GREEN INNOVATION ECOSYSTEM ESTABLISHMENT THROUGH STRATEGIZING THE BUSINESS MODEL IN PUBLIC SECTOR

Pham Quang Huy 1
Vu Kien Phuc 2

ABSTRACT

Objective: This study aims at investigating the relationship between internal control systems (ICS) and accounting data analytics (ADA). This study also examines the ways in which ICS and ADA influence green innovation ecosystem (GIE). Furthermore, it endeavors to explore the digital circular business model innovation (DCBMI) mediation mechanism in the connection between ICS, ADA, and GIE.

Theoretical Framework: Drawing on the practice-based view theory, this study focuses on several constructs and their interconnections namely ICS, ADA, GIE, and DCBMI.

Method: The hypothetico-deductive approach was utilized in this study. The study utilized structural equation modeling to examine the proposed model, which was based on statistical data obtained from a cross-sectional survey of 523 accountants employed in public sector organizations (PSOs).

Results and Discussion: The result substantiated the markedly positive interconnection between ICS and ADA. Also, GIE was verified to be affected by ICS and ADA. Simultaneously, these interconnections were partially mediated by DCBMI.

Research Implications: These observations served as a guide for the leaders of PSOs to identify and capitalize on opportunities to become effective in the digital transformation journey, as well as to develop robust strategies to effectively direct their green innovation process.

Originality/Value: It also enlarges the body literature on GIE through producing empirical evidences concerning the influences of ICS and ADA on GIE within PSOs in developing country. Strikingly, the originality of this investigation lied in studying the mediating effect of DCBMI on the interlinks between ICS and GIE as well as ADA and GIE.

Keywords: Accounting Information System, Business Model Innovation, Circular Economy, Data Analytics, Ecosystem, Green Innovation.

ESTABELECIMENTO DE ECOSISTEMAS DE INOVAÇÃO ECOLÓGICA ATRAVÉS DA ESTRATÉGIA DO MODELO EMPRESARIAL NO SETOR PÚBLICO

RESUMO

Objetivo: Este estudo visa investigar a relação entre sistemas de controle interno (ICS) e análise de dados contábeis (ADA). Este estudo também examina as formas como os ICS e a ADA influenciam o ecossistema de inovação verde (GIE). Além disso, procura explorar o mecanismo de mediação de inovação do modelo empresarial circular digital (DCBMI) na ligação entre ICS, ADA e GIE.

Estrutura Teórica: Com base na teoria da visão baseada na prática, este estudo se concentra em vários construtores e suas interconexões, ou seja, ICS, ADA, GIE e DCBMI.

1 University of Economics Ho Chi Minh City (UEH), Vietnam. E-mail: pquanghuy@ueh.edu.vn
Orcid: https://orcid.org/0000-0002-5722-3462

2 University of Economics Ho Chi Minh City (UEH), Vinh Long Campus. E-mail: phucvk@ueh.edu.vn
Orcid: https://orcid.org/0000-0002-5372-0517
Método: A abordagem hipotético-deductiva foi utilizada neste estudio. O estudio utilizou modelagem de equações estruturais para examinar o modelo proposto, que foi baseado em dados estatísticos obtidos a partir de um levantamento transversal de 523 contadores empregados em organizações do setor público (OSP).

Resultados e Discussão: O resultado fundamentou a interconexão marcadamente positiva entre ICS e ADA. Além disso, verificou-se que o GIE foi afetado pelo ICS e ADA. Simultaneamente, essas interconexões foram parcialmente mediadas pelo DCBMI.

Implicações da investigación: Estas observaciones serviram como un guía para los líderes de las OSP identificarem e capitalizarem oportunidades para se tornarem eficazes na jornada de transformação digital, bem como para desenvolverem estrategias robustas para direcionarem eficazmente o seu processo de inovação ecológica.

Originalidade/valor: Ele também amplia a literatura corporal sobre GIE através da produção de evidências empíricas sobre as influências de ICS e ADA em GIE dentro de OSPs em países em desenvolvimento. Surpreendentemente, a originalidade dessa investigação residiu no estudo do efeito mediador do DCBMI nas interligações entre ICS e GIE, bem como ADA e GIE.

Keywords: Sistema de Información Contábil, Inovação do Modelo de Negócios, Economia Circular, Análise de Dados, Ecossistema, Inovação Ecológica.

CREACIÓN DE ECOSISTEMAS DE INNOVACIÓN VERDE MEDIANTE LA ESTRATEGIA DEL MODELO DE NEGOCIO EN EL SECTOR PÚBLICO

RESUMEN

Objetivo: Este estudio tiene como objetivo investigar la relación entre los sistemas de control interno (ICS) y el análisis de datos contables (ADA). Este estudio también examina las formas en que ICS y ADA influyen en el ecosistema de innovación verde (GIE). Además, se esfuerza por explorar el mecanismo de mediación de la innovación del modelo de negocio circular digital (DCBMI) en la conexión entre ICS, ADA y GIE.

Marco teórico: Basándose en la teoría de la vista basada en la práctica, este estudio se centra en varios constructos y sus interconexiones, a saber, ICS, ADA, GIE y DCBMI.

Método: En este estudio se utilizó el enfoque hipotético-deductivo. El estudio utilizó modelos de ecuaciones estructurales para examinar el modelo propuesto, que se basó en datos estadísticos obtenidos de una encuesta transversal de 523 contadores empleados en organizaciones del sector público (OSP).

Resultados y discusión: El resultado corroboró la interconexión marcadamente positiva entre ICS y ADA. Además, se verificó que GIE se vio afectado por ICS y ADA. Simultáneamente, estas interconexiones fueron parcialmente mediadas por DCBMI.

Implicaciones de la investigación: Estas observaciones sirvieron de guía para que los líderes de las OSP identificaran y capitalizaran las oportunidades para ser eficaces en el viaje de transformación digital, así como para desarrollar estrategias sólidas para dirigir eficazmente su proceso de innovación verde.

Originalidad/Valor: También amplia la literatura corporal sobre el GIE a través de la producción de evidencias empíricas sobre las influencias del ICS y la ADA sobre el GIE dentro de las OSP en los países en desarrollo. Sorprendentemente, la originalidad de esta investigación radica en estudiar el efecto mediador de DCBMI en las interrelaciones entre ICS y GIE, así como ADA y GIE.

Palabras clave: Sistema de Información Contable, Innovación del Modelo de Negocio, Economía Circular, Análisis de Datos, Ecossistema, Innovación Verde.

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1 INTRODUCTION

Environmental and natural resources have been significantly more severely impacted by the growing threat of climate change (Lusmeida et al., 2023). Global consciousness regarding environmental challenges and the potential catastrophes they may cause has increased in recent years (Ganesh & Venugopal, 2024). Accordingly, green innovation is a viable approach that simultaneously safeguards the environment and promotes economic expansion. Building on the perspectives of Zeng et al. (2022), the integration of environmentally sustainable practices with innovative progress constitutes green innovation. Innovation is highly regarded and promoted in emerging markets, specifically within public sector organizations (PSOs) (De Vries et al., 2018). Unfortunately, organizations encounter significant challenges in utilizing their internal capabilities and resources to successfully execute the entirety of the green innovation process. In order to confront these obstacles, collaboration is required between organizations and their stakeholders, including universities, suppliers, consumers, and governments (Günzel-Jensen & Rask, 2021). Against this backdrop, the green innovation ecosystem (GIE) acts as a framework through which one can examine multiagent collaboration in sustainable management within the PSOs. Building on the perspectives of Zeng et al. (2022), the innovation ecosystem known as the GIE aims to enhance the circumstances that facilitate green innovation.

Nevertheless, in an intricate setting, the green innovation may encounter challenges due to uncertainties surrounding cost inputs, research and development efforts, pressures arising from multiagent cooperation, levels of technological knowledge, and the necessity to harmonize green business strategies with financial objectives (Somlai, 2022). Additionally, the proliferation of innovation worldwide has led to a diverse range of urgent requirements on the implementation of management control methods (Tu et al., 2022). Internal control system (ICS), is widely recognized as a method or framework that is implemented to manage, oversee, and guide an organization towards the accomplishment of a specific objective. Securing stability, integrity, and trust necessitates the implementation of efficient ICS (Nguyen & Duong, 2024). Hence, it is noteworthy to highlight the prospective advantages of ICS in fostering organizational innovation within the PSOs (Tu et al., 2022). Remarkably, data analytics, in this particular situation, refers to the process of extracting valuable insights from large databases by using algorithms. Accounting data analytics (ADA) is a specific method that utilizes financial transactions to extract information. ADA can be utilized to produce precise measurement and visualization of the organization's financial information and patterns. Additionally, ADA can
promote the smooth running of the organization, the attainment of sustainable development goals, and the maintenance or enhancement of performance.

More importantly, in recent times, the emergence of environmental and social concerns, as well as government demands, has led to the development of GIE. The primary objective of GIE is to create an environment that promotes green innovation (Li & Shi, 2022). This includes utilizing digital technology and implementing environmental management techniques (Demirel & Kesidou, 2018). Concerning to this, circular business models seek to improve sustainability by disconnecting an organization’s economic growth from the depletion of resources. This is achieved by reducing, narrowing, and slowing down the flow of resources. The utilization of digital and smart technology plays a crucial role in promoting the separation of economic growth from the exploitation of resources. These technologies facilitate the reduction of resource waste for both companies and customers by enabling more meticulous monitoring of resource usage throughout the production, consumption, and disposal of products and services.

Even though GIE has been the subject of numerous calls for more research (Fan et al., 2022), very few academic works have actually concentrated on it (Li & Shi, 2022), and scarcity of quantitative studies have addressed it in management domain (Rosa et al., 2023). This phenomenon has generated a need to reassess and develop a comprehensive understanding of the emerging ecosystem in order to harness greater potential and ensure green innovation within the PSO, which is GIE. Drawing inspiration from the dearth of established scholarly literature on the subject matter concerning the potential impact of ADA and ICS on driving GIE, this research is primarily motivated by an examination of how ICS and ADA can build up the GIE through digital circular business model innovation (DCBMI). The investigation also highlights opportunities for both theoretical and practical contributions to this field. Furthermore, this lacuna in theory gives rise to the following thought-provoking questions in research.

**RQ1. Does ICS illustrate an influence on ADA?**

**RQ2. Do ICS and ADA illustrate an influence on GIE?**

**RQ3. Does DCBMI serve as the mediators in the interconnection between ICS and GIE as well as the interconnection between ADA and GIE?**

In theoretical aspect, the necessity for sustainable development is driving the growing interest in GIE, although quantitative research on this subject is still in its nascent stages (Rosa et al., 2023). The culmination of the research is to expand the existing body of knowledge regarding the formulation and operationalization of GIE within PSOs in developing nations. Based on the current comprehension of researchers, this may be the initial scholarly publication to present novel and crucial perspectives on the extraordinarily distinct effects of ADA and ICS.
on GIE. Also, an examination of the impact of ICS on ADA constituted the novelty of this study. Furthermore, what sets this study apart is its investigation and evaluation of the mediating function of DCBMI in the relationships between ICS and GIE as well as ADA and GIE.

In practical aspect, practitioners would undeniably gain from comprehensive analyses of the acquired results, as they would provide guidance on how to identify and capitalize on opportunities for green innovation. In practice, this would be possible by increasing practitioners' awareness and recognition of the extent of ICS and ADA. As a result, GIE could be improved. The notable observation further emphasized that practitioners should prioritize increasing their focus on DCBMI, as doing so would effectively leverage the implementation of a more comprehensive solution, enabling PSOs to achieve the highest level of success in GIE. Furthermore, government influencers and policymakers were urged to prioritize innovative attributes and create an environment conducive to innovation deployment by implementing policies that promote the development of digital circular business models and incentivize and stimulate the implementation of digital technologies-based ADA advancements.

This manuscript is specifically unfolded as follows. The theoretical framework and conceptual aspects are covered in Section 2. The research model and the development of hypotheses are mapped out in Section 3. The research methodology for the collection and analysis of the data is outlined in Section 4. Insightful information acquired from mathematical analyses and discussion are explored in Section 5. In Section 6, this manuscript concludes with some suggestions for possible follow-up studies in this domain.

2 LITERATURE REVIEW AND THEORETICAL BASIS

Practice-based view theory. Building on the perspectives of Khan et al. (2023), organizations often fail to recognize or implement advantageous practices as a result of the limited rationality exhibited by their managers. In this regard, the practice-based view theory posits that an organization's competitive advantage is derived not solely from its knowledge, but also from its operational procedures. Since its proposal by Bromiley and Rau (2014), practice-based view theory as an additional theoretical foundation for resource-based view and dynamic capability has garnered considerable interest. The goal of practice-based view theory is to elucidate the reasons for variation in organizational performance in response to widely available practices that are neither unique nor incomparable (Bromiley & Rau, 2014).
Accounting data analytics. Expanding upon the viewpoints expressed by Al-Hattami et al. (2021), an accounting information system refers to the extensive implementation of accounting software designed to facilitate the inputting and processing of financial data, as well as the oversight and management of matters concerning the economic and financial operations of an organization. ADA in this study pertains to an information system for accounting that is driven by big data in order to accurately measure and visualize a company's financial data and trends in order to ensure the seamless functioning of the organization, the attainment of sustainable development goals, and the preservation or enhancement of overall performance.

Internal control system. The concept of ICS refers to a framework that includes policies, processes, procedures, analysis, and strategies. It is implemented by the board of directors and other personnel within an organization. The main goal of ICS is to achieve operational effectiveness and efficiency by managing risks and providing reasonable assurance for the organization's missions and goals (Michelon et al., 2015). This is done in a structured, ethical, cost-effective, and accountable manner, while also complying with relevant laws and regulations. Additionally, ICS aims to protect resources from loss, misuse, and damage.

Digital circular business model innovation. Circular business model innovation, as defined by Bocken et al. (2019), entails alterations to the business model that incorporate, execute, and profit from circular economy practices. These practices include designing products to have a longer lifespan and ensuring their durability in order to slow resource loops, as well as employing recycling methods to close the loop. In order to capitalize on circular economy practices, DCBMI can be defined as novel and non-trivial changes to the organization's business model that are enabled or embodied in digital technologies (van Eechoud & Ganzaroli, 2023).

Green innovation ecosystem. The innovation ecosystem can be considered as a network of interdependent entities that includes core enterprises, upstream and downstream companies, and users. According to Lancker et al. (2016), there are four parts to an innovation ecosystem namely innovation processes, ecological systems, between-subjects networks, and innovation subjects. Integrating organizational green innovation with an innovation ecosystem can result in GIE. One way to ponder at multi-agent interaction in sustainable management is through the GIE. Building on the perspectives of Zeng et al. (2022), the GIE is an innovation ecosystem that aims to enhance the environment that fosters green innovation.
3 THEORETICAL FRAMEWORK

3.1 RESEARCH HYPOTHESIS DEVELOPMENT

Given the substantial amount of sensitive data that was contained within the accounting systems and required to be protected at all times, an unauthorized assessment would wreak devastation on the accounting department. Regrettably, the risk associated with the transmission and storage of data has escalated in the era of the digital economy (Xiwena et al., 2021). Thus, it prompted an examination of the internal controls implemented by accounting information system to safeguard against computer infections, hackers, and ensure network security. Undoubtedly, the implementation of effective internal control measures contributes to the enhancement of information system quality and dependability. This is achieved across various domains, including the maintenance of accuracy, integrity, and security by providing suitable information processing techniques, storage methods, and outputs to mitigate fraud and losses associated with information system adoption, the prevention, investigation, and correction of errors, and the restoration of system functionality. Leveraging the analyses of the previous analysis, the current investigation's hypothesis can be logically articulated as follows.

Hypothesis 1 (H1). ICS instigates a significant effect on ADA in a significant and positive manner.

Considering the significant impact that public sector innovation has on tackling the economic and social obstacles that the PSOs encounters, the implementation of a successful ICS will aid PSOs in streamlining their activities and making effective use of their resources (Tu et al., 2022). PSOs can ensure optimal resource utilization, increase the efficacy of public assets, promote transparency, and strengthen accountability with the aid of an effective and efficient ICS. By facilitating the establishment of suitable objectives and encouraging staff engagement in the innovation process, knowledge utilization, and task completion, ICS can support PSOs by allowing them to concentrate their resources on innovation (Shen et al., 2020). Leveraging the analyses of the previous analysis, the current investigation's hypothesis can be logically articulated as follows.

Hypothesis 2 (H2). ICS instigates a significant effect on DCBMI in a significant and positive manner.

According to Ma et al. (2022), the organization's strategic management, information sharing, and operational processes may be greatly improved with a strong system of internal controls. This will also help to reduce systemic risks in the organization's operations and
innovation efforts. By implementing mechanisms for scientific risk assessment, consultation, and supervision, organizations will be able to make informed decisions about green innovation projects. This will help them avoid under- or over-investment in the projects based on the subjective desires of key stakeholders, and it will also reduce the impact of agency problems on decision-making. Better internal controls can propel green innovations, according to Ma et al. (2022). Leveraging the analyses of the previous analysis, the current investigation's hypothesis can be logically articulated as follows.

**Hypothesis 3 (H3).** ICS instigates a significant effect on GIE in a significant and positive manner.

By leveraging big data analytics technologies, organizations can gain insights into previously unknown factors such as supply, capacity, and demand. In this instance, it interprets and synthesizes data from multiple sources to assist decision-makers (Côrte-Real et al., 2019). In addition, accounting information systems are indispensable for organizations in the business world. Accounting information systems can enhance organizational and managerial operations by providing managers at all levels with access to current, accurate data that can be used to manage performance. Consequently, ADA enables DCBMI by introducing two primary effects on the value creation and capture mechanisms of circular business model innovation. Leveraging the analyses of the previous analysis, the current investigation's hypothesis can be logically articulated as follows.

**Hypothesis 4 (H4).** ADA instigates a significant effect on DCBMI in a significant and positive manner.

Big data analytics is a critical domain of forthcoming technology that has the potential to generate value for businesses across various industries. As a consequence, it possesses the capacity to facilitate the generation of value for institutions, thereby potentially enhancing financial outcomes, market performance, and stakeholder satisfaction (Vitari & Raguseo, 2020). It is widely recognized among organizations worldwide that an efficient accounting information system is crucial for attaining their strategic and operational objectives. The provision of financial information by accounting information systems enables users to make informed decisions, conduct effective planning, and exercise control. This capability significantly improves performance, both financial and non-financial, and is of utmost significance in the pursuit of the sustainable development goals (Huy & Phuc, 2020). Leveraging the analyses of the previous analysis, the current investigation's hypothesis can be logically articulated as follows.
Hypothesis 5 (H5). ADA instigates a significant effect on GIE in a significant and positive manner.

Formulation and operationalization of the GIE necessitate the ability to establish connections between extremely dissimilar contexts of opportunity and sets of competencies. DCBMI are designed to enable the provision of products/services, collaborations, transactions as well as engagement with stakeholders. The involvement of stakeholders, demonstrated by cooperative initiatives involving local, national, and supranational organizations, strengthens the interdependence between cultural establishments and their respective communities as well as the wider social structure. These digital business models can warrant accomplishment and increased profitability even in dynamic and unpredictable business settings (Mancuso et al., 2023). Leveraging the analyses of the previous analysis, the current investigation's hypothesis can be logically articulated as follows.

Hypothesis 6 (H6). DCBMI instigates a significant effect on GIE in a significant and positive manner.

Figure 1
Hypothesized model

Source: Researchers’ elaboration, 2024

3.2 MATERIALS AND METHOD

3.2.1 Operationalization of Research Variables

An investigational framework employing the hypothetico-deductive method was utilized to achieve the study's objective. Following an exhaustive review of the relevant
literature, the criteria for measuring each concept in the present study were determined. Pre-established reliability and validity have been attributed to each of the instruments utilized in the research. Subsequently, an arduous back-translation technique was employed to ensure the equivalentness of the source and target texts. Initially composed in English, the questionnaire underwent a meticulous process of translation into Vietnamese. Prior to conducting a more extensive survey, a preliminary evaluation of the measuring instruments was performed via a small-scale pilot test. Thirty individuals participated in the small-scale pilot survey, which utilized a cohort of respondents acquired easily from the target demographic through PSOs. All variables achieved Cronbach’s alpha values exceeding 0.7, a threshold that is deemed satisfactory. Utilizing a five-point Likert scale, responses ranged from one (extremely disappointed) to five (extremely satisfied).

**Accounting data analytics.** The ADA construct was conceptualized as a second-order aggregate of three first-order micro-foundational constructs – Descriptive analytics; Predictive analytics; Prescriptive analytics which were derived from those proposed by Almubaydeen et al. (2023).

**Internal control system.** In the context of this investigation, the criteria for ICS were derived from the work of Xiwena et al. (2021). The five fundamental categories were assessed using this scale, which comprised the following: control environment, risk assessment, control activities, information and communication, and monitoring.

**Digital circular business model innovation.** The DCBMI construct was conceptualized as a second-order aggregate of three first-order micro-foundational constructs - Digital circular-orientated value creation, Digital circular-orientated value delivery, Digital circular-orientated value capture which were derived from those proposed by Mancuso et al. (2023).

**Green innovation ecosystem.** There are four items which were derived from those proposed by Fan et al. (2022) and Zeng et al. (2022) were employed in this investigation to assess GIE.

### 3.2.2 Target Population and Sampling Procedure

Subjects of the study’s survey were accountants employed by PSOs in the southern region of Vietnam. Convenience and snowball sampling techniques were employed in conjunction for the present investigation. According to Gupta (2021), it was recommended that the sample size fall within the range of 5:1 to 20:1, with 5 and 20 denoting the sample size for each individual item. An assortment of data was collected spanning from September 2023 to
March 2024. A final sample size of 523 cases, accompanied by a data loss rate of 27 percent, remained for analysis subsequent to the screening and examination of the questionnaires. The SPSS 29.0 and SmartPLS 4.1.0.2 were employed to analyze the statistical data in this research. Based on the socio-demographic profile of the sample, it was determined that females comprised the majority of the participants, comprising 78.20 percent, while males constituted 21.80 percent. Regarding the age of the participants, it was found that the group aged "30-40" comprised 75.91 percent of the entire sample. The group aged "40-50" accounted for approximately 22.75 percent. In contrast, the category labeled "over 50" comprised an inconsequential 1.34 percent, securing the lowest ranking among the aforementioned groups.

With respect to their academic capabilities, the vast majority of the participants possessed at least a graduate degree. The respondents have accumulated over eight years of experience in the field of accounting. The results' validity may be compromised due to the possibility of common method bias (CMB), given that statistical data in this study was gathered from a solitary questionnaire. In accordance with this methodology, we evaluated the complete collinearity VIF scores of construct items in accordance with Kock's (2015) instructions. The VIF scores, which varied between 1.182 and 2.599, fell below the suggested threshold of 3.3. This value indicates that CMB was not a significant issue in the dataset (Kock, 2015).

4 RESULTS AND DISCUSSION

4.1 STATISTICAL ASSESSMENT ON MEASUREMENT MODEL

*Construct validity & reliability.* The results shown in Table 1 confirmed that most latent variables had Cronbach's alpha values greater than 0.7, indicating that the indicators were consistent with one another (Hair et al., 2022), with the exception of GIE’s Cronbach's alpha value. According to Hair et al. (2022), rho_A values should be greater than 0.70 to be considered to indicate the achievement of internal consistency reliability. Most latent variables had rho_A values greater than 0.7, with the exception of GIE’s rho_A value. Although the Cronbach’s alpha value and rho_A value for GIE only had the values lower than 0.7, they were high enough to recognize the reliability of the variables employed in the current study. Besides, validity, which included both convergent and discriminant validity, referred to how well the measurement represented the construct it was meant to evaluate. The average variance extracted (AVE) should be larger than 0.5 for all variables (Hair et al., 2022) and lower than CR (Table 1), with the exception of GIE’s AVE. Nevertheless, the convergent validity may be confirmed.
in this circumstance if one of the constructs’ AVE ranged from 0.40 to 0.50 and if the composite reliability (CR) values were higher than 0.60 (Fornell & Larcker, 1981). According to Hair et al. (2022), every factor should have a loading value greater than 0.70. Most latent variables met this criterion, with the exception of GIE’s outer loading value. Building on the perspectives of Hair et al. (2014), the value of outer loading between 0.4 and 0.7 could be retained when it was possible to enhance the AVE value. Taken together, Table 1 confirmed that the measurement model of this study achieved the convergent validity.

### Table 1

**Results summary of measurement model assessment**

<table>
<thead>
<tr>
<th>Constructs and operationalization</th>
<th>Convergent validity</th>
<th>Construct reliability</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor Loadings</td>
<td>AVE</td>
<td>Cronbach’s Alpha</td>
</tr>
<tr>
<td>Accounting data analytics</td>
<td>ADA</td>
<td>0.863 - 0.880</td>
<td>0.764</td>
</tr>
<tr>
<td>Descriptive analytics</td>
<td>DA</td>
<td>0.823 - 0.859</td>
<td>0.710</td>
</tr>
<tr>
<td>Predictive analytics</td>
<td>PDA</td>
<td>0.793 - 0.838</td>
<td>0.659</td>
</tr>
<tr>
<td>Prescriptive analytics</td>
<td>PCA</td>
<td>0.838</td>
<td>0.659</td>
</tr>
<tr>
<td><strong>Internal control system</strong></td>
<td>ICS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control environment</td>
<td>COE</td>
<td>0.796 - 0.846</td>
<td>0.682</td>
</tr>
<tr>
<td>Risk assessment</td>
<td>RA</td>
<td>0.877 - 0.834</td>
<td>0.739</td>
</tr>
<tr>
<td>Control activities</td>
<td>COA</td>
<td>0.910</td>
<td>0.760</td>
</tr>
<tr>
<td>Information and Communication</td>
<td>IAC</td>
<td>0.797 - 0.875</td>
<td>0.704</td>
</tr>
<tr>
<td>Monitoring</td>
<td>MON</td>
<td>0.901</td>
<td>0.707</td>
</tr>
<tr>
<td><strong>Digital circular business model innovation</strong></td>
<td>DCBMI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital circular-orientated value creation</td>
<td>VCR</td>
<td>0.818 - 0.866</td>
<td>0.701</td>
</tr>
<tr>
<td>Digital circular-orientated value delivery</td>
<td>VD</td>
<td>0.818 - 0.853</td>
<td>0.704</td>
</tr>
<tr>
<td>Digital circular-orientated value capture</td>
<td>VCA</td>
<td>0.824 - 0.850</td>
<td>0.699</td>
</tr>
<tr>
<td><strong>Green innovation ecosystem</strong></td>
<td>GIE</td>
<td>0.725</td>
<td>0.475</td>
</tr>
</tbody>
</table>

Source: processed primary data, 2024

**Correlations and discriminant validity.** The discriminant validity was evaluated through the application of the heterotrait-monotrait ratio (HTMT) and the Fornell-Larcker criterion. A compilation of the results obtained from these matrices was presented in Table 2. The data in Table 2 demonstrated that the square root of the AVE for each construct (diagonal elements)
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was significantly larger than the square root of its correlations with other constructs (off-diagonal elements), thus meeting the requirement outlined by Fornell and Larcker (1981).

Table 2

Results summary of Discriminant validity using Fornell–Larcker process

<table>
<thead>
<tr>
<th></th>
<th>COA</th>
<th>COE</th>
<th>DA</th>
<th>GIE</th>
<th>IAC</th>
<th>MON</th>
<th>PCA</th>
<th>PDA</th>
<th>RA</th>
<th>VCA</th>
<th>VCR</th>
<th>VD</th>
</tr>
</thead>
<tbody>
<tr>
<td>COA</td>
<td>0.872</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COE</td>
<td>0.340</td>
<td>0.826</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>0.065</td>
<td>0.028</td>
<td>0.874</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>GIE</td>
<td>0.123</td>
<td>0.200</td>
<td>0.240</td>
<td>0.689</td>
<td></td>
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</tr>
<tr>
<td>IAC</td>
<td>0.086</td>
<td>0.286</td>
<td>0.008</td>
<td>0.017</td>
<td>0.839</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>MON</td>
<td>0.140</td>
<td>0.324</td>
<td>0.096</td>
<td>0.130</td>
<td>0.149</td>
<td>0.841</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCA</td>
<td>0.012</td>
<td>0.014</td>
<td>0.325</td>
<td>0.163</td>
<td>0.120</td>
<td></td>
<td>0.027</td>
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<tr>
<td>PDA</td>
<td>0.106</td>
<td>0.050</td>
<td>0.409</td>
<td>0.167</td>
<td>0.064</td>
<td>0.065</td>
<td>0.205</td>
<td>0.843</td>
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<tr>
<td>RA</td>
<td>0.092</td>
<td>0.317</td>
<td>0.129</td>
<td>0.118</td>
<td>0.062</td>
<td>0.170</td>
<td>0.054</td>
<td>0.017</td>
<td>0.859</td>
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<tr>
<td>VCA</td>
<td>0.160</td>
<td>0.214</td>
<td>0.094</td>
<td>0.142</td>
<td>0.156</td>
<td>0.081</td>
<td>0.065</td>
<td>0.118</td>
<td>0.134</td>
<td>0.836</td>
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</tr>
<tr>
<td>VCR</td>
<td>0.095</td>
<td>0.242</td>
<td>0.271</td>
<td>0.257</td>
<td>0.085</td>
<td>0.216</td>
<td>0.072</td>
<td>0.189</td>
<td>0.113</td>
<td>0.324</td>
<td>0.838</td>
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</tr>
<tr>
<td>VD</td>
<td>0.094</td>
<td>0.178</td>
<td>0.105</td>
<td>0.179</td>
<td>0.036</td>
<td>0.117</td>
<td>0.082</td>
<td>0.097</td>
<td>0.108</td>
<td>0.067</td>
<td>0.337</td>
<td>0.839</td>
</tr>
</tbody>
</table>

Source: processed primary data, 2024

Furthermore, Heseler et al. (2015) reported that all HTMT values should be less than 0.90, and the upper limit of the confidence intervals should also be less than 1 to provide further evidence that the constructs were distinct and differentiated. On the basis of the results presented in Table 3, it was possible to conclude that discriminant validity was not an issue in this research.

Table 3

Results summary for discriminant validity on Heterotrait–Monotrait ratio

<table>
<thead>
<tr>
<th></th>
<th>COA</th>
<th>COE</th>
<th>DA</th>
<th>GIE</th>
<th>IAC</th>
<th>MON</th>
<th>PCA</th>
<th>PDA</th>
<th>RA</th>
<th>VCA</th>
<th>VCR</th>
<th>VD</th>
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</thead>
<tbody>
<tr>
<td>COA</td>
<td>0.424</td>
<td></td>
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<tr>
<td>COE</td>
<td>0.080</td>
<td>0.038</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>0.176</td>
<td>0.281</td>
<td>0.309</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>IAC</td>
<td>0.104</td>
<td>0.367</td>
<td>0.025</td>
<td>0.072</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MON</td>
<td>0.170</td>
<td>0.416</td>
<td>0.118</td>
<td>0.175</td>
<td>0.189</td>
<td></td>
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</tr>
<tr>
<td>PCA</td>
<td>0.087</td>
<td>0.055</td>
<td>0.409</td>
<td>0.228</td>
<td>0.155</td>
<td>0.040</td>
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</tr>
<tr>
<td>PDA</td>
<td>0.132</td>
<td>0.097</td>
<td>0.494</td>
<td>0.215</td>
<td>0.083</td>
<td>0.091</td>
<td>0.265</td>
<td></td>
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</tr>
<tr>
<td>RA</td>
<td>0.111</td>
<td>0.400</td>
<td>0.154</td>
<td>0.168</td>
<td>0.094</td>
<td>0.209</td>
<td>0.082</td>
<td>0.044</td>
<td></td>
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</tr>
<tr>
<td>VCA</td>
<td>0.198</td>
<td>0.277</td>
<td>0.115</td>
<td>0.199</td>
<td>0.196</td>
<td>0.101</td>
<td>0.085</td>
<td>0.149</td>
<td>0.168</td>
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</tr>
<tr>
<td>VCR</td>
<td>0.118</td>
<td>0.313</td>
<td>0.333</td>
<td>0.356</td>
<td>0.106</td>
<td>0.271</td>
<td>0.104</td>
<td>0.240</td>
<td>0.143</td>
<td>0.412</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VD</td>
<td>0.116</td>
<td>0.231</td>
<td>0.125</td>
<td>0.244</td>
<td>0.048</td>
<td>0.147</td>
<td>0.104</td>
<td>0.122</td>
<td>0.134</td>
<td>0.085</td>
<td>0.424</td>
<td></td>
</tr>
</tbody>
</table>

(Source: processed primary data, 2024)
4.2 FULL STRUCTURAL EQUATION MODELING AND HYPOTHESES TESTING

The $R^2$ was 0.014 for ADA while $R^2$ for DCBMI and GIE were 0.154 and 0.130, respectively. The significance of the contribution of the independent variables to the accuracy of dependent variable predictions was then determined using the $f^2$ effect size associated with each independent factor. As shown in Table 4, the $f^2$ effect size results for each variable indicated that the significance varied from small to medium. This study also fortified gratifying predictive relevance as the $Q^2$ values for ADA, DCBMI, and GIE were 0.005, 0.053, and 0.057, respectively, which were well above zero. Rested on the bootstrap outcomes (percentile bootstrapping, two-tailed test, 0.05 significance level, with 10,000 resamples) in Table 4, ICS substantially and positively impacted ADA ($\beta = 0.117$; $t$-value = 2.569; $p$-value = 0.010); DCBMI ($\beta = 0.303$; $t$-value = 7.486; $p$-value = 0.000); GIE ($\beta = 0.122$; $t$-value = 2.967; $p$-value = 0.003). Likewise, ADA substantially and positively impacted DCBMI ($\beta = 0.215$; $t$-value = 5.626; $p$-value = 0.000) and GIE ($\beta = 0.200$; $t$-value = 5.147; $p$-value = 0.000). As anticipated by H6, the results disclosed that DCBMI depicted a direct positive impact on GIE ($\beta = 0.189$; $t$-value = 4.276; $p$-value = 0.000). In this regard, H1-H6 were accepted. Additionally, the mediating impacts of DCBMI were evaluated. First, the significance of ICS’s indirect impact on GIE through DCBMI was evaluated. Given that the direct effects of ICS on GIE were also supported and that the indirect effects were significant ($t$-value = 3.726; $p$-value = 0.000), it was determined that DCBMI partially mediated the association between ICS and GIE (Hair et al., 2022). Likewise, the indirect effect of ADA on GIE through DCBMI was significant ($t$-value = 3.369; $p$-value = 0.001), it was determined that DCBMI partially mediated the association between ADA and GIE (Hair et al., 2022). As a result, the findings indicated partial mediations.
Table 4
Results summary of hypotheses acceptance

<table>
<thead>
<tr>
<th>Relevant path</th>
<th>Path coefficient</th>
<th>SE</th>
<th>95% Confidence interval</th>
<th>VIF</th>
<th>t-value</th>
<th>p-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct effect</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICS ➔ ADA</td>
<td>0.117</td>
<td>0.046</td>
<td>[0.026 - 0.204]</td>
<td>1.000</td>
<td>2.569</td>
<td>0.010</td>
<td>Accepted</td>
</tr>
<tr>
<td>ICS ➔ DCBMI</td>
<td>0.303</td>
<td>0.040</td>
<td>[0.221 - 0.379]</td>
<td>1.014</td>
<td>7.486</td>
<td>0.000</td>
<td>Accepted</td>
</tr>
<tr>
<td>ICS ➔ GIE</td>
<td>0.122</td>
<td>0.041</td>
<td>[0.039 - 0.198]</td>
<td>1.122</td>
<td>2.967</td>
<td>0.003</td>
<td>Accepted</td>
</tr>
<tr>
<td>ADA ➔ DCBMI</td>
<td>0.215</td>
<td>0.038</td>
<td>[0.140 - 0.291]</td>
<td>1.014</td>
<td>5.626</td>
<td>0.000</td>
<td>Accepted</td>
</tr>
<tr>
<td>ADA ➔ GIE</td>
<td>0.200</td>
<td>0.039</td>
<td>[0.117 - 0.271]</td>
<td>1.069</td>
<td>5.147</td>
<td>0.000</td>
<td>Accepted</td>
</tr>
<tr>
<td>DCBMI ➔ GIE</td>
<td>0.189</td>
<td>0.044</td>
<td>[0.100 - 0.272]</td>
<td>1.181</td>
<td>4.276</td>
<td>0.000</td>
<td>Accepted</td>
</tr>
<tr>
<td><strong>Indirect effect</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICS ➔ DCBMI ➔ GIE</td>
<td>0.057</td>
<td>0.015</td>
<td>[0.030 - 0.090]</td>
<td>3.726</td>
<td>0.000</td>
<td>Accepted</td>
<td></td>
</tr>
<tr>
<td>ADA ➔ DCBMI ➔ GIE</td>
<td>0.041</td>
<td>0.012</td>
<td>[0.021 - 0.069]</td>
<td>3.369</td>
<td>0.001</td>
<td>Accepted</td>
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</tr>
<tr>
<td>R²</td>
<td>0.014</td>
<td>0.154</td>
<td>0.130</td>
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<td></td>
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<tr>
<td>Q²</td>
<td>0.005</td>
<td>0.053</td>
<td>0.057</td>
<td></td>
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</tbody>
</table>
| Source: processed primary data, 2024

4.3 DISCUSSION AND IMPLICATION

*Theoretical implication.* The objective of this study was to elucidate the impact of ICS and ADA on DCBMI in the context of GIE establishment. To achieve this, six hypotheses were investigated. Positive effects of all the hypothesized constructs in the proposed model were validated by the statistical results. The validation of the first set of three hypotheses' outcomes emphasized the critical importance of ICS in ADA improvement, DCBMI formation, and GIE development. Without a doubt, ICS, which was instrumental in ensuring the efficient and effective implementation of organizational operations, also provided reasonable assurance regarding the achievement of GIE establishment objectives. Furthermore, these results supported the second set of hypotheses, which suggested that the ADA had a beneficial impact on DCBMI and GIE. It meant that the application of the intersection between accounting information systems and big data analytics would result in an enhancement of DCBMI and, by extension, the GIE. On the other hand, the research findings corroborated the beneficial impact of DCBMI on the GIE in PSOs. It appeared that DCBMI could provide PSOs with the means to maintain their positions and develop their advantages in the GIE amidst the current era of disruptive change brought about by digitalization and significant challenges. This was due to the fact that organizations would consider society and their stakeholders as they developed their business models. Significantly, these results also highlighted the importance of DCBMI as an intermediary between ICS and GIE as well as ADA and GIE, thereby establishing a case for
redefining the function of DCBMI and reshaping the current business model to accommodate GIE.

*Practical implication.* The findings of this study enabled actionable recommendations for PSOs. Priority must be given to highlighting the function of ICS and the advantages it provides for PSOs in the context of DCBMI formulation with respect to GIE establishment. Therefore, it is crucial to prioritize the reshaping of the internal control environment, increase employee awareness regarding internal controls, optimize implementation of various aspects such as the risk assessment mechanism and internal supervision, control activities, and information and communication in alignment with the advancements in modern technologies. Secondly, in consideration of the advantages of ADA, PSO accounting processes must be digitized so as to deliver timely and accurate data. Therefore, it is recommended that the potential resolutions of the ADA be executed concurrently. These resolutions include the following: infrastructure and technological installation to facilitate interindustry interactions by increasing the flow of information; allocation of appropriate budgets and advanced technologies to transform accounting work processes; and increased involvement of accounting staff in the preparation and development of accounting information systems in the context of digital transformations. Particularly with regard to ADA-related training and continuing education programs for accounting personnel, increasing apprehension should be directed in that direction. Thirdly, the significance of DCBMI was emphasized, and this study also generated suggestions for pursuing multiple metrics to attain. In order to enhance the acquisition of valuable information for the formation of effective business innovation models, it is imperative to strengthen connections with both domestic and international organizations. Additionally, ongoing education and training should be provided in the domain of business model design and updating, while an examination of the approaches taken by countries at the forefront of contemporary business model development should be undertaken. Finally, it is advisable that government agencies issue guidance regarding accounting practices and internal control principles in relation to digitalization, so as to ensure the long-term viability of this category of organization. In light of the fact that legal regulations should govern the dissemination of digitalization mechanisms to prevent their abuse and misuse, there should be a greater emphasis on resolutions that strengthen data and information security protection and raise widespread awareness of the dangers associated with irresponsible behavior.
5 CONCLUSION

Despite emphasizing noteworthy contributions and implications, the ongoing scholarly endeavor in a nascent field of study encountered several inevitable limitations. The primary constraint of this research was its geographical scope, which was confined to a particular region of Vietnam. It is recommended that any conclusions or generalizations drawn from this study be approached with caution, as it lacks external validity. Subsequent investigations may therefore concentrate on diverse national and cultural contexts in order to juxtapose the results of the current study. Additionally, as a consequence of temporal and financial limitations, the informants for the present investigation were selected using a snowball and convenience method. Subsequent investigations employing systematic sampling techniques to obtain a substantial sample size may therefore be capable of extrapolating these results and providing all-encompassing management solutions. Furthermore, the utilization of cross-sectional data analysis rendered the parameters inert as opposed to dynamic. Paradoxically, the interrelationships among the variables examined in this research were fluid and susceptible to modification. On the basis of these analyses, longitudinal studies with greater depth could investigate and provide additional theoretical information.

ACKNOWLEDGEMENTS

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REFERENCES


van Eechoud, T., & Ganzaroli, A. (2023). Exploring the role of dynamic capabilities in digital circular business model innovation: Results from a grounded systematic inductive analysis.


