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Digital Information Systems on Business Agility and Innovation in the Era of Industry 6.0

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Abstract
The primary objective of this study is to analyze the impact of advanced digital information systems on business agility and innovation within the industry 6.0 framework. Novelty in this research is to develop new dimension of digital information systems, business agility, and innovation. In this quantitative research, data will be collected using a structured questionnaire. The data will then be analyzed using Structural Equation Modeling. The sample size will be a minimum of 210 respondents, in accordance with SEM guidelines. The study confirms that Digital Information Systems (DIS) significantly improve Business Agility and that Business Agility positively influences Innovation. However, Digital Information Systems do not directly improve Innovation. Instead, Business Agility acts as a mediator, meaning that Digital Information Systems enhances Innovation indirectly through Business Agility. This finding highlights the indirect role of Digital Information Systems in fostering Innovation. Simply adopting digital systems is not enough to drive Innovation; rather, organizations must leverage these systems to enhance their agility, which in turn facilitates innovation. Future research should incorporate qualitative approaches (e.g., case studies, expert interviews) to better understand the mechanisms behind agility-driven innovation.

Keywords: Digital Information System, Business Agility, Innovation
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1.0 INTRODUCTION

The rapid evolution of digital technologies has led to significant transformations in the global business landscape (Junaedi et al., 2024). The emergence of Industry 6.0 introduces a new paradigm where advanced technologies such as artificial intelligence (AI), quantum computing, blockchain, edge computing, and hyper-automation seamlessly integrate to enhance business operations (Junaedi, Renaldo, Sudarno, et al., 2023; Renaldo et al., 2023). Unlike previous industrial revolutions, Industry 6.0 emphasizes human-AI collaboration, sustainability, and ultra-intelligent automation, driving businesses to adopt more sophisticated digital information systems (Mukhsin et al., 2024).

In this digital era, business agility and innovation are critical factors for organizational success (Putra & Kudri, 2024). Digital Information Systems (DIS) provide real-time data processing, automation, and predictive analytics, enabling companies to respond swiftly to market dynamics. However, the extent to which these systems influence business agility and innovation in the Industry 6.0 framework remains an area requiring further exploration. This research seeks to fill this gap by examining the impact of next-generation digital information systems on business agility and innovation in various industries.

The rapid advancement of Industry 6.0 is revolutionizing the way businesses operate, driven by the seamless integration of artificial intelligence (AI), quantum computing, blockchain, edge computing, and hyper-automation. Unlike previous industrial revolutions that focused on automation and digitalization, Industry 6.0 emphasizes human-AI collaboration, self-optimizing systems, and sustainable digital transformation (Renaldo, 2024b).

One of the most significant shifts in this era is the role of Digital Information Systems (DIS) in enhancing business agility and innovation. Companies are no longer relying solely on traditional ERP and CRM systems; instead, they are adopting AI-powered analytics, decentralized blockchain networks, and IoT-driven smart systems to make real-time decisions and optimize operations.

However, despite the promising potential of these technologies, businesses face several challenges in their adoption (Nyoto et al., 2023):

- Complexity of Integration – Many organizations struggle to integrate new Industry 6.0 digital systems with legacy IT infrastructures.
- Cybersecurity Risks – As businesses become more interconnected, data breaches and cyber threats pose significant risks to operational continuity.
- Skills Gap – The workforce must adapt to new roles that require a combination of AI, data science, and system automation expertise.
- High Implementation Costs – Advanced digital information systems require substantial investment in technology, training, and infrastructure.
- Regulatory Uncertainty – The absence of clear regulations regarding AI ethics, data privacy, and digital security creates barriers for businesses adopting Industry 6.0 systems.

These challenges create a phenomenon where businesses must strike a balance between leveraging cutting-edge digital systems for agility and innovation while overcoming the barriers to adoption and risks associated with rapid technological transformation (Mehmood et al., 2024). The extent to which businesses can successfully navigate these challenges will determine their competitiveness and sustainability in the Industry 6.0 era.

The field of digital information systems has undergone continuous advancement, evolving from traditional Enterprise Resource Planning (ERP) systems to AI-powered decision-support systems that leverage machine learning, big data analytics, and blockchain technology. The existing literature highlights several key developments:

- AI-Driven Digital Systems – Recent studies indicate that AI-powered systems enhance decision-making, automate repetitive tasks, and improve efficiency in business operations (Smith & Johnson, 2023).
- Blockchain for Secure Information Management – Blockchain-based digital systems ensure data integrity, reducing fraud risks and enhancing trust in digital transactions (Lee et al., 2022).
- Edge Computing and IoT – Real-time data processing using edge computing and IoT devices enables businesses to respond to market changes with minimal latency (Martinez et al., 2021).
- Hyper-Automation and Robotics – Companies adopting hyper-automation have reported significant improvements in productivity and cost reduction (Kumar & Patel, 2024).
- Sustainability and Green IT – The integration of sustainable digital systems in Industry 6.0 focuses on reducing energy consumption while maintaining high performance (Chen & Wang, 2023).

The primary objective of this study is to analyze the impact of advanced digital information systems on business agility and innovation within the Industry 6.0 framework (Renaldo, 2024a). Specifically, this research aims to:

- Examine how AI-driven digital information systems enhance business agility in highly dynamic markets.
- Develop a conceptual framework for integrating hyper-automation and digital intelligence into corporate strategies for sustainable innovation.
- Provide policy recommendations for businesses seeking to leverage Industry 6.0 technologies for competitive advantage.
- Develop new dimensions for Digital Information Systems, Business Agility and Innovation.

2.0 LITERATURE REVIEW

Dynamic Capabilities Theory (DCT) – Teece, Pisano, & Shuen (1997)

The Dynamic Capabilities Theory (DCT) suggests that firms must continuously develop their ability to sense, seize, and transform resources to maintain a competitive advantage in a rapidly changing environment (Vuchkovski et al., 2023). Digital Information Systems (DIS) enable firms to sense market trends, seize opportunities, and reconfigure resources efficiently. AI, blockchain, and cloud-based DIS support firms in transforming their business models and driving innovation. Businesses must integrate cognitive AI, real-time data analytics, and hyper-automation to stay competitive. Teece (2020) emphasized the role of AI-powered digital systems in enhancing business agility. Wamba et al. (2022) found that firms using real-time digital platforms have faster innovation cycles.

Digital Information Systems and Business Agility

Business agility refers to an organization's ability to rapidly adapt to market changes, customer demands, and technological disruptions (Marillo et al., 2024). Digital Information Systems (DIS) play a crucial role in enabling business agility by providing real-time data access, predictive analytics, and automated decision-making.

- AI-Driven Decision Support Systems – Research by (Renaldo, Jollyta, et al., 2022) highlights that AI-integrated information systems enhance agility by automating routine decision-making and forecasting market trends.

- Cloud Computing and Agility – Studies show that businesses leveraging cloud-based digital systems can scale operations quickly and adapt to fluctuating demands (Mukhsin et al., 2023).
- Edge Computing and IoT – (Renaldo, 2024c) argue that edge computing reduces latency in data processing, enabling businesses to respond in real time to operational and market fluctuations.

Digital Information Systems and Innovation

Innovation is a key driver of competitive advantage in Industry 6.0. Organizations that leverage big data, AI, blockchain, and automation in their digital information systems tend to outperform competitors in product and process innovation (Zulkifli et al., 2023).

- Big Data Analytics for Innovation – Big data-driven insights enable companies to identify new market opportunities, personalize customer experiences, and develop innovative business models (Renaldo et al., 2024).
- Blockchain for Secure Innovation – Blockchain-based digital information systems enhance data integrity, transparency, and decentralized decision-making, fostering innovation in digital finance and supply chain management (Hadi et al., 2023).
- Hyper-Automation and AI-Powered Systems – Businesses adopting hyper-automation (AI, machine learning, and robotic process automation) experience faster innovation cycles and cost-efficient product development.

Industry 6.0: A New Digital Business Paradigm

Industry 6.0 represents an evolution beyond Industry 4.0 and 5.0, focusing on human-AI collaboration, intelligent automation, and sustainable innovation (Williams et al., 2024). Key features include (Suhardjo et al., 2024):

- Cognitive AI Systems – Unlike traditional AI, cognitive AI systems in Industry 6.0 can self-learn, adapt, and work alongside human decision-makers (Nifise et al., 2024).
- Quantum Computing in Business – Quantum computing accelerates complex data processing, enabling real-time strategic decision-making in finance, logistics, and healthcare (Xu et al., 2024).
- Sustainability-Driven Digital Systems – Green IT and energy-efficient digital architectures are becoming essential in Industry 6.0, aligning with global sustainability goals (Renaldo, Hafni, et al., 2022).

Hypothesis

H1: Digital Information Systems improves Business Agility
H2: Digital Information Systems improves Innovation
H3: Business Agility improves Innovation
H4: Digital Information Systems increases Innovation through Business Agility

Research Framework

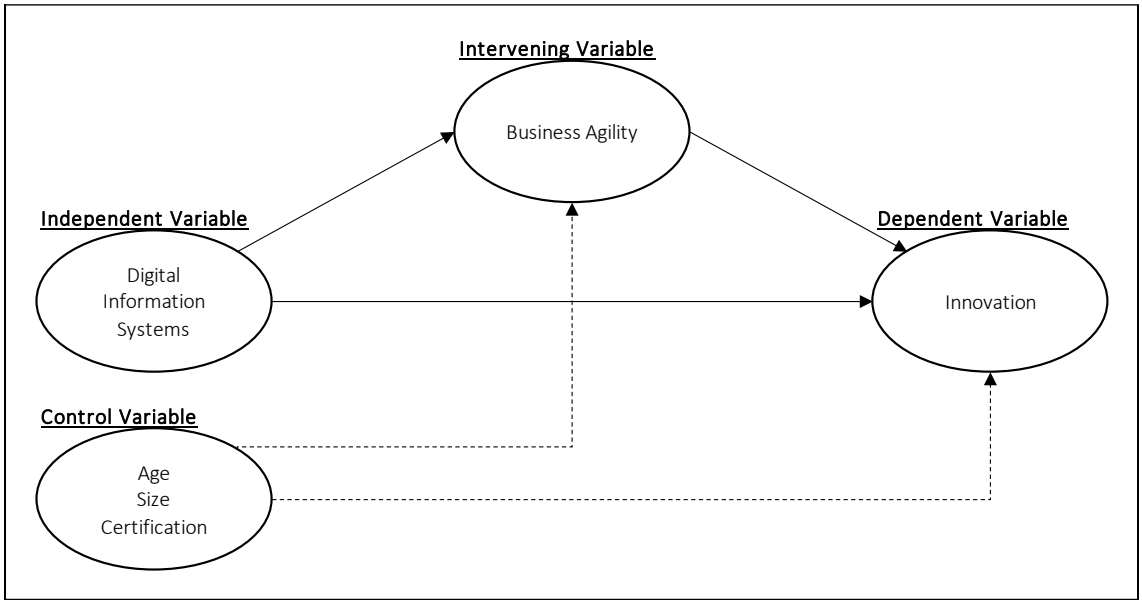

Figure 1. Research Framework

3.0 METHODOLOGY

Research Design

This quantitative study will utilize a structured questionnaire to gather data, employing a 6-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) to assess participants' responses (Sekaran & Bougie, 2016). The collected

data will be analyzed using various techniques, including descriptive statistics to summarize dataset characteristics, validity and reliability tests to ensure measurement accuracy and consistency, and Structural Equation Modeling (SEM) to explore variable relationships and test the proposed hypotheses. These analytical methods will provide valuable insights into underlying patterns and relationships, facilitating a comprehensive examination of the research questions.

Population and Sample

This study targets companies and industries that have adopted Digital Information Systems (DIS) in the Industry 6.0 era. These businesses span various sectors, leveraging advanced digital technologies to enhance agility and drive innovation. Given the impracticality of examining the entire population, a sample will be selected using purposive sampling, focusing on companies that actively implement DIS and have documented innovation initiatives. The sample will consist of at least 210 respondents, following SEM guidelines, which recommend a minimum of 10 times the number of dimensions in the questionnaire (18 indicators and 3 control variables) to ensure robust and reliable results (Hair et al., 2019). This sampling strategy ensures the relevance and adequacy of the sample, forming a strong basis for hypothesis testing and analyzing the relationships between variables.

Variable Operationalizations

The operationalization of variables is detailed in Appendix 1. This study incorporates firm age (Age), firm size (Size), and certification as control variables. Age is determined by the number of years since the firm's establishment, while Size is assessed based on the total number of employees. Certification is measured by the number of digital certifications the firm has obtained.

Descriptive Statistics

Descriptive statistics provide an overview of the demographic and operational characteristics of both respondents and companies (Lind et al., 2018). The company profile includes information such as industry type, company size, and years in operation, offering context for the organizational environment in which the study is conducted. Meanwhile, the respondent profile captures key details like job title, years of experience, and educational background to better understand participant demographics and their relevance to the research. Regarding key variables, the study will report statistical measures such as mean, median, mode, standard deviation, minimum, and maximum values, providing insights into data distribution, central tendencies, and variability among respondents. These statistical insights will contribute to a thorough analysis of the data and the relationships between the examined variables.

Validity and Reliability Test

To assess validity, the outer loadings test is applied, requiring values greater than 0.4 (for a sample of 210) to confirm the adequacy of the sample for further analysis. Additionally, the average variance extracted (AVE) must exceed 0.5 to ensure that each item is effectively represented by its corresponding factor. For reliability, Cronbach's Alpha is used to evaluate the internal consistency of the scales, with a threshold of 0.7 or higher indicating acceptable reliability, meaning the items within each scale consistently measure the same construct. This study also employs discriminant validity, ensuring that all results remain below 0.8. These validation and reliability measures enhance the robustness and dependability of the research's measurement instruments.

Multicollinearity Test

The multicollinearity test is used to assess the correlation between independent variables in a research model. A well-fitting model is identified by the Variance Inflation Factor (VIF), which should be below 10. If the VIF meets this criterion, the subsequent analysis can proceed.

Model Test

This test evaluates the proportion of variance explained by the independent variables in the dependent variables. A higher R^2 value indicates stronger explanatory power, representing the first model test. The second test is the f-square test, where a higher value suggests a stronger effect from the independent variable. The final test is predictive relevance (Q^2), and the Q^2 value is calculated using the following formula:

$$Q^2 = 1 - (1 - R_1^2)(1 - R_2^2) \ldots (1 - R_n^2)$$

Predictive relevance is a test used to assess the quality of observation values generated through the blindfolding procedure by examining the Q^2 value. If the Q2 value is greater than 0, it indicates good observation quality, whereas a Q^2 value less than 0 suggests poor observation quality. For structural models, Q^2 predictive relevance measures how effectively the model produces conservation values and its parameter estimates. A Q^2 value greater than 0 signifies that the model has predictive relevance, while a Q^2 value of 0 or less indicates lower predictive relevance. The higher the Q^2 value, the greater the predictive relevance. Ideally, all three model tests should yield high values.

Model Fit Analysis

This study uses AMOS which has several criteria such as Chi-square, P value, Chi-square/df, RMSEA, GFI, AGFI, PGFI, SRMR, NFI, TLI, CFI, AIC, and BIC. The criteria will be seen in table 8.

Structural Equation Modeling Analysis

This study employs Structural Equation Modeling (SEM) to examine the impact of independent, intervening, and control variables on the dependent variable. The SEM analysis is conducted using CB-SEM through SMART PLS. The structural equations developed are as follows:

$$\text{Business Agility} = a_1 \text{ Digital Information Systems} + a_2 \text{ Age} + a_3 \text{ Size} + a_4 \text{ Blue Certification} + e_1$$

$$\text{Innovation} = a_5 \text{ Digital Information Systems} + a_6 \text{ Business Agility} + a_7 \text{ Age} + a_8 \text{ Size} + a_9 \text{ Blue Certification} + e_2$$

Hypothesis Testing

Path coefficients (β) from SEM will be used to test the direct relationships between variables. A p-value less than 0.05 indicates a significant relationship. Standardized coefficients (β) will help determine the strength and direction of these relationships.

Mediation Test

Baron & Kenny's method is used to evaluate whether the mediator reduces the direct effect between the independent and dependent variables. SEM is employed to test the indirect effects, with a p-value less than 0.05 indicating significant indirect effects. This study may also use the Sobel Test or bootstrapped confidence intervals for further analysis.

4.0 RESULTS AND DISCUSSION

Descriptive Statistics

Table 1. Descriptive Statistics Output (Metric Type and No Missings)

Name	No.	Mean	Median	Scale min	Scale max	Observed min	Observed max	Standard deviation	Excess kurtosis	Skewness	Cramér-von Mises p value
X1.1	1	4.47	4	3	6	3	6	0.656	-0.169	0.175	0
X1.2	2	4.51	5	3	6	3	6	0.619	-0.284	-0.018	0
X1	3	4.49	4.5	3	6	3	6	0.493	0.441	0.088	0
X2.1	4	4.52	5	3	6	3	6	0.677	-0.201	0.006	0
X2.2	5	4.53	5	3	6	3	6	0.618	-0.288	0.012	0
X2	6	4.53	4.5	3	6	3	6	0.524	0.362	-0.030	0
X3.1	7	4.54	5	3	6	3	6	0.641	-0.203	-0.089	0
X3.2	8	4.53	5	3	6	3	6	0.656	-0.232	0.131	0
X3	9	4.54	4.5	3	6	3	6	0.519	0.192	0.062	0
Z1.1	10	4.50	5	3	6	3	6	0.596	-0.404	-0.068	0
Z1.2	11	4.48	4	3	6	3	6	0.595	-0.386	0.142	0
Z1	12	4.49	4.5	3	6	3	6	0.439	0.531	-0.175	0
Z2.1	13	4.59	5	3	6	3	6	0.613	-0.179	-0.207	0
Z2.2	14	4.58	5	3	6	3	6	0.694	-0.308	0.181	0
Z2	15	4.58	4.5	3	6	3	6	0.520	0.524	0.070	0
Z3.1	16	4.51	4	3	6	3	6	0.671	-0.205	0.108	0
Z3.2	17	4.53	5	3	6	3	6	0.618	-0.258	-0.128	0
Z3	18	4.52	4.5	3	6	3	6	0.471	0.702	-0.052	0
Y1.1	19	4.60	5	3	6	3	6	0.783	-0.344	-0.169	0
Y1.2	20	4.46	4	3	6	3	6	0.769	-0.333	0.145	0
Y1	21	4.53	4.5	3	6	3	6	0.653	0.338	0.135	0
Y2.1	22	4.49	4	3	6	3	6	0.788	-0.406	0.179	0
Y2.2	23	4.49	4	3	6	3	6	0.738	-0.278	0.140	0
Y2	24	4.49	4.5	3	6	3	6	0.642	0.133	0.172	0
Y3.1	25	4.51	5	3	6	3	6	0.751	-0.315	0.001	0
Y3.2	26	4.50	5	3	6	3	6	0.782	-0.398	-0.060	0
Y3	27	4.51	4.5	3	6	3	6	0.656	-0.079	-0.247	0
Age	28	4.07	4	1	6	1	6	1.123	0.698	-0.802	0
Size	29	3.94	4	2	6	2	6	0.931	-0.870	0.017	0
Certification	30	4.04	4	1	6	1	6	0.990	-0.567	-0.225	0

Source: Processed data, 2024

The results of the descriptive statistical tests indicate that the variables of digital information systems, business agility, and innovation, measured using a 6-point Likert scale, yield favorable results. The average age of the

companies is 4 years, with company size falling in category 4, representing 151-200 employees. Additionally, each company holds an average of 4 certifications related to digital matters.

Validity and Reliability Test

Table 2. Loading Factor Output

	Outer loadings (standardized)
X1 <- Digital Information Systems	0.559
X2 <- Digital Information Systems	0.663
X3 <- Digital Information Systems	0.617
Y1 <- Innovation	0.659
Y2 <- Innovation	0.716
Y3 <- Innovation	0.775
Z1 <- Business Agility	0.526
Z2 <- Business Agility	0.605
Z3 <- Business Agility	0.618
Age <- Age	1.000
Certification <- Certification	1.000
Size <- Size	1.000

Source: Processed data, 2024

The results of the outer loadings test show that all values exceed 0.4, indicating that all indicators are valid and the analysis can proceed to the next stage.

Table 3. Construct Reliability and Validity Output

	Cronbach's alpha (standardized)	Cronbach's alpha (unstandardized)	Composite reliability (rho_c)	Average variance extracted (AVE)
Digital Information Systems	0.636	0.637	0.646	0.378
Business Agility	0.626	0.625	0.609	0.341
Innovation	0.783	0.783	0.761	0.516
Age	1.000	1.000	1.000	1.000
Size	1.000	1.000	1.000	1.000
Certification	1.000	1.000	1.000	1.000

Source: Processed data, 2024

The analysis results show that all reliability criteria are above 0.7, and the AVE value is greater than 0.5. This indicates that the criteria have been met, allowing the analysis to proceed to the next stage.

Table 4. Discriminant Validity Output

	Age	Business Agility	Certification	Digital Information Systems	Innovation	Size
Age						
Business Agility	0.147					
Certification	0.096	0.292				
Digital Information Systems	0.236	0.965	0.280			
Innovation	0.252	1.080	0.318	1.044		
Size	0.010	0.380	0.127	0.338	0.336	

Source: Processed data, 2024

The analysis results reveal that nearly all outcomes of the discriminant validity test are below 0.8, indicating that the requirements for discriminant validity have been met, allowing the analysis to proceed to the next stage.

Multicollinearity Test

Table 5. Multicollinearity Test Output

	VIF
X1	1.167
X2	1.368
X3	1.305
Y1	1.542
Y2	1.630
Y3	1.779
Z1	1.178
Z2	1.254
Z3	1.347
Age	1.000
Size	1.000
Certification	1.000

Source: Processed data, 2024

The test results show that all VIF values are below 10, indicating that the research model is free from multicollinearity issues and can proceed to the next stage of analysis.

Model Test

Table 6. Coefficient Determination Test Output

	R-square
Business Agility	0.846
Innovation	0.810

Source: Processed data, 2024

Based on the test results for the business agility variable, the R-square value is 0.846. This means that the variables digital information systems, age, size, and certification have an effect of 84.6% on innovation, while the rest is influenced by other factors. While the R-square value for the innovation variable is 0.810. This means that the variables digital information systems, business agility, age, size, and certification have an effect of 81.0% on innovation, while the rest is influenced by other factors.

Table 7. f-square Test Output

	f-square
Age -> Business Agility	0.000
Age -> Innovation	0.023
Business Agility -> Innovation	0.463
Certification -> Business Agility	0.013
Certification -> Innovation	0.017
Digital Information Systems -> Business Agility	0.429
Digital Information Systems -> Innovation	0.347
Size -> Business Agility	0.030
Size -> Innovation	0.005

Source: Processed data, 2024

Based on the results of the f-square test, it can be seen that the dominance of the results has a large number. This means that most of the independent variables have a good influence on the digital performance and sustainability variables.

In calculating predictive relevance (Q^2), it is obtained based on the following calculations:

$$Q^2 = 1 - (1 - 0.846)\ (1 - 0.810) = 0.971$$

This means that the model in this study has a relevant predictive value, where the model used can explain the information in the research data by 97.1%.

Table 8. CB-SEM Fit Model

	Cut-off	Estimated model	Information
Chi-square	Small	89.513	Fit
Number of model parameters		30	
Number of observations		210	
Degrees of freedom		48	
P value	> 0.05	0.000	Marginal Fit
ChiSqr/df	< 2	1.865	Fit
RMSEA	< 0.05	0.064	Marginal Fit
RMSEA LOW 90% CI	< 0.08	0.043	Fit
RMSEA HIGH 90% CI	< 0.1	0.085	Fit
GFI	> 0.9	0.934	Fit
AGFI	> 0.9	0.893	Marginal Fit
PGFI	> 0.5	0.575	Fit
SRMR	< 0.08	0.099	Marginal Fit
NFI	> 0.9	0.887	Marginal Fit
TLI	> 0.9	0.921	Fit
CFI	> 0.9	0.943	Fit
AIC	Lower is better	149.513	Fit
BIC	Lower is better	249.927	Fit

Source: Processed data, 2024

Based on the research results, it can be seen that most of the CB-SEM criteria have met the fit criteria. Therefore, this research can be continued to the next stage.

Structural Equation Modeling Analysis

Table 9. Structural Equation Modeling Output

	Parameter estimates	Standard errors	T values	P values (1-tailed)	Results
Digital Information Systems -> Business Agility	0.737	0.134	5.494	0.000	Accepted in 1%
Digital Information Systems -> Innovation	0.137	0.866	0.159	0.437	Rejected
Business Agility -> Innovation	1.843	1.124	1.639	0.052	Accepted in 10%
Age -> Business Agility	-0.002	0.015	0.158	0.438	
Age -> Innovation	0.039	0.024	1.631	0.052	
Size -> Business Agility	0.046	0.019	2.434	0.008	
Size -> Innovation	-0.023	0.058	0.402	0.344	
Certification -> Business Agility	0.027	0.017	1.564	0.060	
Certification -> Innovation	0.016	0.039	0.409	0.342	

Source: Processed data, 2024

Based on the results of SEM testing, it can be seen that all variables have a positive influence on both digital performance and sustainability. The resulting structural equations are as follows:

Business Agility = 0.737 Digital Information Systems – 0.002 Age + 0.046 Size + 0.027 Certification

Innovation = 0.137 Digital Information Systems + 1.843 Business Agility + 0.039 Age – 0.023 Size + 0.016 Certification

Table 10. Mediation Test Output

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values (1-tailed)
Digital Information Systems -> Business Agility -> Innovation	0.259	0.259	0.036	7.088	0.000
Age -> Business Agility -> Innovation	0.001	0.000	0.029	0.029	0.489
Size -> Business Agility -> Innovation	0.066	0.067	0.030	2.191	0.014

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values (1-tailed)
Certification -> Business Agility -> Innovation	0.042	0.042	0.026	1.640	0.051

Source: Processed data, 2024

Hypothesis Testing

The results of the one-tailed SEM test indicate that some hypotheses are accepted while others are rejected, with the following details:

H1: Digital Information Systems improves Business Agility, accepted in 1%

H2: Digital Information Systems improves Innovation, rejected

H3: Business Agility improves Innovation, accepted in 10%

To assess hypothesis 3, we use mediation test result, with the following details:

H4: Digital Information Systems increases Innovation through Business Agility, Accepted in 1%

Discussion

Digital Information Systems improves Business Agility

Digital Information Systems (DIS) play a crucial role in enhancing Business Agility by enabling organizations to respond swiftly to market changes, technological advancements, and customer demands. The integration of advanced digital systems, such as cloud computing, AI-driven analytics, real-time data processing, and automation, allows businesses to make faster, data-driven decisions, optimize workflows, and adapt to emerging challenges efficiently.

Business Agility refers to a company's ability to sense opportunities and threats, respond quickly, and continuously innovate. DIS enhances this by:

1. Real-Time Decision Making – Digital systems provide instant access to data, allowing companies to make timely and informed decisions in response to market fluctuations.
2. Process Automation & Efficiency – Automating business operations reduces manual delays and inefficiencies, improving response time.
3. Collaboration & Flexibility – Cloud-based platforms and digital communication tools enhance cross-functional collaboration, enabling agile adaptation to changes.
4. Predictive Analytics & AI – Machine learning and predictive analytics help anticipate market trends, allowing companies to proactively adjust their strategies.

The Dynamic Capabilities Theory (Teece, Pisano, & Shuen, 1997) states that organizations sustain a competitive advantage by continuously developing, integrating, and reconfiguring their resources to adapt to dynamic environments.

Digital Information Systems align with Dynamic Capabilities Theory in three key ways:

1. Sensing (Identifying Opportunities & Threats)
   - Digital systems enable firms to collect and analyze real-time market data (e.g., customer preferences, competitor strategies).
   - AI and big data analytics help identify emerging trends, allowing businesses to seize opportunities faster.
2. Seizing (Responding with Strategic Actions)
   - Cloud-based ERP, CRM, and automation tools enhance decision-making speed and efficiency.
   - Businesses can quickly pivot their strategies based on digital insights, improving agility.
3. Transforming (Continuous Innovation & Adaptation)
   - Digital transformation allows businesses to reconfigure their processes, structures, and business models for sustained agility.
   - Companies adopting IoT, blockchain, and AI-driven innovation can continuously evolve, ensuring long-term success.

Digital Information Systems improves Innovation

While Digital Information Systems (DIS) enhance data processing, communication, and decision-making, they do not inherently drive innovation. Innovation requires creativity, strategic vision, and an organizational culture that fosters experimentation and risk-taking—factors that cannot be fully automated or digitized.

Key reasons why DIS does not directly improve innovation:

a. Technology is a Tool, Not an Innovator
   - Digital systems provide infrastructure (e.g., data storage, AI, automation) but do not generate new ideas on their own.

- Innovation stems from human creativity, leadership, and collaboration, which cannot be replaced by technology.

b. Dependency on Organizational Culture
   - Even with advanced digital tools, companies without an innovation-driven culture struggle to generate breakthrough ideas.
   - Firms must actively encourage risk-taking and experimentation beyond just implementing digital systems.

c. Lack of Strategic Integration
   - Many organizations invest in digital transformation but fail to align it with strategic innovation goals.
   - Simply having digital systems does not guarantee market-disrupting innovations—it depends on how they are used.

d. Focus on Efficiency Over Creativity
   - DIS is primarily designed to optimize operations, reduce costs, and improve decision-making, not necessarily to generate innovation.
   - Innovation requires a mindset shift, not just digital efficiency.

According to Dynamic Capabilities Theory (Teece, Pisano, & Shuen, 1997), firms sustain competitive advantage by continuously sensing opportunities, seizing them, and transforming their resources. The explanations are:

1. Sensing – Digital systems help companies collect and analyze data, but identifying innovative opportunities still requires human intuition and strategic foresight.
2. Seizing – Even with digital tools, firms must have agile leadership and a risk-taking culture to capitalize on new opportunities.
3. Transforming – Successful innovation depends on a firm's ability to reconfigure its resources, processes, and mindset, not just its technology.

Business Agility improves Innovation

Business Agility enhances a company's ability to sense opportunities, respond quickly, and continuously adapt, creating an environment that fosters innovation. Agile organizations can experiment, iterate, and scale new ideas rapidly, making them more likely to develop breakthrough products, services, or business models.

Key reasons why Business Agility improves Innovation:

a. Faster Adaptation to Market Changes
   - Agile firms quickly respond to customer demands and technological advancements, enabling them to stay ahead of competitors in innovation.
   - The ability to pivot and implement new ideas ensures that companies remain at the forefront of industry trends.

b. Encouragement of Risk-Taking & Experimentation
   - Business Agility reduces bureaucratic barriers, allowing companies to test and refine innovative ideas without excessive delays.
   - Agile firms embrace a fail-fast, learn-fast culture, leading to more breakthrough innovations.

c. Enhanced Cross-Functional Collaboration
   - Agile businesses promote teamwork across departments, integrating insights from R&D, marketing, customer service, and technology.
   - This cross-functional approach drives creativity and innovation by combining different perspectives.

d. Improved Resource Allocation
   - Agile firms quickly reallocate resources to support promising innovations, rather than being stuck in rigid long-term planning cycles.
   - This flexibility ensures that new ideas receive funding, talent, and technological support faster.

According to Dynamic Capabilities Theory (Teece, Pisano, & Shuen, 1997), firms maintain competitive advantage by developing capabilities that allow them to sense opportunities, seize them, and transform their resources. Business Agility is a critical enabler of these dynamic capabilities:

a. Sensing (Opportunity Recognition)
   - Agile firms continuously scan the environment for emerging market trends, customer needs, and technological advancements.
   - This allows them to identify innovation opportunities faster than less agile competitors.

b. Seizing (Strategic Response)
   - Once an opportunity is identified, agile firms quickly mobilize resources to develop new products, services, or business models.

- Agility ensures that organizations can implement innovative ideas efficiently before market conditions change.

c. Transforming (Continuous Evolution)
   - Business Agility supports continuous reconfiguration of structures, processes, and strategies to sustain long-term innovation.
   - Agile firms embrace change and develop organizational learning capabilities, ensuring they can innovate repeatedly over time.

Digital Information Systems increases Innovation through Business Agility

Digital Information Systems (DIS) provide the technological foundation that enhances Business Agility, which in turn fosters innovation. While DIS alone does not directly drive innovation, it enables organizations to become more agile by improving data-driven decision-making, operational flexibility, and responsiveness to change. This increased agility then allows companies to experiment, iterate, and implement innovative solutions more effectively.

1. Digital Information Systems Enable Business Agility
   - Real-Time Data for Faster Decisions: DIS provides accurate, real-time information, enabling businesses to respond quickly to market shifts and customer needs.
   - Automation and Process Efficiency: Digital tools streamline workflows, reduce manual effort, and allow companies to allocate resources dynamically, improving agility.
   - Cloud and AI-Driven Flexibility: Cloud computing, AI, and big data analytics help firms quickly scale operations and adapt strategies, increasing agility.
2. Business Agility Drives Innovation
   - Faster Experimentation and Prototyping: Agile businesses test new ideas quickly, reducing the time from concept to market.
   - Adaptive Market Strategies: Agility enables companies to identify emerging trends early and develop innovative solutions ahead of competitors.
   - Collaborative Innovation: Agile structures break down silos, fostering cross-functional teamwork and idea-sharing that enhance innovation.

According to Dynamic Capabilities Theory (Teece, Pisano, & Shuen, 1997), firms must develop capabilities to sense opportunities, seize them, and transform their resources to maintain a competitive edge. The explanations are:

1. Sensing: Digital Information Systems help businesses analyze vast amounts of data, identifying innovation opportunities.
2. Seizing: Business Agility ensures that organizations act on insights quickly, transforming ideas into innovative products and services.
3. Transforming: Continuous innovation is supported by reconfiguring internal processes and adapting to changing environments through agility.

Age, Size, and Certification Improve Business Agility

Firm age does not improve business agility, firm size improves business agility, and certification improves business agility. As firms age, they develop complex hierarchical structures, which slow down decision-making and reduce flexibility (Bureaucratic Inertia). Long-established businesses may hesitate to adopt new technologies or adapt to changing market conditions due to entrenched routines and legacy systems (Resistance to Change). Older firms tend to prioritize stability over experimentation, making them less responsive to dynamic environments (Risk Aversion). While firm age may bring experience and industry knowledge, it does not necessarily translate into agility. Instead, agility depends on organizational mindset and adaptability, not just years in business.

Contrary to common assumptions, larger firms can leverage their resources, technology, and economies of scale to enhance agility. While small firms may be inherently flexible, large firms can achieve agility by leveraging digital transformation, decentralizing decision-making, and fostering agile leadership. Large firms have better financial capacity to invest in AI, big data analytics, and digital platforms, which improve responsiveness (Access to Advanced Technology). Larger organizations can afford to establish separate innovation units or R&D departments focused on agility-driven projects (Dedicated Innovation Teams). Large firms operate in multiple markets, enabling them to rapidly shift strategies in response to changing conditions (Global Presence and Diversification). Many successful corporations (e.g., Amazon, Google, Tesla) implement agile management techniques, proving that size does not necessarily hinder agility (Agile Frameworks in Large Firms).

Certifications (e.g., ISO 9001, Agile, Six Sigma) enhance agility by enforcing structured yet adaptable frameworks that help firms respond efficiently to market changes. Certifications promote efficient workflows that allow for quick pivots without sacrificing quality (Standardized Yet Flexible Processes). Certified firms gain competitive advantages, enabling faster entry into new markets and supply chains (Enhanced Credibility & Market Trust). Certifications encourage continuous improvement and real-time performance tracking, which are key elements of business agility (Data-Driven Decision-Making). Certified firms are better prepared for regulatory changes, minimizing disruptions and improving adaptability (Regulatory Compliance Reduces Risk). Certification acts as a strategic enabler of agility, helping firms balance standardization and flexibility, ensuring they remain competitive in volatile markets.

Firm age alone does not improve agility due to bureaucracy and resistance to change. Firm size can enhance agility if leveraged correctly with technology and agile leadership. Certification fosters agility by standardizing processes while maintaining flexibility.

Age, Size, and Certification Improve Innovation

Firm age improves innovation, firm size does not improve innovation, and certification does not improve innovation. Older firms have accumulated knowledge, experience, and industry expertise, which contribute to innovation in several ways. Long-standing firms have well-developed research and development (R&D) departments, enabling continuous innovation (Established R&D Capabilities). Over time, firms develop deep market insights and expertise, allowing them to create solutions tailored to customer needs (Industry-Specific Knowledge). Older firms accumulate capital and financial reserves, making it easier to invest in high-risk, high-reward innovation projects (Financial Stability for Risk-Taking). Established firms collaborate with universities, startups, and suppliers, enhancing their ability to adopt and implement new ideas (Strong Networks & Partnerships). Many legacy firms (e.g., IBM, Siemens, Toyota) have successfully transformed their business models by leveraging experience-driven innovation. While young firms may drive radical innovation, older firms sustain innovation through structured, experience-driven approaches.

Larger firms often struggle with innovation due to internal complexities and risk-averse cultures. Several reasons explain this. Large organizations have rigid hierarchies and long approval processes, making innovation implementation slower (Bureaucratic Slowdown). Instead of experimenting with new ideas, big firms often prioritize operational efficiency and short-term profits (Risk Aversion & Focus on Efficiency). The larger a company grows, the harder it is to align all departments toward a single innovation goal (Innovation Paralysis Due to Complexity). Research shows that startups and SMEs tend to drive breakthrough innovations, while large firms focus on incremental improvements (Disruptive Innovation Often Comes from Small Firms). Many large firms acquire startups (e.g., Facebook acquiring Instagram, Google acquiring DeepMind) because they struggle to innovate internally. While large firms have resources, size alone does not guarantee innovation—organizational culture and leadership play a bigger role.

Certifications standardize processes, which can sometimes hinder creativity and experimentation. Certifications like ISO 9001 enforce strict procedures and controls, limiting flexibility for radical innovation (Focus on Compliance, Not Creativity). Certified firms often prioritize efficiency and risk minimization, rather than exploring unconventional ideas (Process-Driven Mindset). While certifications enhance reliability and quality (Susanti et al., 2025), they do not necessarily foster disruptive thinking or experimentation (Innovation Requires Flexibility, Not Just Standards). Many of the most innovative companies (e.g., Tesla, SpaceX, Apple) prioritize disruptive innovation rather than adhering strictly to certification-based approaches. While certifications improve efficiency and credibility, they do not directly drive innovation, a culture of creativity and risk-taking is more important.

Firm age fosters innovation by leveraging experience, networks, and financial stability. Firm size does not guarantee innovation due to bureaucracy and risk aversion. Certification improves process efficiency but does not inherently drive innovation.

5.0 CONCLUSION

Conclusion

The study confirms that Digital Information Systems (DIS) significantly improve Business Agility and that Business Agility positively influences Innovation. However, Digital Information Systems do not directly improve Innovation. Instead, Business Agility acts as a mediator, meaning that Digital Information Systems enhances Innovation indirectly through Business Agility.

This finding highlights the indirect role of Digital Information Systems in fostering Innovation. Simply adopting digital systems is not enough to drive Innovation; rather, organizations must leverage these systems to enhance their agility, which in turn facilitates innovation.

Implications

Theoretical Implication. This study reinforces Dynamic Capabilities Theory, showing that firms need to develop agility as a capability to translate digital investments into innovation outcomes. It challenges the assumption that technology alone drives innovation, emphasizing the importance of organizational flexibility and adaptability.

Practical Implication. For business leaders, investing in Digital Information Systems should be accompanied by strategies to enhance Business Agility, such as agile leadership, flexible workflows, and a culture of rapid adaptation. for policymakers, policies encouraging digital transformation should focus on agility-building initiatives rather than just technology adoption. For technology developers, the focus should shift toward developing customizable, agile-friendly digital solutions rather than just standardized systems.

Limitations

The study may be limited in scope, focusing on specific industries or regions, which may affect generalizability. It relies on self-reported data, which may introduce response bias in measuring Business Agility and Innovation. The causality assumption is based on statistical mediation rather than longitudinal tracking, which could limit insights into long-term effects.

Recommendations

For Companies. Implement agile frameworks (e.g., Scrum, Lean, Design Thinking) to maximize the benefits of Digital Information Systems. Invest in continuous learning programs to develop agility at all organizational levels. Integrate real-time analytics and AI-driven decision-making tools to enhance responsiveness.

For Researchers. Further studies should explore industry-specific variations in how Digital Information Systems enhance Business Agility and Innovation. Future research should incorporate qualitative approaches (e.g., case studies, expert interviews) to better understand the mechanisms behind agility-driven innovation. Longitudinal studies are recommended to track the long-term impact of digital transformation on agility and innovation.

Future Research

There are some developable topics such as: Exploring the Role of Organizational Culture: How does a culture of agility influence the relationship between DIS and Innovation?; Examining External Factors: How do regulations, market competition, and economic conditions moderate the impact of Business Agility on Innovation?; Industry-Specific Studies: Does the impact of Digital Information Systems on agility and innovation differ between tech-intensive vs. traditional industries?; and Advanced Mediation Models: Investigating multiple mediators, such as organizational learning, leadership adaptability, and digital literacy (Junaedi, Renaldo, Yovita, et al., 2023), to see how they shape the agility-innovation link.

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Appendix 1

Variable	Dimension	Indicator	Sources
Digital Information Systems (X)	System Integration	Our company's digital information system integrates seamlessly with other business applications	(Rashid & Kausik, 2024)
		The compatibility of our digital systems enhances workflow efficiency and reduces operational disruptions	
	Data Management and Analytics	Our company utilizes real-time data analytics to improve decision-making and operational efficiency	(Onwubuariri et al., 2024)
		The availability of real-time data enhances our company's ability to respond quickly to market changes	
	System Security and Reliability	Our company has implemented robust cybersecurity measures to protect digital information from cyber threats	Novelty
		Employees are regularly trained on data security protocols to ensure the safe handling of sensitive information	
Business Agility (Z)	Responsiveness to Market Changes	Our company can quickly adjust business strategies in response to market fluctuations	(Homburg et al., 2007)
		Management makes data-driven decisions efficiently to adapt to external changes	
	Organizational Flexibility	Our company can modify internal processes to accommodate new technologies and innovations	(Bhatti et al., 2013)
		Employees are encouraged to embrace change and adjust to evolving business needs	
	Technological Adaptation	Our company regularly adopts new digital tools and technologies to enhance business agility	Novelty
		The implementation of digital solutions has improved our ability to scale operations efficiently	
Innovation (Y)	Development of New Products / Services	Our company continuously develops new products or services to meet customer needs	(Weng et al., 2015)
		Innovation in our products/services provides a competitive advantage in the market	

Variable	Dimension	Indicator	Sources
	Process Innovation	Our company leverages digital technology to enhance operational processes and efficiency	(Martínez-Peláez et al., 2023)
		The adoption of innovative business processes has reduced costs and improved productivity	
	Technological Innovation	Our company invests in emerging technologies (e.g., AI, IoT, blockchain) to drive innovation	Novelty
		The use of advanced digital technologies has significantly improved our company's innovation capabilities	