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Opening the black box of digital servitization in manufacturing SMEs

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Abstract

This study examines how ambidextrous innovation and market orientation jointly shape digital servitisation and, through relational capabilities, customer lifetime value (CLV) in Vietnamese manufacturing small and medium-sized enterprises (SMEs). Survey data from 205 firms are analysed with partial least squares structural equation modelling using a two-stage hierarchical component model for digital servitisation, market orientation, inter-functional alignment, and customer participation in value co-creation. The results show that both exploitative and exploratory innovation are positively associated with digital servitisation, with exploratory innovation showing the stronger association. Market orientation strengthens these associations. Digital servitisation is also positively associated with inter-functional alignment and customer participation in value co-creation, which in turn are positively associated with CLV. The study conceptualises digital servitisation as an integrative dynamic capability that links upstream ambidextrous innovation and market orientation to downstream financial value in an emerging-economy SME context, and highlights relational mechanisms that open the “black box” between digital strategies and long-term customer value.

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1. Introduction

Competition in manufacturing is being transformed by digitalisation. Industry 4.0 technologies such as the Internet of Things, cloud computing, and advanced analytics enable a shift from stand-alone products to data-enabled product-service systems (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Lenka *et al.*, 2017; Reim *et al.*, 2021). Digital servitisation (DS)—the digitally enabled extension of servitisation—allows manufacturers to offer advanced services such as remote monitoring, predictive maintenance, and outcome-based solutions (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Kamalaldin *et al.*, 2020; Kohtamäki *et al.*, 2020). While these offerings promise new revenue models and closer customer relationships, many firms struggle to convert digital investments into performance and experience a “digital paradox” when service strategies and organisational capabilities lag behind (Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020; Reim *et al.*, 2021). In this study, the digital paradox refers to the observation that adopting digital technologies does not automatically translate into superior outcomes

when firms lack complementary service strategies and the organisational and relational capabilities needed to embed those technologies in customer-facing value creation. Our model addresses this issue by positioning digital servitisation as an integrative dynamic capability and by testing the internal (inter-functional alignment) and external (customer participation in value co-creation) mechanisms through which DS is associated with customer lifetime value (CLV). From a dynamic capabilities perspective, this “digital paradox” reflects a capability gap: firms may invest in digital technologies (resources), but still fail to sense viable service opportunities, seize them through coherent service strategies, and transform internal processes and external relationships to deliver and capture value (O’Reilly & Tushman, 2008; Teece *et al.*, 1997). Accordingly, our model frames DS as an integrative dynamic capability and empirically examines upstream capability antecedents (ambidextrous innovation and market-oriented sensing) and downstream relational mechanisms (inter-functional alignment and customer participation) that can help explain how digital investments are more likely to translate into long-term customer value (CLV) (Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Reim *et al.*, 2021). A central capability in this context is innovation ambidexterity, the ability to pursue exploratory and exploitative innovation simultaneously (He & Wong, 2004; March, 1991; O’Reilly & Tushman, 2008). Exploratory innovation involves experimentation with new technologies, products, and markets, whereas exploitative innovation focuses on refining existing offerings, processes, and routines. Ambidextrous organisations are better able to respond to turbulence and sustain performance (March, 1991; O’Reilly & Tushman, 2008). However, relatively little is known about how exploration and exploitation jointly shape DS in small and medium-sized enterprises (SMEs), particularly in emerging economies. Market orientation (MO) captures routines for generating, disseminating, and responding to market intelligence (Kohli & Jaworski, 1990; Matsuno *et al.*, 2002; Narver & Slater, 1990). It reflects customer orientation, competitor orientation, and inter-functional coordination that guide innovation priorities and implementation (Kohli & Jaworski, 1990; Narver & Slater, 1990). Prior research suggests that MO strengthens the effects of entrepreneurial and innovation activities on performance by aligning new offerings with customer needs and competitive conditions (Atuahene-Gima & Ko, 2001; Matsuno *et al.*, 2002). Yet its role as a moderator in the innovation ambidexterity–digital servitisation linkage has not been empirically tested. DS also requires linking internal and external relational processes. Internally, the delivery of complex digital solutions depends on inter-functional alignment (IFA) that includes shared objectives,

coordinated processes, and coherent decision-making across functions such as research and development, information technology (IT), production, service, marketing, and sales (Joshi *et al.*, 2003; Kohtamäki *et al.*, 2020). Externally, digital technologies enable customers to participate more actively in value co-creation (cost per completed view [CPVC]) by sharing data, configuring services, and engaging in joint problem-solving (Payne *et al.*, 2008; Vargo & Lusch, 2008; Yi & Gong, 2013). These relational mechanisms may be crucial for translating DS into economic outcomes such as CLV, defined as the net present value of future cash flows generated by a customer relationship (Gupta *et al.*, 2006; Kumar *et al.*, 2004; Kumar & Reinartz, 2018; Rust *et al.*, 2004; Venkatesan & Kumar, 2004). From a dynamic capabilities perspective, organisations must integrate, build, and reconfigure resources to address rapidly changing environments (O’Reilly & Tushman, 2008; Teece *et al.*, 1997). DS can be viewed as such a dynamic capability that connects upstream innovation activities with downstream value creation and capture (Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Reim *et al.*, 2021). Service-dominant logic further emphasises value co-creation through ongoing interactions and resource integration among actors (Payne *et al.*, 2008; Vargo & Lusch, 2008). Combining these perspectives suggests that DS links ambidextrous innovation and market-oriented sensing to relational capabilities and long-term customer value. In Vietnam, the National Digital Transformation Programme (Decision No. 749/QĐ-TTg) has accelerated policy pressure for SMEs to adopt digital solutions, while firm-level evidence suggests uneven technology adoption and substantial implementation challenges (Cirera *et al.*, 2021; Government of Vietnam, 2020). For manufacturing SMEs, limited financial slack and digital skills often constrain large-scale digital projects, which makes capability-based pathways particularly relevant: firms are more likely to benefit from digital servitisation when they can combine both exploratory and exploitative innovation, systematically use market intelligence to prioritise service opportunities (MO), leverage internal coordination (IFA), customer involvement (CPVC) to share data, reduce uncertainty, and co-develop solutions under resource constraints (Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020; Payne *et al.*, 2008; Reim *et al.*, 2021). This context motivates our focus on (i) ambidextrous innovation and MO as upstream drivers of DS and (ii) relational capabilities as mechanisms linking DS to CLV.

2. Theoretical framework and hypotheses development

2.1. Innovation, ambidexterity, and digital

servitisation

Digital servitisation is the process through which manufacturers embed digital technologies into product-service offerings to create data-enriched, often outcome-based solutions (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Kamalaldin *et al.*, 2020; Lenka *et al.*, 2017; Reim *et al.*, 2021). DS requires resource reallocation, process redesignation, and relationship reconfiguration with customers and ecosystem partners, and can therefore be viewed as a dynamic capability (Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Teece *et al.*, 1997). Exploitative and exploratory innovation can contribute to DS through distinct mechanisms and may also involve resource trade-offs (He & Wong, 2004; March, 1991; O'Reilly & Tushman, 2008). Exploitative innovation supports DS by leveraging existing installed base, standardising data flows, and improving reliability and scalability of digitally enabled services (e.g., incremental digital add-ons, process refinement) (Coreynen *et al.*, 2020; Kohtamäki *et al.*, 2020). In contrast, exploratory innovation is critical for experimenting with new digital technologies, service logics, and data-driven business models that underlie advanced services and outcome-based offerings (He & Wong, 2004; Lenka *et al.*, 2017). Because SMEs face constrained resources, prioritising one logic may crowd out the other; however, DS often requires a complementary configuration in which exploitation stabilises and scales service delivery while exploration generates novel digital service concepts (Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Reim *et al.*, 2021). Therefore, we propose separate positive associations for each innovation type with DS. This hypothesis, therefore, expects that both innovation logics will positively support DS:

H_{1a}: Exploitative innovation is positively associated with DS

H_{1b}: Exploratory innovation is positively associated with DS

2.2. Market orientation as a boundary condition

Market orientation reflects the extent to which a company generates, disseminates, and responds to market intelligence (Kohli & Jaworski, 1990; Narver & Slater, 1990). It guides which innovation projects are prioritised and how they are implemented (Matsuno *et al.*, 2002; Narver & Slater, 1990). In SMEs, MO can act as a boundary-spanning capability that links internal innovation efforts to external signals (Atuahene-Gima & Ko, 2001; Matsuno *et al.*, 2002). A strong MO enables firms to identify promising digital service opportunities, align innovation efforts with customer needs, and interpret competitive dynamics within digital platforms and ecosystems (Coreynen *et al.*,

2020; Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020).

Digital servitisation research emphasises that digitalisation generates financial value only when it is aligned with customer needs, service strategy, and relational processes, rather than being driven by technology push alone (Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020; Reim *et al.*, 2021). In this context, MO functions as a market-sensing and interpretation capability that helps SMEs to identify areas where incremental digital improvements (exploitation) are valued and where experimentation (exploration) can be transformed into viable digital service offerings and relational value propositions (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020). Accordingly, MO is expected to enhance the translation of both innovation logics into DS. Firms with high MO are better positioned to recognise which incremental improvements should be digitally enabled and which exploratory initiatives can generate novel digital service solutions (Atuahene-Gima & Ko, 2001; Kohli & Jaworski, 1990).

H_{2a}: MO positively moderates the relationship between exploitative innovation and DS

H_{2b}: MO positively moderates the relationship between exploratory innovation and DS

The proposed research model and hypothesised relationships are presented in Figure 1.

2.3. Digital servitisation and relational capabilities

Digital servitisation stretches across product development, IT, operations, logistics, and customer-facing functions (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Kamalaldin *et al.*, 2020; Kohtamäki *et al.*, 2020). Effective delivery of digital services relies on shared goals, synchronised planning, and coordinated execution—the essence of IFA (Joshi *et al.*, 2003; Kohtamäki *et al.*, 2020). DS initiatives such as predictive maintenance contracts or digital platforms typically require new cross-functional routines, data architectures, and performance metrics that, over time, can enhance IFA (Joshi *et al.*, 2003; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017).

H₃: DS is positively associated with inter-functional alignment

Digital technologies can also create new opportunities for customer participation in value co-creation. Through remote monitoring, portals, and digital platforms, customers can provide real-time data usage, configure service parameters, co-design solutions, and give continuous feedback (Payne *et al.*, 2008; Vargo & Lusch, 2008; Yi & Gong, 2013). DS thus provides a fertile context for co-production, interaction, and citizenship behaviours

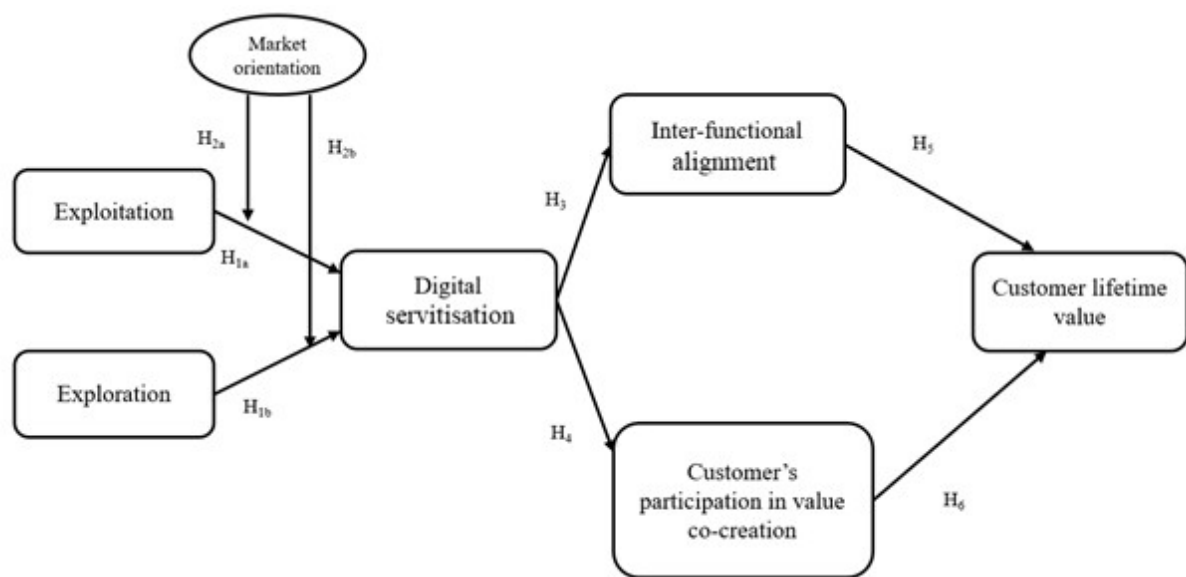


Figure 1. Research model and hypotheses (H_{1a} – H_6)

that characterise CPVC (Payne *et al.*, 2008; Yi & Gong, 2013).

H_4 : DS is positively associated with customers' participation in value co-creation

2.4. Relational mechanisms and customer lifetime value

Customer lifetime value connects acquisition, retention, and cross-buying behaviour with firm value (Gupta *et al.*, 2006; Rust *et al.*, 2004; Venkatesan & Kumar, 2004). Traditionally, CLV research has emphasised marketing programmes and customer behaviour, but organisational capabilities such as IFA and CPVC are increasingly recognised as antecedents (Kumar *et al.*, 2004; Kumar & Reinartz, 2018; Payne *et al.*, 2008). Strong IFA helps ensure that promises made in marketing and sales are reliably delivered by operations and service, reducing failures and enhancing satisfaction and loyalty (Joshi *et al.*, 2003). High CPVC deepens relationships through trust, mutual learning, and solution fit, which supports retention and share of wallet (Payne *et al.*, 2008; Vargo & Lusch, 2008; Yi & Gong, 2013). The following hypotheses are therefore proposed:

H_5 : Inter-functional alignment is positively associated with CLV

H_6 : Customers' participation in value co-creation is positively associated with CLV

Together, H_1 – H_6 position DS as an integrative dynamic capability that channels ambidextrous innovation and MO

into relational mechanisms and CLV in manufacturing SMEs (Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Reim *et al.*, 2021; Teece *et al.*, 1997).

3. Methodology

3.1. Sampling and data collection

Data were collected via a structured questionnaire sent by post to manufacturing SMEs in Vietnam, with telephone and email reminders. Participation was voluntary; respondents were informed about the study's purpose and confidentiality protections, and they provided informed consent prior to completing the questionnaire. The sampling frame was derived from the list of manufacturing SMEs provided by the Ministry of Industry and Trade of Vietnam. Due to practical access constraints and incomplete reachable contact details for SME owners/managers within this directory, probability-based random sampling was not feasible. We therefore used a non-probability, purposive approach by contacting manufacturing SMEs with available postal addresses and confirming eligibility via follow-up calls. To mitigate sectoral and regional bias, we targeted firms across multiple manufacturing subsectors and major industrial provinces in the North, Centre, and South. The survey targeted owners and general managers, who were expected to have an overview of innovation projects, digital initiatives, and commercial operations. Of 230 questionnaires distributed, 205 usable responses were obtained after removing cases with substantial missing data or inconsistent answers. The sample covers a broad range of subsectors, including food

and beverages, textiles and clothing, wood and furniture, metal goods and machinery, electronics, and other light industries, and mainly privately owned business-to-business firms. Respondents were located in major industrial provinces across the North, Centre, and South, consistent with evidence on the geographic dispersion of firm-level technology adoption in Vietnam (Cirera *et al.*, 2021). National digital transformation policies, such as Decision No. 749/QD-TTg, further underline the strategic importance of digitalisation for Vietnamese SMEs (Government of Vietnam, 2020). This sectoral and regional diversity provides a solid empirical basis for examining how ambidextrous innovation and DS capabilities relate to CLV.

3.2. Measures

All latent constructs were measured with multi-item scales adapted from prior validated instruments and tailored to the SME context. Unless otherwise stated, items used five-point Likert scales (1 = strongly disagree, 5 = strongly agree). The questionnaire was developed in English, translated into Vietnamese, and back-translated by independent bilingual experts. A pilot test with SME managers led to minor wording refinements.

Innovation ambidexterity is captured by two first-order reflective constructs: exploitative innovation and exploratory innovation, measured with items adapted from prior ambidexterity scales (He & Wong, 2004; March, 1991; O'Reilly & Tushman, 2008). Exploitative innovation involves refining existing products, processes, and technologies, while exploratory innovation involves experimenting with new technologies, products, and markets.

Digital servitisation is measured as a multidimensional construct reflecting the extent to which firms use digital technologies to support and deliver advanced services and outcome-based offerings (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Kamalaldin *et al.*, 2020; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Reim *et al.*, 2021). MO captures customer orientation, competitor orientation, and inter-functional coordination based on established scales (Kohli & Jaworski, 1990; Matsuno *et al.*, 2002; Narver & Slater, 1990). IFA is conceptualised with three dimensions, namely operational, tactical, and strategic alignment that tap coordination of workflows, joint planning, and shared long-term priorities across key functions (Joshi *et al.*, 2003). CPVC is measured via co-production, interaction, and citizenship behaviours adapted from existing value co-creation scales (Payne *et al.*, 2008; Yi & Gong, 2013).

Customer lifetime value is defined as the net present value of expected profits from a focal customer segment

over the remaining duration of the relationship (Gupta *et al.*, 2006; Kumar & Reinartz, 2018; Rust *et al.*, 2004; Venkatesan & Kumar, 2004). Given limited transaction-level data in Vietnamese SMEs, CLV is operationalised as a composite index combining managers' assessments of average order value, purchase frequency, gross margin, and expected relationship length for the main customer segment, consistent with prior CLV applications in data-limited contexts (Gupta *et al.*, 2006; Kumar *et al.*, 2004; Venkatesan & Kumar, 2004). Although this perceptual composite approach is pragmatic in data-scarce SME settings (Gupta *et al.*, 2006; Kumar *et al.*, 2004; Venkatesan & Kumar, 2004), objective transaction-level or accounting data were not available to assess convergent validity against financial records in the present study. We therefore interpret CLV as a manager-perceived proxy and highlight this limitation, encouraging future work to triangulate with archival customer profitability and retention data where feasible.

To reduce common method bias (CMB), several procedural remedies were implemented, including ensuring anonymity and psychological separation between the predictor and criterion constructs. Ex post, CMB was assessed using common guidelines from the behavioural research literature (Podsakoff *et al.*, 2003).

3.3. Data Analysis

Data screening and descriptive statistics were conducted in SPSS (IBM, USA). Given that the study aims to explain and predict key constructs, the model includes several higher-order constructs, and SME data may deviate from normality, partial least squares structural equation modelling (PLS-SEM) was employed using SmartPLS (Hair *et al.*, 2021). PLS-SEM is suitable for complex models with relatively small to medium sample sizes and does not require multivariate normality (Hair *et al.*, 2021). A two-stage hierarchical component model was applied to estimate the reflective higher-order constructs (Becker *et al.*, 2012). In the first stage, lower-order dimensions (LOCs) and their indicators were estimated; in the second stage, LOC scores served as indicators for the reflective higher-order constructs (DS, MO, IFA, CPVC) (Becker *et al.*, 2012). Standard procedures were followed to assess reliability, convergent validity, and discriminant validity of the measurement model. Reliability and convergent validity were evaluated using composite reliability and average variance extracted (AVE) (Fornell & Larcker, 1981; Hair *et al.*, 2021). Discriminant validity was assessed by comparing the square root of AVE with inter-construct correlations.

4. Results

4.1. Measurement model

All reflective constructs exhibit satisfactory indicator loadings and internal consistency. Composite reliabilities exceed recommended thresholds, and AVE values indicate adequate convergent validity (Fornell & Larcker, 1981; Hair *et al.*, 2021). The reliability and convergent validity results for the higher-order constructs are presented in Table 1.

Discriminant validity is assessed using the Fornell–Larcker criterion (Fornell & Larcker, 1981). These results support the adequacy of the measurement model for testing the structural relationships. Discriminant validity for the higher-order constructs, assessed using the Fornell–Larcker criterion, is shown in Table 2.

4.2. Structural model assessment

The structural model explains substantial proportions of variance in DS, IFA, CPVC, and CLV ($R^2_{DS} = 0.668$, $R^2_{IFA} = 0.248$, $R^2_{CPVC} = 0.228$, $R^2_{CLV} = 0.372$). Both exploitative and exploratory innovation show positive, significant associations with DS, supporting H1a and H1b, with the coefficient for exploratory innovation being clearly stronger. The detailed structural model results, including the standardised path coefficients, t-values, p-values, and effect sizes, are reported in Table 3. In addition, the direct association of market orientation with DS is positive and significant ($\beta = 0.154$, $p = 0.007$). Stone–Geisser’s Q^2

values indicate predictive relevance for the endogenous constructs ($Q^2_{DS} = 0.637$, $Q^2_{IFA} = 0.196$, $Q^2_{CPVC} = 0.175$, $Q^2_{CLV} = 0.355$). The overall structural model, including the standardised path coefficients and R^2 values for the endogenous constructs, is shown in Figure 2.

Interaction terms between MO and each innovation type are positive and significant, supporting H2a and H2b. Higher levels of MO strengthen the association between both exploitative and exploratory innovation and DS, consistent with the view of MO as a boundary-spanning capability that directs innovation efforts towards valuable digital service opportunities (Atuahene-Gima & Ko, 2001; Kohli & Jaworski, 1990; Matsuno *et al.*, 2002; Narver & Slater, 1990). Ambidextrous innovation is thus more effectively translated into digital services in SMEs that systematically generate and use market intelligence.

To facilitate interpretation of the moderation effects, we probed the interactions using simple slopes (conditional effects) at low and high levels of MO (–1 SD and +1 SD). For exploitative innovation, the conditional effect on DS increases from 0.127 at low MO to 0.581 at high MO. For exploratory innovation, the conditional effect on DS increases from 0.313 at low MO to 0.761 at high MO. Figure 3 visualises these interaction patterns and highlights that market-oriented SMEs translate both innovation logics

Table 1. Measurement model for higher-order constructs: reliability and convergent validity

	Cronbach's alpha	CR	AVE	Outline
CPVC	0.870	0.920	0.794	0.869–0.907
EL_IA	0.818	0.873	0.578	0.705–0.806
EX_IA	0.833	0.878	0.545	0.725–0.818
IFA	0.875	0.923	0.800	0.858–0.919
MO	0.861	0.913	0.778	0.862–0.893
DS	n/a (two-stage HCM)	n/a (two-stage HCM)	n/a (two-stage HCM)	Second-order construct (two-stage HCM); reliability/validity assessed at first-order level (Tables A1–A3)
CLV	n/a (single-indicator index)	n/a (single-indicator)	n/a (single-indicator)	Manager-perceived CLV composite index operationalised as a single indicator (Section 3.2)

Notes: DS is modelled as a second-order construct using a two-stage hierarchical component model (HCM); therefore, internal consistency and AVE metrics are evaluated at the first-order construct level (Tables A1–A3). CLV is operationalised as a single-indicator composite index, so Cronbach's alpha/CR/AVE are not applicable.

Abbreviations: AVE: Average variance extracted; CLV: Customer lifetime value; CPVC: Cost per completed view; CR: Composite reliability; DS: Digital servitisation; EL_IA: Exploration logic–innovation ambidexterity; EX_IA: Exploitation logic–innovation ambidexterity; IFA: Inter-functional alignment; MO: Market orientation.

Table 2. Discriminant validity for higher-order constructs (Fornell–Larcker criterion)

	CLV	CPVC	DS	EL_IA	EX_IA	IFA	MO
CLV	1.000	–	–	–	–	–	–
CPVC	0.504	0.891	–	–	–	–	–
DS	0.096	0.477	1.000	–	–	–	–
EL_IA	0.119	0.353	0.642	0.760	–	–	–
EX_IA	0.028	0.255	0.490	0.295	0.738	–	–
IFA	0.524	0.423	0.498	0.425	0.264	0.894	–
MO	0.017	0.095	0.127	0.023	-0.110	0.029	0.882

Notes: The square root AVE values are shown by the data on the bold diagonal. For the higher-order construct (DS) and the single-item CLV index, AVE-based diagnostics are not applicable; their diagonal values are shown as 1.000 for completeness. For DS (higher-order construct) and CLV (single-item index), the diagonal is fixed at 1.000.

Abbreviations: AVE: Average variance extracted; CLV: Customer lifetime value; CPVC: Cost per completed view; DS: Digital servitisation; EL_IA: Exploration logic–innovation ambidexterity; EX_IA: Exploitation logic–innovation ambidexterity; IFA: Inter-functional alignment; MO: Market orientation.

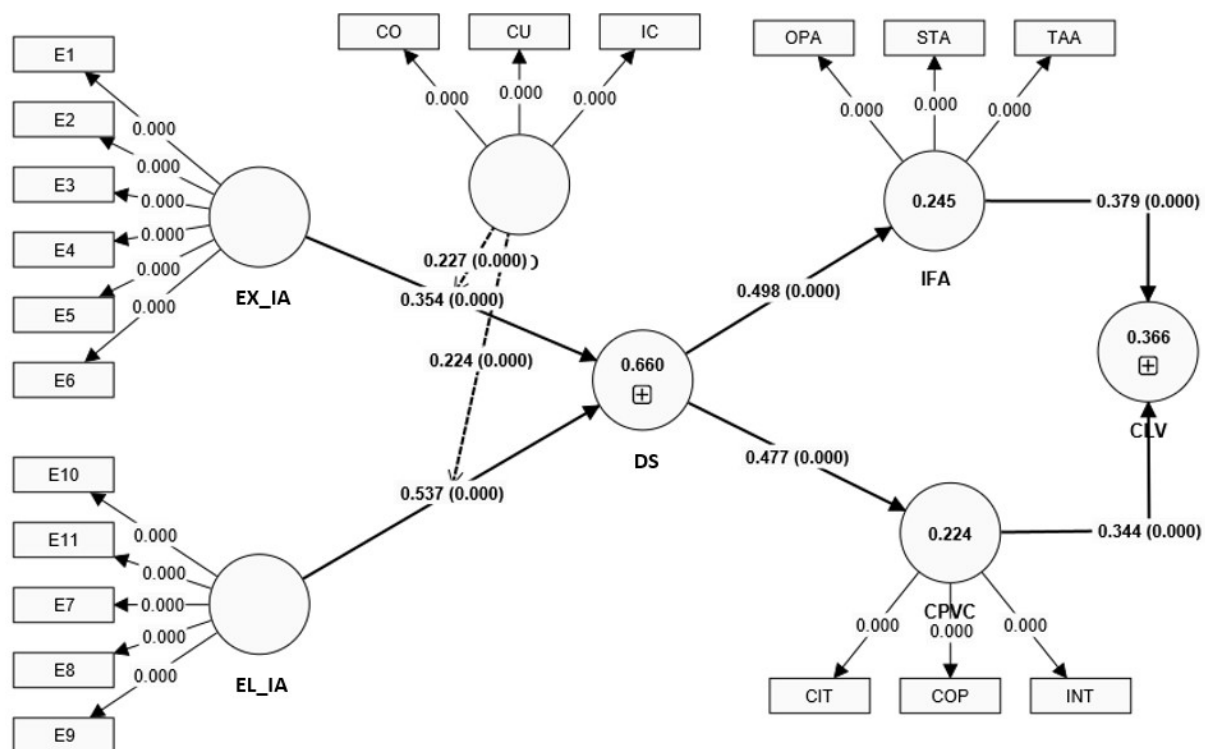


Figure 2. Partial least squares structural equation modelling results for the research model (standardised path coefficients and R^2 values)

Abbreviations: CIT: Customer integration (technology); CLV: Customer lifetime value; CO: Customer Orientation; COP: Company performance; CU: Customer use; DS: Digital servitisation; E: Efficiency; EL_IA: Exploration logic–innovation ambidexterity; EX_IA: Exploitation logic–innovation ambidexterity; IC: Innovation capability; IFA: Inter-functional alignment; INT: Intention; OPA: Organisational process agility; STA: Strategic agility; TAA: Technology adoption ability.

into digital servitisation more strongly.

Digital servitisation is significantly and positively associated with both IFA and CPVC, supporting H3 and H4. Firms with stronger DS capabilities report greater alignment across key internal functions and higher levels of customer involvement in co-creating solutions (Joshi *et al.*, 2003; Kamalaldin *et al.*, 2020; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Payne *et al.*, 2008; Yi & Gong, 2013). This is consistent with the view that DS represents an organisational and relational transformation rather than a purely technological initiative (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Reim *et al.*, 2021).

Finally, IFA and CPVC are positively and significantly associated with CLV, supporting H5 and H6. The results suggest that DS is associated with CLV not only directly but also indirectly through stronger cross-functional alignment and richer customer co-creation behaviour

(Kumar *et al.*, 2004; Kumar & Reinartz, 2018; Payne *et al.*, 2008; Rust *et al.*, 2004; Venkatesan & Kumar, 2004). Together, these findings provide coherent support for the proposed model: innovation ambidexterity—especially exploratory innovation—is positively associated with DS; MO strengthens these associations; DS is associated with stronger internal and external relational capabilities; and these relational mechanisms are associated with higher CLV in Vietnamese manufacturing SMEs. The bootstrapping results for the specific and total indirect effects are presented in Table 4.

5. Discussion, implications and conclusion

This study advances three streams of literature. First, it contributes to research on innovation ambidexterity and dynamic capabilities by clarifying how exploratory and exploitative innovation jointly support DS in SMEs (He &

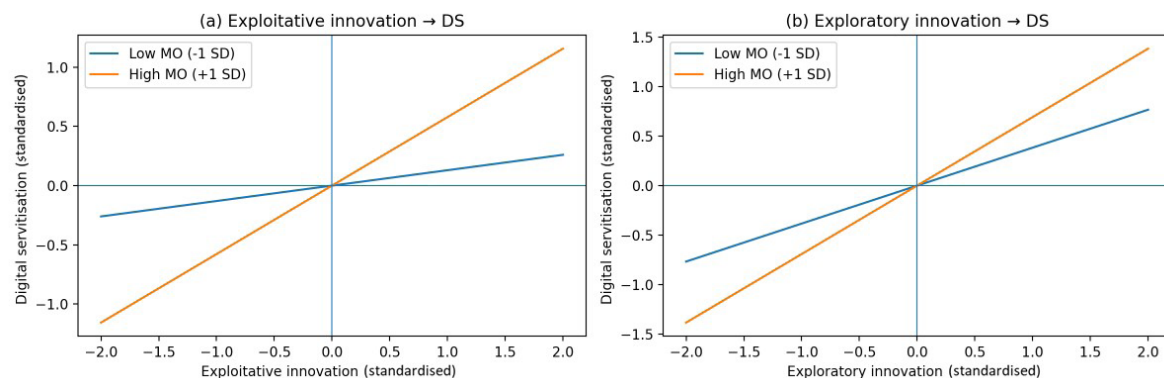


Figure 3. Simple slope plots for the moderation effects of market orientation. (a) The moderating effect of market orientation on the exploitative innovation–digital servitisation relationship. (b) The moderating effect of market orientation on the exploratory innovation–digital servitisation relationship. Abbreviations: DS: Digital servitisation; MO: Market orientation; SD: Standard deviation.

Table 3. Structural model results: standardised path coefficients, *t*-values, *p*-values and effect sizes (*f*²)

Hypothesis	Relationship	β	<i>t</i>	<i>p</i> -value	<i>f</i> ²	Result
H1a	EX_IA → DS	0.354	7.548	<0.001	0.335	Accepted
H1b	EL_IA → DS	0.537	12.836	<0.001	0.782	Accepted
H2a	MO × EX_IA → DS	0.227	3.570	<0.001	0.125	Accepted
H2b	MO × EL_IA → DS	0.224	4.011	<0.001	0.141	Accepted
H3	DS → IFA	0.498	10.477	<0.001	0.330	Accepted
H4	DS → CPVC	0.477	8.680	<0.001	0.295	Accepted
H5	IFA → CLV	0.379	6.637	<0.001	0.188	Accepted
H6	CPVC → CLV	0.344	6.286	<0.001	0.155	Accepted
–	MO → DS (direct effect)	0.154	2.702	0.007	0.069	–

Abbreviations: CLV: Customer lifetime value; CPVC: Cost per completed view; DS: Digital servitisation; EL_IA: Exploration logic–innovation ambidexterity; EX_IA: Exploitation logic–innovation ambidexterity; IFA: Inter-functional alignment; MO: Market orientation.

Table 4. Bootstrapping results for specific and total indirect effects

Indirect effect	β	t	p -value
DS \rightarrow CLV (total indirect via IFA and CPVC)	0.353	10.604	<0.001
DS \rightarrow IFA \rightarrow CLV	0.189	6.232	<0.001
DS \rightarrow CPVC \rightarrow CLV	0.164	6.112	<0.001
EL_IA \rightarrow CLV (total indirect)	0.190	8.009	<0.001
EX_IA \rightarrow CLV (total indirect)	0.125	6.238	<0.001

Note: β denotes standardised indirect effects estimated via bootstrapping; p -values are two-tailed.

Abbreviations: CLV: Customer lifetime value; CPVC: Cost per completed view; DS: Digital servitisation; EL_IA: Exploration logic–innovation ambidexterity; EX_IA: Exploitation logic–innovation ambidexterity; IFA: Inter-functional alignment.

Wong, 2004; March, 1991; O'Reilly & Tushman, 2008; Teece *et al.*, 1997). Ambidexterity is known to foster innovation and performance; the results show that, in the DS context, exploratory innovation has a stronger association with exploitative innovation, playing a complementary role (March, 1991; O'Reilly & Tushman, 2008). MO emerges as a boundary condition that strengthens both associations, suggesting that sensing and interpreting market signals is critical for converting ambidextrous innovation into viable digital service offerings (Atuahene-Gima & Ko, 2001; Kohli & Jaworski, 1990; Matsuno *et al.*, 2002; Narver & Slater, 1990).

Second, the study enriches DS research and service-dominant logic by showing how DS links to downstream customer value through relational mechanisms (Coreynen *et al.*, 2020; Gebauer *et al.*, 2021; Kamalaldin *et al.*, 2020; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017; Payne *et al.*, 2008; Reim *et al.*, 2021; Vargo & Lusch, 2008). DS is conceptualised as an integrative, higher-order capability that reconfigures internal coordination and customer interfaces (Gebauer *et al.*, 2021; Kohtamäki *et al.*, 2020; Lenka *et al.*, 2017). Empirically, the findings indicate that DS is positively associated with both IFA and CPVC, which in turn are positively associated with CLV. This helps to unravel the “black box” between digital transformation initiatives and economic performance (Payne *et al.*, 2008; Vargo & Lusch, 2008).

For managers, the findings highlight several priorities. Exploratory and exploitative innovation should be treated as complementary levers: continuous improvement of existing offerings remains necessary, but investments in

exploratory digital initiatives such as pilots with sensors, data-driven services, and new business models may be particularly important for strengthening DS capabilities (He & Wong, 2004; Lenka *et al.*, 2017; O'Reilly & Tushman, 2008). Given the resource constraints typical of Vietnamese manufacturing SMEs (limited financial slack and digital skills), a phased approach is often more feasible: begin with low-cost, modular pilots for strategically important customers and scale them after demonstrating measurable service and customer value. SMEs can also leverage cloud-based, pay-as-you-go solutions and collaborate with technology providers and key customers to access skills and share implementation risks. Strengthening MO is also likely to be beneficial, as it ensures that innovation projects are guided by a deep understanding of customer problems and competitive dynamics (Kohli & Jaworski, 1990; Matsuno *et al.*, 2002; Narver & Slater, 1990). Managers may also view DS as an organisational change process: cross-functional teams, shared metrics, and integrated data architectures can help firms realise the potential of digital services and are more likely to support IFA (Joshi *et al.*, 2003; Kohtamäki *et al.*, 2020). Finally, linking DS to CLV may encourage a long-term customer-equity perspective, focusing on retention, cross-buying, and relationship value rather than short-term revenue (Gupta *et al.*, 2006; Kumar *et al.*, 2004; Rust *et al.*, 2004; Venkatesan & Kumar, 2004).

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Conflict of interest

The authors declare they have no competing interests.

Author contributions

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Ethics approval and consent to participate

Ethical approval by an institutional review board/ethics committee was not required for this study under prevailing research governance practices in Vietnam for anonymous, non-interventional questionnaire surveys involving adult business owners/managers. Participation was voluntary, and informed consent was obtained prior to data collection. No personally identifiable information was collected, and the data were analysed in aggregate form.

Consent for publication

Not applicable. This manuscript does not contain any individual person's data or images in an identifiable form. All survey responses were collected anonymously and are reported only in aggregate and/or fully anonymised form. During the consent process, participants were informed that their anonymised data may be used for academic publications.

Availability of data

The datasets generated and/or analysed during the current study are not publicly available due to confidentiality and ethical restrictions associated with survey data from SMEs. De-identified data are available from the corresponding author upon reasonable request, subject to approval of the request, relevant institutional requirements, and the signing of a data-use agreement (if applicable).

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Appendix

A. Measurement model details

Table A1 reports reliability and convergent validity for the lower-order constructs (LOCs). Tables A2 and A3 provide indicator loadings (LOC level and stage-2 loadings for higher-order constructs). Table A4 reports Heterotrait–Monotrait ratios for the main latent variables, and Table A5 reports variance inflation factor values for the structural model paths.

Table A1. Reliability and convergent validity (lower-order constructs)

Construct	α	ρ_A	CR	AVE
CIT	0.869	0.869	0.905	0.656
CO	0.788	0.794	0.863	0.611
COP	0.843	0.844	0.888	0.614
CU	0.870	0.873	0.902	0.607
EL	0.818	0.827	0.873	0.578
EX	0.833	0.836	0.878	0.545
IC	0.862	0.869	0.900	0.644
INT	0.805	0.809	0.873	0.632
OPA	0.873	0.874	0.908	0.664
STA	0.888	0.893	0.914	0.641
TAA	0.853	0.859	0.895	0.632

Abbreviations: AVE: Average variance extracted; CIT: Customer integration (technology); CO: Customer Orientation; COP: Company performance; CR: Composite reliability; CU: Customer use; EL: Exploration logic; EX: Exploitation logic; IC: Innovation capability; INT: Intention; OPA: Organisational process agility; STA: Strategic agility; TAA: Technology adoption ability.

Table A2. Indicator loadings (lower-order constructs)

Indicator	Construct	Loading
CPVC10	CIT	0.805
CPVC11	CIT	0.808
CPVC12	CIT	0.807
CPVC13	CIT	0.816
CPVC14	CIT	0.814
MO10	CO	0.804
MO7	CO	0.813
MO8	CO	0.731
MO9	CO	0.777
CPVC1	COP	0.768
CPVC2	COP	0.796
CPVC3	COP	0.778
CPVC4	COP	0.809
CPVC5	COP	0.766
MO1	CU	0.720
MO2	CU	0.784
MO3	CU	0.779
MO4	CU	0.811
MO5	CU	0.794
MO6	CU	0.784
E10	EL	0.818
E11	EL	0.763
E7	EL	0.732
E8	EL	0.725
E9	EL	0.762
E1	EX	0.709
E2	EX	0.724
E3	EX	0.705
E4	EX	0.745
E5	EX	0.735
E6	EX	0.806

(cont'd...)

Table A2. (Continued)

Indicator	Construct	Loading
MO11	IC	0.799
MO12	IC	0.853
MO13	IC	0.781
MO14	IC	0.822
MO15	IC	0.753
CPVC6	INT	0.799
CPVC7	INT	0.752
CPVC8	INT	0.841
CPVC9	INT	0.785
IFA1	OPA	0.836
IFA2	OPA	0.836
IFA3	OPA	0.832
IFA4	OPA	0.785
IFA5	OPA	0.782
IFA11	STA	0.784
IFA12	STA	0.746
IFA13	STA	0.773
IFA14	STA	0.805
IFA15	STA	0.817
IFA16	STA	0.874
IFA10	TAA	0.758
IFA6	TAA	0.831
IFA7	TAA	0.746
IFA8	TAA	0.759
IFA9	TAA	0.872

Abbreviations: CIT: Customer integration (technology); CLV: Customer lifetime value; CO: Customer Orientation; COP: Company performance; CPVC: Customer participation value co-creation; CU: Customer use; E: Efficiency; EL: Exploration logic; EX: Exploitation logic; IC: Innovation capability; IFA: Inter-functional alignment; INT: Intention; MO: Market orientation; OPA: Organisational process agility; STA: Strategic agility; TAA: Technology adoption ability.

Table A3. Stage-2 loadings used in the two-stage hierarchical component model

Indicator (stage-1 latent scores/ composite index)	Construct	Loading
CLV	CLV	1.000
CIT	CPVC	0.907
COP	CPVC	0.896
INT	CPVC	0.869
D_raw	D	1.000
E10	EL	0.818
E11	EL	0.763
E7	EL	0.732
E8	EL	0.725
E9	EL	0.762
E1	EX	0.709
E2	EX	0.724
E3	EX	0.705
E4	EX	0.745
E5	EX	0.735
E6	EX	0.806
OPA	IFA	0.858
STA	IFA	0.919
TAA	IFA	0.904
CO	MO	0.893
CU	MO	0.862
IC	MO	0.891

Abbreviations: CIT: Customer integration (technology); CLV: Customer lifetime value; CO: Customer Orientation; COP: Company performance; CPVC: Customer participation value co-creation; CU: Customer use; D: Digitalisation; E: Efficiency; EL: Exploration logic; EX: Exploitation logic; IC: Innovation capability; IFA: Inter-functional alignment; INT: Intention; MO: Market orientation; OPA: Organisational process agility; STA: Strategic agility; TAA: Technology adoption ability.

Table A4. HTMT ratios (higher-order constructs)

	CLV	CPVC	D	EL	EX	IFA	MO
CLV	–	–	–	–	–	–	–
CPVC	0.540	–	–	–	–	–	–
D	0.096	0.509	–	–	–	–	–
EL	0.128	0.414	0.702	–	–	–	–
EX	0.071	0.292	0.529	0.350	–	–	–
IFA	0.561	0.483	0.531	0.498	0.299	–	–
MO	0.062	0.106	0.130	0.116	0.142	0.090	–

Abbreviations: CLV: Customer lifetime value; CPVC: Customer participation value co-creation; D: Digitalisation; EL: Exploration logic; EX: Exploitation logic; HTMT: Heterotrait–Monotrait; IFA: Inter-functional alignment; MO: Market orientation.

Table A5. Collinearity assessment (VIF for structural paths)

Path	VIF
CPVC -> CLV	1.217
D -> CPVC	1.000
D -> IFA	1.000
EL -> D	1.113
EX -> D	1.125
IFA -> CLV	1.217
MO -> D	1.046
MO × EL -> D	1.149
MO × EX -> D	1.151

Abbreviations: CLV: Customer lifetime value; CPVC: Customer participation value co-creation; D: Digitalisation; EL: Exploration logic; EX: Exploitation logic; IFA: Inter-functional alignment; MO: Market orientation; VIF: Variance inflation factor.