizational learning could be examined to provide a more comprehensive understanding of the innovation process.

Qualitative and Mixed-Method Approaches

The current study employs a quantitative research design, which provides statistical evidence of relationships between variables. However, it does not fully capture the lived experiences and perspectives of entrepreneurs. Future research should incorporate qualitative or mixed-method approaches, such as in-depth interviews, case studies, and ethnographic analysis, to gain deeper insights into how entrepreneurs interact with AI technologies in real-world contexts.

Such approaches would help uncover the cognitive processes, decision-making strategies, and challenges faced by entrepreneurs when integrating AI into their business operations, thereby enriching the understanding of the phenomenon.

Conclusions

The current research offers empirical evidence, which shows that the development of cognitive skills, the implementation of AI, and the introduction of new products are closely intertwined in the context of entrepreneurship. The findings demonstrate that entrepreneurs who have better cognitive skills, including analytical thinking, flexibility, and adaptability to problems, are more inclined to utilize AI technologies and have better product innovation outcomes. Meanwhile, the introduction of AI enhances the influence of cognitive skills considerably on innovation by allowing entrepreneurs to process more complicated information, automate processes, and make more accurate and data-driven decisions. One of the most important contributions of the research is the mediating role of AI adoption. The results establish AI as an interface that transforms human cognitive advantages into concrete innovation results. This provides further evidence that innovation in modern digital ecosystems is not only a human endeavor but is more likely to involve human-AI synergy. In this regard, AI serves as a cognitive enhancer, and it increases the ability of the entrepreneur to be creative, identify opportunities, and develop products more effectively. Such findings should be considered complementary to existing research on entrepreneurial cognition and digital innovation because they offer empirical evidence from a large group of entrepreneurs, many of whom are required to work under resource-limited and fast-paced technological conditions. The analysis underscores the theoretical importance of encouraging entrepreneurial ecosystems, training

institutions, and policymakers to invest in the development of cognitive skills as well as AI literacy to equip entrepreneurs to deal with digital transformation. The enhancement of cognitive readiness and access to AI tools can deliver a significant boost to the pace of innovation and help maintain a competitive advantage in the ever-more digitalized economy. In summary, the study has found that the future of entrepreneurial innovation does not merely lie in the adoption of technology but also in the integration of human cognitive abilities with processes driven by AI. With such synergy, entrepreneurs will be in a position to unlock new opportunities, be more innovative, and develop more innovative products in dynamic markets.

Appendices

Survey

Empowering Entrepreneurs: The Mediation Role of AI Adoption in Cognitive Skill and Product Innovation

Please rate your agreement with the following statements using a 7-point scale:

1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neutral, 5 = Somewhat Agree, 6 = Agree, 7 = Strongly Agree

Section 1: Demographics

1. Age: _____
2. Gender: _____
3. Education Level: _____
4. Industry: _____
5. Years of Entrepreneurial Experience: _____

Section 2: AI Adoption

1. I regularly use AI tools in my business operations.
2. AI technologies are integrated into my product development processes.
3. I feel confident using AI tools to support decision-making.
4. AI helps me identify new opportunities for innovation.
5. AI has improved the efficiency and accuracy of my business tasks.

Section 3: Cognitive Skill Development

1. AI tools enhance my ability to solve complex business problems.
2. I use AI to evaluate multiple perspectives before making decisions.
3. AI encourages me to think critically about business strategies.
4. I adapt quickly to new AI technologies and tools.
5. AI motivates me to continuously improve my cognitive and analytical skills.

Section 4: Product Innovation

1. AI helps me generate innovative product ideas.
2. I use AI to explore customer needs and market trends for product development.
3. AI contributes to the design and development of new products.
4. AI has accelerated the time it takes to bring new products to market.

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5. AI has increased the uniqueness and competitiveness of my products.

Participant Information Sheet

Research Project Title: Empowering Entrepreneurs: The Mediation Role of AI Adoption in Cognitive Skill and Product Innovation

1. Purpose of the Study

This research aims to explore how cognitive skill development influences product innovation among entrepreneurs, and whether AI adoption plays a mediating role in this relationship. The study seeks to provide insights into how entrepreneurs can leverage cognitive skills and AI technologies to enhance innovation outcomes.

2. Procedures

Participants will be asked to complete a survey that includes questions about their demographic background, entrepreneurial experience, use of AI tools, cognitive skills, and product innovation practices. The survey is expected to take approximately 10-15 minutes to complete.

3. Confidentiality

All responses will be kept strictly confidential and used solely for research purposes. Data will be anonymized and stored securely. No personally identifiable information will be disclosed in any reports or publications resulting from this study.

4. Voluntary Participation

Participation in this study is entirely voluntary. You may choose to withdraw at any time without any consequences. You may also skip any questions you do not wish to answer.

5. Risks and Benefits

There are no known risks associated with participating in this study. The potential benefit includes contributing to research that may help entrepreneurs better understand the role of cognitive skills and AI in driving innovation.

6. Contact Information

If you have any questions about this study or your participation, please contact the research team at:

Email: E4371566@tees.ac.uk

Phone: +447402833633

Participant Consent Form

Research Project Title: Empowering Entrepreneurs: The Mediation Role of AI Adoption in Cognitive Skill and Product Innovation

Purpose of the Study

You are invited to participate in a research study conducted by [Researcher's Name] from [Institution Name]. The purpose of this study is to explore how cognitive skill development influences product innovation and AI adoption among entrepreneurs, and to examine the mediating role of AI adoption in this relationship.

Procedures

If you agree to participate in this study, you will be asked to complete a survey that includes questions about your experiences with AI tools, your cognitive skills, and your involvement in product innovation. The survey will take approximately 10-15 minutes to complete.

Voluntary Participation

Your participation in this study is entirely voluntary. You may choose not to participate or to withdraw at any time without any consequences. You may also skip any questions that you do not wish to answer.

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Confidentiality

All information collected in this study will be kept confidential. Your responses will be anonymized and stored securely. Only the research team will have access to the data, and results will be reported in a way that does not identify individual participants.

Risks and Benefits

There are no known risks associated with participating in this study. While there may be no direct benefits to you, your participation will contribute to a better understanding of the role of cognitive skills and AI adoption in entrepreneurial innovation.

Contact Information

If you have any questions about this study or your participation, please contact:

Arshad Mehmood Raja

Email: E4371566@tees.ac.uk

Participant Agreement

I have read and understood the information provided above. I understand that my participation is voluntary and that I can withdraw at any time. I consent to participate in this research study.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Arshad M. Raja

Acquisition, analysis, or interpretation of data: Arshad M. Raja

Drafting of the manuscript: Arshad M. Raja

Critical review of the manuscript for important intellectual content: Arshad M. Raja

Supervision: Arshad M. Raja

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. Business School Research Ethics Sub-Committee issued approval (2026 Jun 34572 RAJA). **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Data Availability Statements

The datasets (and/or code) supporting this study are available from the corresponding author upon reasonable request.

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