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Green omnichannel capability and brand loyalty management: organisational assessments of customer green perception and behaviour in Thai businesses

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Abstract: This study examines how green omnichannel capability supports brand loyalty management through customer green perception and green customer behaviour. Survey data were collected from 600 businesses in Thailand and analysed using structural equation modelling. The results show that green omnichannel capability positively influences customer green perception ($\beta = 0.609$) and green customer behaviour ($\beta = 0.404$). Customer green perception also positively influences green customer behaviour ($\beta = 0.350$). In addition, customer green perception ($\beta = 0.413$) and green customer behaviour ($\beta = 0.382$) positively influence brand loyalty management. All hypothesised paths were significant at $p < 0.001$. The model explains 50.5% of the variance in brand loyalty management. The findings position green omnichannel capability as a market-facing business innovation capability. As the data were obtained from organisational respondents, the customer-related constructs are interpreted as managerial assessments rather than direct customer-level evidence.

Keywords: green omnichannel capability; customer green perception; green customer behaviour; brand loyalty management; sustainability marketing.

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1 Introduction

Digital transformation has changed the logic of marketing channel management. Firms increasingly compete by coordinating digital platforms, physical touchpoints, logistics interfaces, customer data and post-purchase communication into an integrated market-facing system. Omnichannel marketing therefore extends beyond operating multiple channels by integrating channels, information, fulfilment processes and customer experience across the customer journey (Beck and Rygl, 2015; Verhoef et al., 2015; Lemon and Verhoef, 2016). Recent digital retailing research also shows that technology-enabled transformation alters how firms design customer experiences, coordinate touchpoints, and create value across physical and digital environments (Grewal et al., 2020; Hoyer et al., 2020).

Recent evidence from Thai business contexts further indicates that channel and operational performance depend on the integration of organisational change, technology management, customer engagement, supply chain agility, logistics flexibility and governance mechanisms. Related procurement and channel studies show that firms require coordinated organisational, technological and inter-organisational capabilities to improve performance and resilience across business systems (Sukhawattanakun et al., 2023; Sukhawattanakun, 2026; Supapon et al., 2026).

Sustainability expectations have added a further strategic dimension to omnichannel marketing. Firms are increasingly expected to communicate environmental responsibility, reduce resource waste, improve transparency and support more responsible consumption. Sustainability-oriented innovation is not limited to green products or cleaner production but also encompasses organisational routines, market practices, and business processes that create economic, environmental, and social value (Adams et al., 2016; Watson et al., 2020). Green innovation research similarly suggests that environmental responsibility can be embedded into product innovation, operational systems and organisational capabilities (Dangelico, 2016; Saunila et al., 2018; Takalo et al., 2021). Within this context, omnichannel marketing provides a relevant mechanism through which firms can communicate, deliver and reinforce green value across connected customer touchpoints.

This study conceptualises green omnichannel capability as a market-facing business innovation capability. The construct reflects a firm's ability to integrate online and offline marketing channels with sustainability-oriented communication, fulfilment, customer engagement and relationship management practices. For example, firms may use digital platforms to provide green product information, reduce printed materials, design sustainable delivery options, support packaging return programmes, apply data analytics to improve demand planning and use loyalty programmes to encourage responsible consumption (Adams et al., 2016; Watson et al., 2020; Sukhawattanakun, 2026). Therefore, green omnichannel capability is not simply a promotional activity but a capability that aligns channel integration with environmental responsibility and customer-related value creation. This capability-based interpretation is consistent with research suggesting that market-facing capabilities and an innovation orientation can support business innovation when firms integrate market information and capabilities in strategic planning and implementation (Pscheidt-Gieseler et al., 2018; Nuryakin et al., 2021; Sukhawattanakun, 2026).

The relationship between green omnichannel capability and brand loyalty management requires further theoretical attention. Customer loyalty in sustainability-oriented markets is shaped not only by product quality, service experience or price value, but also by how customers perceive a firm's environmental initiatives and whether those initiatives translate into customer-related behavioural responses. Prior studies have linked green brand image, green satisfaction, green trust, perceived green value and green purchase intention to customer responses (Chen, 2010; Chen and Chang, 2012), while omnichannel research suggests that channel integration and customer experience can strengthen engagement and loyalty across connected touchpoints (Gao and Huang, 2021; Zhang et al., 2024).

Despite these developments, three issues remain insufficiently explained. First, omnichannel studies have largely examined channel integration, customer journey design, retail transformation and digital technology, while the sustainability-oriented role of omnichannel capability has received less systematic attention (Reinartz et al., 2019; Gerea et al., 2021; Vhatkar et al., 2024). Second, green marketing research has explained how green brand equity, perceived green value, green trust and green loyalty shape customer responses, but has paid less attention to how integrated channel systems make sustainability initiatives visible, credible and actionable across customer touchpoints (Chen, 2010; Chen and Chang, 2012; Martínez, 2015; Papista and Dimitriadis, 2019). Third, prior studies have mainly examined green perception, green behaviour and loyalty from the consumer side. Less attention has been given to how firms assess and manage these customer-related mechanisms as part of a broader market-facing capability (Lin and Huang, 2012; Yadav and Pathak, 2017; Zhao et al., 2025).

This study addresses these gaps by examining green omnichannel capability as a business innovation capability that connects sustainability-oriented channel integration with brand loyalty management. The proposed model focuses on two customer-related mechanisms. Customer green perception captures how firms manage customers' recognition, interpretation and evaluation of green initiatives across channel touchpoints. Green customer behaviour examines how firms encourage, support, and monitor customer-related green behaviour through communication, channel design, reward systems, and participation mechanisms. Brand loyalty management refers to the firm's management of loyalty-related outcomes, including trust, repeat purchase, advocacy, relationship continuity and sustained customer support.

The study develops a dual-pathway explanation of how green omnichannel capability supports loyalty-related management outcomes. The first pathway is perception-based, in which green omnichannel capability makes sustainability initiatives more visible, credible, and meaningful across customer touchpoints. The second pathway is behaviour-based, in which green omnichannel capability encourages customer-related green actions and supports relationship continuity. The model also recognises that perception and behaviour are connected mechanisms, as customers are more likely to participate in green behaviour when sustainability initiatives are consistently understood and trusted. The proposed pathway logic is consistent with prior research linking perceived green value, green trust, environmental concern, environmental attitude and perceived behavioural control to green purchase intention and green behaviour (Chen and Chang, 2012; Lin and Huang, 2012; Yadav and Pathak, 2017; Ogiemwonyi et al., 2023).

Thailand provides a suitable empirical context for this investigation. Businesses in Thailand face increasing pressure to digitalise marketing channels, respond to

sustainability expectations and maintain customer loyalty under competitive market conditions. The study uses survey data collected from 600 manufacturing, trading and service businesses in Thailand. Respondents were organisational representatives with knowledge of marketing channel practices, sustainability initiatives, customer-related strategies and business operations. The findings are therefore interpreted as managerial assessments of customer-related mechanisms rather than direct consumer responses.

The study contributes to research on business innovation and sustainability marketing in four ways. First, the study conceptualises green omnichannel capability as a market-facing business innovation capability that embeds sustainability responsibility into channel architecture, digital communication, fulfilment processes and relationship management. Second, the proposed framework clarifies the complementary roles of customer green perception and green customer behaviour as mechanisms linking green omnichannel capability to brand loyalty management. Third, the empirical evidence from Thai businesses extends green customer research beyond direct consumer responses by showing how firms manage customer-related green perception, green behaviour and loyalty outcomes within sustainability-oriented omnichannel systems. Fourth, the study links green omnichannel capability to broader perspectives on dynamic channel capability and channel resilience.

Accordingly, the study addresses the following research question: how does green omnichannel capability support brand loyalty management through customer green perception and green customer behaviour in Thai businesses? To answer this question, structural equation modelling is used to test the relationships among the four latent constructs and to assess the explanatory power of the proposed dual-pathway framework.

2 Literature review and hypothesis development

2.1 *Green omnichannel capability as a business innovation capability*

Green omnichannel capability refers to a firm's ability to integrate online and offline marketing channels with sustainability-oriented communication, digital coordination, fulfilment processes, customer engagement and relationship management. The construct reflects a market-facing capability through which firms align channel integration, environmental responsibility and customer-related value creation. In the present study, green omnichannel capability is measured using retained indicators coded as GOC, which represent green channel integration, digital applications, automated warehouse management, paperless communication, green channel incentives, lower-impact distribution, and continuous channel improvement.

Green omnichannel capability can be positioned within a broader capability-integration logic. Prior studies show that channel performance, dynamic channel capability and retail-wholesale resilience are strengthened when digital, relational, operational and governance capabilities are coordinated across business systems (Sukhawattanakun, 2026; Sukhawattanakun et al., 2026; Supapon et al., 2026). From this perspective, green omnichannel capability is broader than conventional channel integration because the construct connects digital-physical coordination with sustainability-oriented communication, fulfilment, customer participation and loyalty-related management.

Green omnichannel capability is conceptually distinct from several related constructs. Conventional omnichannel integration mainly emphasises the coordination of online and offline channels, customer touchpoints, and journey continuity, whereas green omnichannel capability embeds environmental responsibility into channel coordination (Beck and Rygl, 2015; Verhoef et al., 2015; Lemon and Verhoef, 2016). The construct also differs from green marketing capability, which primarily concerns the development and communication of green value propositions, because green omnichannel capability focuses on how green value is delivered, reinforced and managed across connected digital and physical channels. In addition, the construct extends sustainability communication by moving beyond message delivery to include fulfilment processes, customer participation, data use and relationship management. Finally, green omnichannel capability differs from digital channel capability in that the construct does not focus solely on digital enablement but integrates digital coordination with sustainability-oriented customer engagement and loyalty-related management outcomes. Accordingly, green omnichannel capability can be understood as a market-facing business innovation capability that combines channel integration, environmental responsibility and customer-related value creation (Adams et al., 2016; Dangelico, 2016; Watson et al., 2020).

The concept builds on omnichannel marketing logic, which views channels as connected customer touchpoints rather than separate routes to market. Omnichannel systems require the coordination of digital interfaces, physical locations, customer data, logistics processes, product information and post-purchase communication across the customer journey (Beck and Rygl, 2015; Verhoef et al., 2015; Lemon and Verhoef, 2016). Green omnichannel capability extends this logic by embedding sustainability into channel design, customer-facing operations and relationship management. The capability, therefore, concerns not only how firms connect channels but also how they use those channels to communicate green value, reduce waste, support responsible fulfilment, and encourage customer participation in sustainability-related activities.

Prior research on channel integration further supports the capability-based view of omnichannel management. Online-offline integration can influence retailer-level and channel-level outcomes, while cross-channel integration has been associated with sales growth and channel performance in retail contexts (Cao and Li, 2015; Herhausen et al., 2015). More recent omnichannel research also highlights the role of integration quality, perceived fluency and customer engagement in shaping customer responses across connected channels (Shen et al., 2018; Li and Gong, 2024). These findings support the view that omnichannel capability operates as an integrative mechanism linking channel coordination, customer experience and performance outcomes.

Sustainability-oriented innovation research provides a theoretical foundation for this capability view. Sustainability-oriented innovation involves changes in organisational routines, market practices and business processes that generate economic, environmental and social value (Adams et al., 2016; Watson et al., 2020). Green innovation research also emphasises that environmental responsibility can be embedded into products, operations and organisational capabilities rather than treated as a separate environmental activity (Dangelico and Pujari, 2010; Saunila et al., 2018; Takalo et al., 2021). From this perspective, green omnichannel capability represents a business innovation capability through which firms integrate sustainability communication, green fulfilment, customer data and relationship-building mechanisms into a coherent market-facing system.

2.2 *Green omnichannel capability and customer green perception*

Customer green perception refers to how customers recognise, interpret and evaluate a firm's green initiatives across connected touchpoints. In the present study, customer green perception is measured using retained indicators coded as CGP, which represent managerial practices related to sustainability information needs, online communication, influencer-based awareness, green production communication, online engagement, multimedia content, awareness evaluation, and public reporting. Because the data were collected from businesses, customer green perception is interpreted as a managerial assessment of customer-related perception rather than a direct customer self-report.

Green marketing research suggests that customer responses to environmental initiatives depend on credibility, perceived value and trust. Green brand image, green satisfaction and green trust have been associated with favourable customer responses and green brand equity (Chen, 2010). Green perceived value and green trust can strengthen purchase intention, whereas perceived green risk may weaken favourable responses (Chen and Chang, 2012). These findings suggest that environmental initiatives are more likely to influence customer responses when they are communicated consistently and perceived as credible across customer touchpoints.

From a capability-integration perspective, digital and channel capabilities can strengthen customer-facing engagement and operational responsiveness when firms coordinate digital marketing, customer interaction, supply-side agility and logistics execution (Sukhawattanakun, 2026). In a green omnichannel context, this coordination can help firms translate sustainability initiatives into clearer, more credible and more actionable customer-facing signals.

Green omnichannel capability can support customer green perception because integrated channels allow sustainability information to appear consistently across websites, social media, product information, service encounters, packaging, delivery communication and loyalty programmes. Compared with a single green campaign, an integrated channel system can reinforce sustainability cues repeatedly throughout the customer journey. Customer journey research emphasises that customer interpretation is formed through sequences of interactions rather than isolated encounters (Lemon and Verhoef, 2016; Hamilton and Price, 2019). Accordingly, firms with stronger green omnichannel capability are expected to manage customer green perception more effectively by ensuring that green information is visible, consistent and credible across connected touchpoints.

H1 Green omnichannel capability has a positive effect on customer green perception.

2.3 *Green omnichannel capability and green customer behaviour*

Green customer behaviour refers to customer-related actions associated with sustainable consumption, including selecting environmentally responsible products, choosing lower-impact channels, participating in recycling or return activities and responding to sustainability-related campaigns. In the present study, green customer behaviour is measured through retained indicators coded GCB, which represent managerial practices related to green product selection, motivational strategies, sustainable consumption communication, low-impact purchasing channels, reusable bag activities, environmental tracking platforms, behavioural data use and green satisfaction feedback. Because the

data were collected from businesses, this construct is interpreted as a managerial assessment of how firms encourage, support and monitor customer-related green behaviour.

Prior research indicates that green customer behaviour is shaped by perceived consumption value, environmental concern, environmental attitude, perceived behavioural control and the practicality of green choices (Lin and Huang, 2012; Yadav and Pathak, 2017; Ogiemwonyi et al., 2023; Zhao et al., 2025). These studies suggest that favourable attitudes alone may not lead to green behaviour when customers lack convenient options, credible information or supportive participation mechanisms. Sustainable behaviour becomes more likely when firms reduce barriers and make green choices accessible within ordinary purchase and post-purchase processes.

Green omnichannel capability can support green customer behaviour by reducing friction in sustainable consumption. Firms may provide green product information online, offer environmentally responsible delivery options, issue digital receipts, support packaging returns through physical touchpoints, and reward green participation through loyalty programmes. Such practices show how integrated channels can translate sustainability communication into practical customer actions. Omnichannel systems also allow firms to connect customer information, fulfilment options and relationship activities across touchpoints, making green behaviour more visible, repeatable and manageable. Since customer experience is shaped throughout the entire journey (Verhoef et al., 2015; Lemon and Verhoef, 2016), integrated green channels can create practical, recurring opportunities for customer-related green behaviour.

H2 Green omnichannel capability has a positive effect on green customer behaviour.

2.4 Customer green perception and green customer behaviour

Customer green perception is expected to support green customer behaviour because customer-related green actions depend in part on how customers understand and evaluate a firm's sustainability initiatives. Clear and credible sustainability communication can help customers recognise the relevance of green choices and participate in environmentally responsible activities. In contrast, unclear, fragmented or symbolic green communication may limit customer participation because customers may not understand the value, reliability or practical relevance of the firm's initiatives.

Green marketing research supports the relationship between perception and behaviour. Green perceived value and green trust can strengthen green purchase intention, while perceived green risk can reduce favourable responses (Chen and Chang, 2012). Consumption value dimensions also influence green product choice, as customers are more likely to choose green products when they perceive functional, emotional, and epistemic value (Lin and Huang, 2012). In developing-market contexts, green purchase behaviour is influenced by attitude, perceived behavioural control, and moral norms (Yadav and Pathak, 2017). These findings suggest that favourable green behaviour is more likely when customers perceive green initiatives as valuable, trustworthy and practically relevant.

Within an omnichannel context, customer green perception serves as an interpretive mechanism linking sustainability communication to green customer behaviour. Customers may first encounter sustainability initiatives through digital content, eco-labels, service staff, product packaging, delivery information or social media

messages. When these signals are coherent and credible across touchpoints, customers are more likely to understand green value and translate that understanding into action. Such actions may include selecting sustainable products, using lower-impact channels, joining recycling campaigns, or participating in green loyalty programmes. Accordingly, firms that manage customer green perception effectively are expected to strengthen green customer behaviour by making sustainability initiatives understandable, credible and actionable.

H3 Customer green perception has a positive effect on green customer behaviour.

2.5 Customer green perception and brand loyalty management

Brand loyalty management refers to the firm's management of loyalty-related outcomes, including trust, repeat purchase, advocacy, relationship continuity and sustained customer support. In the present study, brand loyalty management is measured through retained indicators coded BLM, which represent customer expectations, loyalty strategy planning, relationship-building activities, online relationship channels, membership programmes, privileges for sustainable purchasing, environmentally friendly after-sales service, loyalty evaluation, participation tracking and continuous loyalty strategy improvement. The construct is interpreted as a managerial assessment of loyalty-building mechanisms rather than a direct measure of individual customer loyalty. Green brand equity research suggests that green brand image, green satisfaction and green trust can shape favourable brand evaluations and loyalty-related outcomes (Chen, 2010; Martínez, 2015). Accordingly, brand loyalty management captures how firms manage loyalty-related relationships and programmes in response to customer-related green perception and behaviour.

In sustainability-oriented markets, loyalty management is shaped not only by product quality, service performance, and price value but also by how customers interpret the firm's environmental responsibility. When green initiatives are perceived as credible, relevant and consistent, firms may be better positioned to build trust and long-term brand relationships. Green branding research identifies green brand image, green satisfaction and green trust as drivers of green brand equity (Chen, 2010). Green perceived value and green trust can also support favourable purchase intention (Chen and Chang, 2012). Research on green loyalty further links green image, green trust and green satisfaction with customer loyalty in sustainability-oriented contexts (Martínez, 2015), while consumer-green brand relationship research indicates that relationship quality and satisfaction can strengthen loyalty-related outcomes (Papista and Dimitriadis, 2019). These findings suggest that customers' interpretations of green value, credibility, and responsibility can serve as an important basis for loyalty-related relationship management.

Customer green perception may be especially important in omnichannel systems, as sustainability cues are repeatedly delivered across connected touchpoints. Customers who encounter credible green information across digital platforms, physical channels, fulfilment processes, packaging and service communication may interpret the brand as more responsible and trustworthy. Repeated exposure to consistent sustainability cues can strengthen confidence in the brand and support relationship continuity, participation and loyalty-related management outcomes. Customer green perception is therefore expected to support brand loyalty management.

H4 Customer green perception has a positive effect on brand loyalty management.

2.6 *Green customer behaviour and brand loyalty management*

Green customer behaviour is also expected to support brand loyalty management because repeated participation in sustainable consumption can deepen the customer-brand relationship. Customers who choose green products, use environmentally responsible channels, participate in recycling or return programmes and engage with sustainability campaigns become more familiar with the firm's green value system. Such repeated participation may strengthen trust, satisfaction, identification and relationship continuity.

Research on green loyalty suggests that loyalty toward eco-friendly products is shaped by perceived value, trust, perceived risk, quality and satisfaction (Pahlevi and Suhartanto, 2020). Green image, green trust and green satisfaction have also been linked with loyalty-related outcomes (Martínez, 2015). These studies suggest that loyalty in green markets develops not only through awareness of sustainability claims, but also through repeated experience with green value and credible brand practices.

Omnichannel systems can make green customer behaviour more visible, convenient and repeatable. Customers may repeatedly use digital channels, select lower-impact fulfilment options, return packaging, receive green loyalty rewards and share sustainability experiences through social media. These behaviours increase interaction with the brand and reinforce the firm's sustainability position. Omnichannel loyalty research indicates that the quality of channel integration can influence customer loyalty through engagement and receptiveness to relationship programmes (Gao and Huang, 2021). Recent omnichannel customer experience research further suggests that customer experience is an important mechanism linking omnichannel characteristics with loyalty outcomes (Zhang et al., 2024). Accordingly, green customer behaviour can support brand loyalty management by transforming sustainability-related participation into repeated interaction, relationship reinforcement and loyalty programme engagement.

This logic is consistent with channel capability and resilience perspectives. Customer-related outcomes are strengthened when sensing, orchestration and governance mechanisms are aligned across digital and physical touchpoints (Sukhawattanakun et al., 2026). Similarly, institutional alignment and cross-layer coordination can help stabilise customer-facing practices and support durable relationship outcomes in channel ecosystems (Supapon et al., 2026).

H5 Green customer behaviour has a positive effect on brand loyalty management.

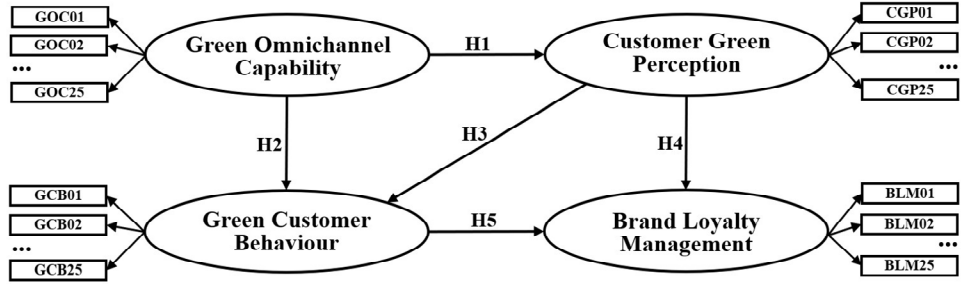
2.7 *Conceptual framework and hypotheses*

The preceding review supports a dual-pathway framework in which green omnichannel capability contributes to brand loyalty management through customer green perception and green customer behaviour. The perception pathway reflects the firm's ability to make green initiatives visible and credible across channels. In contrast, the behaviour pathway reflects the firm's ability to encourage customer-related green actions through integrated communication, fulfilment and participation mechanisms.

The model positions the two pathways as complementary rather than competing. Customer green perception is expected to support brand loyalty management, directly and through its positive effect on green customer behaviour, while green customer behaviour,

in turn, strengthens loyalty management through repeated sustainability-related participation. Based on this logic, the study tests five hypotheses linking green omnichannel capability, customer green perception, green customer behaviour and brand loyalty management. The proposed conceptual framework is presented in Figure 1. Business type is treated as supplementary descriptive evidence and is not included in the main structural model.

Figure 1 Conceptual framework



Note: The item codes shown in the figure represent the measurement indicators for each construct.

3 Methodology

3.1 Research design and sample

The present study employed a quantitative cross-sectional survey design to examine the structural relationships among green omnichannel capability, customer green perception, green customer behaviour and brand loyalty management. Structural equation modelling (SEM) was selected because the proposed framework involved multiple latent constructs and required the simultaneous estimation of measurement quality and structural relationships (Anderson and Gerbing, 1988).

The target population comprised business organisations operating in Thailand. The unit of analysis was the business organisation, and the respondents served as organisational representatives providing managerial assessments of the constructs under investigation. Accordingly, the customer-related constructs in this study represent organisational assessments of customer perception, customer behaviour and loyalty-related management rather than direct individual customer responses. A multistage sampling approach was applied to obtain geographically distributed organisational responses. In the first stage, Thailand was classified into five regional groups: Bangkok and the metropolitan area, the Central region, the Northern region, the Northeastern region and the Southern region. In the second stage, provincial business registration statistics were used to identify provinces with high concentrations of registered businesses within each region (Department of Business Development, 2024). Firms in the selected provinces were then approached using quotas for manufacturing, trading and service businesses. Eligible respondents were business owners, executives, managers or organisational representatives with sufficient knowledge of marketing

channel management, sustainability practices, customer-related strategies and business operations.

Data were collected from May to October 2025. The final sample consisted of 600 valid business responses, equally distributed across manufacturing, trading and service businesses, with 200 responses from each group. The sample size was considered appropriate for structural equation modelling because SEM requires sufficient cases relative to model complexity, parameter estimation and statistical power (Westland, 2010; Wolf et al., 2013). Although the sampling procedure was designed to obtain balanced organisational responses across business types and regions, complete response-rate information and systematic non-response data were not available. This issue is therefore acknowledged as a methodological limitation. Accordingly, the findings should be interpreted as organisational assessments of customer-related mechanisms, rather than direct customer-level responses.

3.2 Measurement instrument

The questionnaire was developed to measure sustainability-oriented channel operations and the four latent constructs in the proposed model. The instrument consisted of four sections. Section 1 collected organisational profile data, including business type, length of operation, business operation pattern, main customer group and sustainability certification status. Section 2 measured sustainability-oriented operations through integrated marketing channels. Section 3 measured the four latent constructs used in the structural model. Section 4 included open-ended questions for additional opinions and recommendations.

For conceptual clarity, the study uses concise theoretical labels in the conceptual framework and manuscript. Green omnichannel capability was measured through indicators coded GOC. Customer green perception was measured through indicators coded CGP. Green customer behaviour was measured through indicators coded GCB. Brand loyalty management was measured through indicators coded BLM. Although some items used customer-oriented wording, the questionnaire was completed by organisational respondents. Accordingly, the unit of analysis was the business organisation, and the customer-related constructs were operationalised as managerial assessments rather than direct responses from individual customers.

Green omnichannel capability captured sustainability-oriented channel integration and digital coordination. Customer green perception captured managerial assessments of how customers recognise and evaluate green initiatives. Green customer behaviour captured how firms encourage, support and monitor customer-related green actions. Brand loyalty management captured the firm's management of loyalty-related relationships, participation and continuous improvement. Thus, the measurement approach was aligned with the organisational-level design of the study and the managerial interpretation of customer-related mechanisms.

All scaled items were measured using a five-point Likert-type scale ranging from 1 = very low to 5 = very high. A Likert-type scale was appropriate because the study measured organisational perceptions and managerial evaluations through multi-item constructs (Batterton and Hale, 2017). Higher scores indicated stronger perceived implementation or higher perceived importance of the relevant practice. The original item structure was retained for consistency with the SPSS and AMOS outputs, whereas the

revised construct labels were used to improve conceptual alignment with the updated framework.

3.3 Content validity, tryout and data collection

Five experts reviewed the draft questionnaire to assess content validity, item-objective congruence, clarity of wording, and construct relevance. The index of item-objective congruence method was used to evaluate the alignment between each questionnaire item and the research objectives. The IOC values ranged from 0.60 to 1.00, exceeding the minimum acceptable criterion of 0.50. The questionnaire was revised in accordance with the experts' recommendations before the tryout stage (Koller et al., 2017).

Before the main survey, the questionnaire was tested with 30 respondents who had characteristics similar to those of the target respondents. The tryout assessed item clarity, preliminary response dispersion, item discrimination and internal consistency. For the scaled items, item discrimination values ranged from 0.397 to 0.782 in Section 2 and from 0.393 to 0.842 in Section 3. Internal consistency was evaluated using Cronbach's alpha, a commonly used reliability measure for multi-item scales (Nunnally and Bernstein, 1994). Section 2 produced a Cronbach's alpha of 0.927, while Section 3 produced a Cronbach's alpha of 0.987. These results indicated satisfactory preliminary reliability and item performance, supporting the suitability of the questionnaire for full-scale data collection (Post, 2016).

Data were collected from business organisations in Thailand. Participation was voluntary, and respondents were informed that the data would be used only for academic research. The questionnaire stated that responses would be treated confidentially and analysed only in aggregate form. These procedures are consistent with recommended practices for reducing response pressure and improving the quality of self-reported survey data (Podsakoff et al., 2003). After screening the completed questionnaires, the final dataset contained 600 valid organisational responses with no missing cases in the organisational profile variables.

3.4 Measurement refinement procedure

The questionnaire contained 120 scaled items in total, comprising 20 items on sustainability-oriented channel operations in Section 2 and 100 items measuring the four latent constructs in Section 3. Before estimating the final structural model, the 100 construct items were refined to yield a parsimonious, theoretically coherent measurement structure. The refinement process was guided by both statistical adequacy and conceptual validity. Items were considered for removal when they showed weak standardised factor loadings, conceptual overlap with other indicators, excessive redundancy within the same construct, or limited contribution to construct validity. Modification indices were reviewed solely as diagnostic information and applied cautiously when theoretically meaningful, rather than used solely to improve model fit. This approach was intended to balance parsimony in measurement with theoretical coverage.

Conceptual coverage was maintained throughout the refinement process to ensure that each construct remained substantively meaningful after item reduction. The retained indicators represented sustainability-oriented channel integration, digital applications, green fulfilment, sustainability communication, customer green perception, behavioural motivation, green participation, loyalty planning and relationship-building activities.

Thus, item reduction did not remove the core conceptual dimensions required to represent the four constructs.

The final retained measurement structure consisted of 33 indicators across four constructs: seven for green omnichannel capability, eight for customer green perception, eight for green customer behaviour, and ten for brand loyalty management. The retained indicators were coded GOC, CGP, GCB and BLM in the revised conceptual framework and appendix. This retained structure was then assessed using confirmatory factor analysis and incorporated into the structural equation model. The retained indicators and their measurement statistics are reported in Table A2. Reporting the retained indicators in the appendix improves transparency regarding the measurement refinement process.

3.5 Data analysis strategy

Data analysis proceeded in five stages. First, descriptive statistics were used to summarise the organisational profile of respondents and the main response patterns. Frequency, percentage, mean and standard deviation were reported. One-way analysis of variance (ANOVA) was also used as a supplementary descriptive analysis to compare selected mean differences across manufacturing, trading and service businesses.

Second, reliability and preliminary factorability were assessed. Internal consistency was examined using Cronbach's alpha during the tryout stage, while construct reliability in the final SEM model was assessed using composite reliability and average variance extracted. The Kaiser-Meyer-Olkin (KMO) value was 0.968, and Bartlett's test of sphericity was significant, supporting the suitability of the data for factor analysis.

Third, confirmatory factor analysis was conducted to assess the measurement model. This stage evaluated whether the retained indicators adequately represented the four latent constructs before testing the structural relationships. Composite reliability and average variance extracted were interpreted with reference to construct reliability and convergent validity assessment criteria (Fornell and Larcker, 1981). Discriminant validity was assessed at the latent-construct level using the Fornell-Larcker logic and a heterotrait-monotrait (HTMT) reference threshold. Model fit was evaluated using multiple fit indices to avoid reliance on a single criterion (Anderson and Gerbing, 1988; Hair et al., 2017).

Fourth, SEM with maximum likelihood estimation was applied to test the five hypothesised relationships. This analytical approach was suitable because the model contained several interrelated latent constructs represented by multiple observed indicators and required joint assessment of measurement adequacy and structural effects (Anderson and Gerbing, 1988). Model fit was assessed using the chi-square test, degrees of freedom, minimum discrepancy divided by degrees of freedom (CMIN/DF), root mean square residual (RMR), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), Tucker-Lewis index (TLI), comparative fit index (CFI) and root mean square error of approximation (RMSEA), following commonly applied SEM fit-assessment guidelines (Anderson and Gerbing, 1988; Hair et al., 2017).

Finally, supplementary regression analysis examined whether sustainability-oriented channel operations in Section 2 were associated with the strategic constructs in Section 3. Business type was also examined as supplementary descriptive evidence using ANOVA. These supplementary analyses were used to provide additional contextual evidence on associations and group differences. However, they were not treated as the main

hypothesis tests because the five hypotheses were evaluated through structural equation modelling.

3.6 Common method bias and ethical considerations

Because the study relied on self-reported survey data from organisational respondents, common-method bias was considered a potential concern. Procedural remedies were adopted during questionnaire design and data collection. Respondents were assured of confidentiality, and the questionnaire was structured to reduce ambiguity and evaluation pressure, consistent with recommendations for survey-based research (Podsakoff et al., 2003). These procedural remedies were intended to reduce social desirability bias, evaluation apprehension and response consistency bias.

Preliminary factorability was supported by a KMO value of 0.968 and Bartlett's test of sphericity, $\chi^2 = 37,579.541$, $df = 4,950$, $p < 0.001$. Harman's single-factor test was used as a preliminary diagnostic check for common-method bias. The first factor explained 24.018% of the total variance, which was below the commonly used 50% threshold. This result suggests that common-method bias was unlikely to dominate the observed relationships. However, Harman's single-factor test was treated only as an initial diagnostic procedure rather than definitive evidence of the absence of common-method bias. Because the data were collected through a single self-reported survey completed by organisational respondents, common-method bias and single-informant bias cannot be completely eliminated.

The study followed standard ethical principles for anonymous organisational survey research. Participation was voluntary, and all participants were informed of their right to decline any question or withdraw from the study without adverse consequences. Organisational and individual responses were treated confidentially and analysed only in aggregate form. No personally identifiable information was reported, and the findings are presented only at the aggregate level. The reported findings do not identify any individual respondent or organisation.

4 Results

4.1 Descriptive results

The final dataset comprised 600 valid responses from businesses operating in Thailand. The sample was evenly distributed across three business types: manufacturing, trading and service businesses, with each group representing 33.3% of the total sample. By business age, the largest group comprised businesses operating for 11 to 15 years, accounting for 26.5% of the sample. Regarding business operation patterns, businesses operating mainly online represented the largest group, accounting for 21.8%.

Among the main customer group, businesses serving specific customer segments interested in green or sustainable products accounted for the largest proportion, at 25.8% of the sample. Regarding environmental or sustainability certification, the largest group comprised businesses that had not yet been certified but planned to apply, accounting for 28.2%. The respondent profile therefore indicates that the sample covered different business types, operating periods, channel patterns, customer groups and sustainability

certification statuses. The full respondent and organisational profile is presented in Table A1.

4.2 Measurement model results

Confirmatory factor analysis was conducted to assess the retained measurement structure. The final measurement model included 33 retained indicators across four latent constructs. Green omnichannel capability was measured by seven indicators; customer green perception by eight; green customer behaviour by eight; and brand loyalty management by ten.

The retained indicators loaded positively on their respective constructs. The standardised factor loadings ranged from 0.704 to 0.765 for green omnichannel capability, from 0.712 to 0.790 for customer green perception, from 0.716 to 0.773 for green customer behaviour and from 0.675 to 0.764 for brand loyalty management. Composite reliability values ranged from 0.894 to 0.923, exceeding the recommended threshold of 0.700. Average variance extracted values ranged from 0.545 to 0.557, exceeding the recommended threshold of 0.500 (Table 1). These results support acceptable construct reliability and convergent validity in the final measurement model. The retained indicators, measurement items, standardised loadings and squared multiple correlations are reported in Table A2.

Discriminant validity was assessed at the latent-construct level using the Fornell-Larcker logic and an HTMT reference threshold. The square roots of the AVEs were 0.739 for green omnichannel capability, 0.746 for customer green perception, 0.739 for green customer behaviour, and 0.738 for brand loyalty management. The inter-construct latent correlations ranged from 0.487 to 0.640, which were lower than the corresponding square roots of AVE and below the conservative HTMT reference threshold of 0.850, as shown in Table 2. The discriminant validity results provide model-level support for construct distinctiveness, although the four constructs remain theoretically related within the proposed green omnichannel and brand loyalty management framework.

Table 1 Measurement model results

<i>Construct</i>	<i>Retained indicators</i>	<i>Loading range</i>	<i>CR</i>	<i>AVE</i>	<i>Assessment</i>
Green omnichannel capability	GOC02, GOC06, GOC10, GOC14, GOC18, GOC22, GOC25	0.704–0.765	0.894	0.546	Acceptable
Customer green perception	CGP01, CGP04, CGP08, CGP09, CGP12, CGP15, CGP19, CGP23	0.712–0.790	0.909	0.557	Acceptable
Green customer behaviour	GCB01, GCB03, GCB07, GCB11, GCB13, GCB17, GCB21, GCB24	0.716–0.773	0.906	0.546	Acceptable
Brand loyalty management	BLM01, BLM02, BLM05, BLM08, BLM09, BLM13, BLM16, BLM20, BLM22, BLM25	0.675–0.764	0.923	0.545	Acceptable

Table 2 Discriminant validity assessment

<i>Construct</i>	<i>GOC</i>	<i>CGP</i>	<i>GCB</i>	<i>BLM</i>
GOC	0.739			
CGP	0.609	0.746		
GCB	0.617	0.596	0.739	
BLM	0.487	0.640	0.629	0.738

Note: Diagonal values represent the square roots of AVE. Off-diagonal values represent latent correlations derived from AMOS standardised estimates and serve as model-level evidence of discriminant validity.

4.3 Structural model fit

The structural model provided a satisfactory fit to the empirical data. The model-fit results were chi-square = 504.255, $df = 490$, $p = 0.318$, CMIN/DF = 1.029, RMR = 0.038, GFI = 0.953, AGFI = 0.946, NFI = 0.956, TLI = 0.999, CFI = 0.999 and RMSEA = 0.007 as shown in Table 3. The fit indices indicate that the proposed structural model was acceptable when considered alongside evidence of theoretical coherence, construct reliability, convergent validity, and discriminant validity. The final AMOS output confirmed that the model was successfully estimated, with 561 distinct sample moments, 71 estimated parameters and 490 degrees of freedom.

Table 3 Structural model fit indices

<i>Fit index</i>	<i>Result</i>	<i>Recommended threshold</i>	<i>Interpretation</i>
Chi-square	504.255	Non-significant preferred	Good
<i>df</i>	490	—	—
<i>p</i> -value	0.318	>0.050	Good
CMIN/DF	1.029	<3.000	Good
RMR	0.038	<0.050	Good
GFI	0.953	>0.900	Good
AGFI	0.946	>0.900	Good
NFI	0.956	>0.900	Good
TLI	0.999	>0.900	Good
CFI	0.999	>0.900	Good
RMSEA	0.007	<0.080	Good

Note: CMIN/DF – chi-square divided by degrees of freedom; RMR – root mean square residual; GFI – goodness-of-fit index; AGFI – adjusted goodness-of-fit index; NFI – normed fit index; TLI – Tucker-Lewis index; CFI – comparative fit index; RMSEA – root mean square error of approximation.

4.4 Hypothesis testing

The structural path results supported all five hypotheses, as shown in Table 4. Green omnichannel capability had positive effects on customer green perception and green customer behaviour, supporting H1 and H2. Customer green perception also positively affected green customer behaviour, supporting H3. In addition, customer green

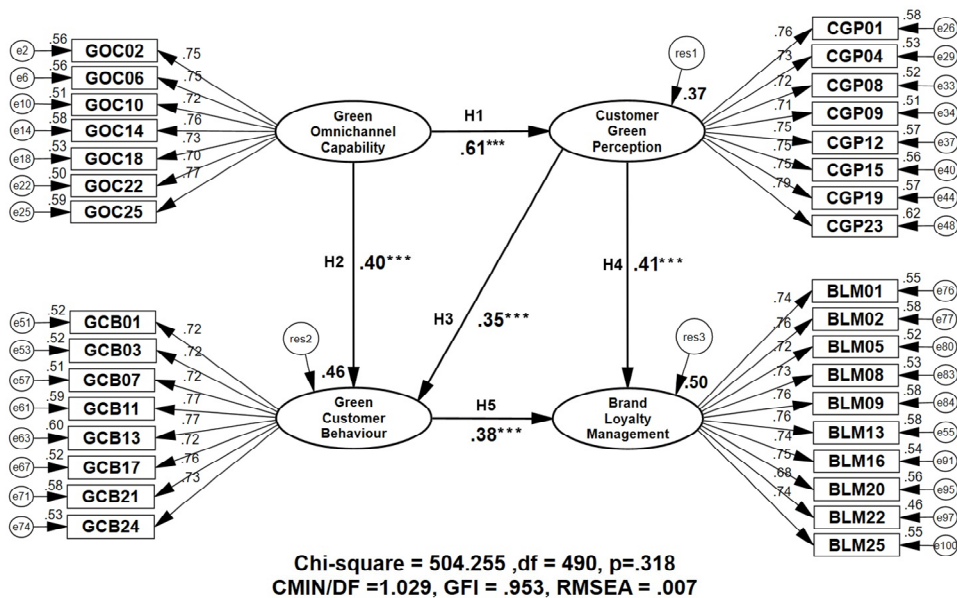
perception and green customer behaviour positively affected brand loyalty management, supporting H4 and H5. Overall, the findings provide empirical support for the proposed dual-pathway framework.

Table 4 Structural path results

Hypothesis	Structural path	Estimate	S.E.	C.R.	p-value	Standardised estimate	Result
H1	GOC → CGP	0.608	0.048	12.558	< 0.001	0.609	Supported
H2	GOC → GCB	0.384	0.049	7.777	< 0.001	0.404	Supported
H3	CGP → GCB	0.334	0.048	6.957	< 0.001	0.350	Supported
H4	CGP → BLM	0.396	0.046	8.529	< 0.001	0.413	Supported
H5	GCB → BLM	0.385	0.049	7.904	< 0.001	0.382	Supported

The pattern of supported paths indicates that green omnichannel capability contributes to brand loyalty management through two connected customer-related mechanisms. Customer green perception represents the perception-based pathway, while green customer behaviour represents the behaviour-based pathway, as illustrated in Figure 2.

Figure 2 Final structural model



4.5 Explanatory power and indirect effects

The squared multiple correlations indicate that the structural model explained 37.1% of the variance in customer green perception, 45.8% in green customer behaviour, and 50.5% in brand loyalty management as presented in Table 5. The explanatory power was therefore strongest for brand loyalty management, suggesting that the proposed

perception-based and behaviour-based pathways provide meaningful explanatory value for loyalty-related management outcomes.

Table 5 Squared multiple correlations

<i>Endogenous construct</i>	<i>R²</i>
Customer green perception	0.371
Green customer behaviour	0.458
Brand loyalty management	0.505

The standardised indirect effects further supported the dual-pathway framework. Green omnichannel capability had a model-based indirect pathway of 0.487 on brand loyalty management through customer green perception and green customer behaviour. Customer green perception also had a model-based indirect pathway of 0.134 on brand loyalty management through green customer behaviour. The indirect-effect pattern suggests that green omnichannel capability is linked to loyalty management not only through customer green perception but also through the behavioural pathway that follows from perception. Because bootstrap confidence intervals were not estimated, the indirect effects are interpreted as model-based indirect pathways rather than formal mediation evidence.

4.6 *Supplementary regression and group-based analyses*

Supplementary regression and group-based analyses were conducted solely to contextualise the SEM results and were not considered primary hypothesis tests. The supplementary regression results showed that sustainability-oriented channel operations were positively associated with green omnichannel capability ($\beta = 0.719$, $R^2 = 0.517$, $F = 640.152$, $p < 0.001$), customer green perception ($\beta = 0.656$, $R^2 = 0.431$, $F = 452.765$, $p < 0.001$), green customer behaviour ($\beta = 0.666$, $R^2 = 0.444$, $F = 476.772$, $p < 0.001$) and the overall management score ($\beta = 0.641$, $R^2 = 0.411$, $F = 417.713$, $p < 0.001$). The direct association with brand loyalty management was not statistically significant ($\beta = 0.065$, $R^2 = 0.004$, $F = 2.565$, $p = 0.110$). This pattern suggests that sustainability-oriented channel operations are more closely associated with green omnichannel capability, customer green perception, and green customer behaviour than with loyalty management. The regression results are reported in Table A3.

The supplementary ANOVA results showed limited differences across manufacturing, trading and service businesses. Sustainability-oriented channel operations showed a marginal difference across the three groups ($F = 2.840$, $p = 0.059$), but the difference did not reach the conventional 0.050 significance level. Green omnichannel capability ($F = 1.816$, $p = 0.164$), customer green perception ($F = 0.211$, $p = 0.810$), green customer behaviour ($F = 0.990$, $p = 0.372$), and the overall management score ($F = 2.162$, $p = 0.116$) did not differ significantly across business types. Brand loyalty management was the only construct showing a statistically significant overall difference across business types ($F = 3.445$, $p = 0.033$). However, the Scheffé post hoc results did not identify clear pairwise differences at the 0.050 level. The group-based results are reported in Table A4.

Overall, the supplementary results support the SEM interpretation. Sustainability-oriented operations were mainly associated with capability, perception, and

behaviour, whereas the proposed indirect pathway structure better explained brand loyalty management. Limited group differences also supported using the full sample for the main model.

5 Discussion

5.1 Interpretation of the main findings

The findings show that green omnichannel capability contributes to brand loyalty management through customer interpretation and participation, not solely through channel integration. This result supports the view that sustainability-oriented channel coordination can function as a market-facing innovation capability that links green value communication with loyalty-related management outcomes (Lemon and Verhoef, 2016).

This finding is consistent with prior capability-based evidence from Thai firms showing that channel performance improves when digital, relational, supply-side and logistics capabilities are coordinated rather than managed separately (Sukhawattanakun, 2026). The result also aligns with conceptual work on dynamic channel capabilities, which argues that adaptive channel systems depend on the integration of sensing, orchestration and governance mechanisms (Sukhawattanakun et al., 2026).

The significant effect of green omnichannel capability on customer green perception indicates that integrated channels can strengthen the visibility and credibility of sustainability initiatives. This finding adds to omnichannel research by showing that channel integration is not only a mechanism for service convenience and journey continuity but also a means of shaping customer-related interpretation of green value (Beck and Rygl, 2015; Gao and Huang, 2021; Zhang et al., 2024).

The significant paths to green customer behaviour suggest that customer-related green actions depend on both channel-enabled support and credible green perception. Rather than emerging only from environmental communication, green customer behaviour is strengthened when firms make sustainable choices practical, visible and repeatable across customer touchpoints (Chen and Chang, 2012; Lin and Huang, 2012; Yadav and Pathak, 2017).

The perception-based pathway suggests that green omnichannel capability supports loyalty management by making sustainability initiatives visible, consistent and credible across customer touchpoints. The behaviour-based pathway suggests that integrated channels can make sustainable customer actions more practical by enabling green communication, fulfilment options, return systems, and loyalty rewards. Together, these pathways indicate that perception builds confidence in green initiatives, while behaviour translates such confidence into repeated sustainability-related participation and relationship continuity (Chen, 2010; Martínez, 2015; Pahlevi and Suhartanto, 2020).

Because the data were collected from businesses rather than directly from customers, the findings should be interpreted as managerial assessments of customer-related mechanisms. The results therefore explain how firms assess and manage customer green perception, green customer behaviour and loyalty-related outcomes within their market-facing systems, rather than providing direct evidence of individual customer attitudes or behaviour.

5.2 *Theoretical contributions*

The study contributes to research on business innovation and sustainability marketing in four ways. First, green omnichannel capability is positioned as a market-facing business innovation capability rather than a conventional channel management practice. Prior omnichannel research has mainly focused on channel integration, customer experience, customer journey design and digital retail transformation (Beck and Rygl, 2015; Verhoef et al., 2015; Lemon and Verhoef, 2016; Reinartz et al., 2019). The present study extends this perspective by explaining how environmental responsibility can be embedded into channel architecture, digital communication, fulfilment processes and customer relationship mechanisms. The capability view is consistent with sustainability-oriented innovation research, which emphasises changes in organisational routines, processes and market practices that create economic, environmental and social value (Adams et al., 2016; Watson et al., 2020).

Second, the study clarifies the mechanism linking green omnichannel capability to brand loyalty management. Green marketing research has examined green trust, green satisfaction, green perceived value, green brand image and green loyalty as important explanations of customer responses to environmental responsibility (Chen, 2010; Chen and Chang, 2012; Martínez, 2015; Pahlevi and Suhartanto, 2020). The present study adds a channel-based explanation by demonstrating that customer green perception and green customer behaviour function as interconnected mechanisms within a sustainability-oriented omnichannel system. The dual-pathway framework therefore explains loyalty-related management outcomes through both interpretation and participation rather than through green communication alone.

Third, the study contributes an organisational-level perspective to research on green customers. Many prior studies rely on direct consumer responses to explain green purchase intention, green behaviour or green loyalty (Lin and Huang, 2012; Yadav and Pathak, 2017; Zhao et al., 2025). The present study instead examines how businesses assess and manage customer-related green perception, green customer behaviour and loyalty-related mechanisms. This perspective is important because firms design and coordinate green omnichannel systems before customers experience them. Accordingly, the study explains customer-related green perception and behaviour from a managerial perspective on capability development, while recognising that the findings do not constitute direct customer-level evidence.

Fourth, the study extends recent framework-building research on dynamic channel capabilities and retail-wholesale channel resilience. The dynamic channel capability framework explains adaptive channel systems through sensing-intelligence, orchestration-adaptability and governance-legitimacy mechanisms (Sukhawattanakun et al., 2026), while the retail-wholesale channel resilience framework explains resilience through structural adaptation, relational-contractual integration, institutional alignment and cross-layer coordination (Supapon et al., 2026). The present study provides empirical evidence by showing how a specific green omnichannel capability operates through customer-related perception and behaviour to support loyalty-related management outcomes. In this way, the study connects dynamic channel capability, sustainability-oriented channel design and brand loyalty management within a single empirical model.

5.3 Managerial implications

The findings offer practical implications for businesses seeking to strengthen brand loyalty through sustainability-oriented omnichannel strategies. Green omnichannel capability should be viewed as an integrated market-facing capability rather than a short-term green campaign. Sustainability communication needs to be embedded across websites, social media, physical stores, product information, delivery interfaces, after-sales services and loyalty programmes. Consistency across these touchpoints can help customers interpret green initiatives as part of the firm's value proposition rather than isolated promotional messages. This implication is consistent with customer journey research, which emphasises that customer experience is shaped across multiple touchpoints before, during and after purchase (Lemon and Verhoef, 2016; Hamilton and Price, 2019). Customer journey design research also suggests that well-designed omnichannel interactions can support brand relationship-building when customers experience autonomy, competence and relatedness across connected touchpoints (Zheng and Li, 2024).

Businesses should also convert green communication into practical customer actions. Green information alone may not be sufficient to strengthen loyalty-related outcomes unless firms provide mechanisms that make sustainable behaviour convenient and repeatable. Examples include lower-impact fulfilment options, digital receipts, reusable packaging, return points, recycling participation, green loyalty rewards and sustainability-related engagement activities. These mechanisms can help customers move from recognising green initiatives to participating in sustainable consumption practices (Lin and Huang, 2012; Yadav and Pathak, 2017; Ogiemwonyi et al., 2023; Zhao et al., 2025).

At the organisational level, managers should embed green omnichannel initiatives into operating systems rather than treating them as isolated marketing campaigns. Firms should align green communication, digital tools, fulfilment processes, partner coordination and loyalty programmes as an integrated capability system (Sukhawattanakun et al., 2023; Supapon et al., 2026). This capability-system approach means that sustainability-related customer experience should be supported not only by marketing communication but also by operational processes, channel governance and inter-organisational coordination.

For Thai businesses, three managerial priorities are suggested. First, firms should ensure consistent green information across online and offline touchpoints. Second, they should design actionable practices that support customer participation in sustainable behaviour. Third, they should use omnichannel data to monitor customer participation and integrate these insights into loyalty programme design. These priorities can help firms transform sustainability initiatives from symbolic communication into visible, credible and repeatable customer experiences.

5.4 Supplementary context

The supplementary analyses reinforce the central SEM interpretation. Sustainability-oriented operations were associated with capability, perception and behaviour, but did not show a direct association with brand loyalty management in the supplementary regression results. This pattern suggests that operational sustainability creates stronger loyalty-related value when translated into customer-facing mechanisms

that shape perceptions and behaviour, rather than being treated as an isolated operational practice (Adams et al., 2016; So and Xu, 2016; Watson et al., 2020).

The group-based analysis showed limited differences across manufacturing, trading and service businesses. Brand loyalty management was the only construct to show a statistically significant overall difference across business types, although the Scheffé post hoc results did not identify clear pairwise differences. This result indicates that business type may provide some contextual variation in loyalty-related management, but the evidence is insufficient to distinguish patterns across specific business groups clearly. Accordingly, the supplementary group-based findings should be interpreted as contextual evidence rather than as competing explanations for the main structural model.

6 Conclusions, limitations and future research

6.1 Conclusions

This study examined green omnichannel capability as a market-facing business innovation capability for strengthening brand loyalty management in Thai businesses. The findings support the proposed dual-pathway framework, in which customer green perception and green customer behaviour connect sustainability-oriented channel integration with loyalty-related management outcomes.

The results show that green omnichannel capability positively influences both customer green perception and green customer behaviour. Customer green perception also strengthens green customer behaviour, while both customer-related mechanisms positively influence brand loyalty management. The model explains 50.5% of the variance in brand loyalty management, indicating that the proposed framework provides substantial explanatory power for loyalty-related management outcomes.

The study contributes to research on business innovation and sustainability marketing by demonstrating that green omnichannel capability extends beyond channel coordination. Rather, green omnichannel capability functions as an integrated market-facing capability that enables firms to make sustainability initiatives visible, credible and actionable across customer touchpoints. The findings suggest that loyalty management in sustainability-oriented omnichannel systems depends on the combined roles of customer-related green perception and customer-related green behaviour.

Because the data were collected from business respondents, the findings should be interpreted as organisational assessments of customer-related green perception, green customer behaviour, and loyalty-related management outcomes, rather than as direct evidence of individual customer attitudes, behaviours, or loyalty.

6.2 Limitations

Several limitations should be acknowledged. First, the cross-sectional design limits the ability to explain how green omnichannel capability, customer green perception, green customer behaviour and brand loyalty management develop over time. Longitudinal research would provide stronger evidence on the dynamic development of these mechanisms.

Second, the study relied on self-reported data from business respondents. Although procedural remedies and common-method bias diagnostics were applied, response bias

cannot be ruled out entirely. In addition, the constructs represent managerial assessments rather than direct customer-level responses. Therefore, the findings should not be interpreted as direct evidence of individual customer perception, behaviour or loyalty. Future studies could use matched firm-customer data to compare managerial assessments with actual customer perceptions, behaviours and loyalty outcomes.

Third, the empirical context was limited to businesses operating in Thailand. Institutional conditions, sustainability regulations, digital maturity and customer expectations may differ across countries and regions. Although regional grouping and business-type quotas were used to obtain geographically distributed organisational responses, complete response-rate information and systematic non-response data were unavailable. As a result, the possibility of non-response bias cannot be fully assessed.

Finally, the indirect effects were interpreted as model-based pathways rather than as formal evidence of mediation, as bootstrap confidence intervals were not estimated. Future research should apply bootstrap procedures to examine the robustness of the proposed indirect pathways.

6.3 Future research directions

Future research may extend the proposed dual-pathway framework in several ways. Longitudinal studies could examine how green omnichannel capability, customer green perception, green customer behaviour and brand loyalty management develop over time. Such research would provide stronger evidence on the dynamic relationships among green channel capability, customer-related perception, customer-related behaviour and loyalty management. Matched firm-customer data would also help compare managerial assessments with actual customer perceptions, behaviours and loyalty responses.

Future studies may examine additional mechanisms linking green omnichannel capability to loyalty-related outcomes, such as green trust, green satisfaction, perceived green value, customer experience quality and green engagement. Research across specific industries or different countries would also clarify how sectoral and institutional contexts shape the proposed framework. Finally, future work should incorporate objective performance indicators, such as loyalty programme participation, repeat purchase records, packaging return rates, recycling participation, delivery efficiency, and carbon footprint reduction, to connect managerial assessments with measurable customer, business, and environmental outcomes.

Future research may also connect green omnichannel capability with broader channel capability and resilience frameworks. The sensing-orchestration-governance logic of the dynamic channel capability framework (Sukhawattanakun et al., 2026) and the layered resilience logic of the retail-wholesale channel resilience framework (Supapon et al., 2026) could be empirically examined in green omnichannel, retail-wholesale or platform-based business ecosystems. This direction would help explain how sustainability-oriented channel capabilities develop across organisational, customer and ecosystem levels, and how such capabilities support longer-term resilience and relationship continuity.

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Declarations

The questionnaire and research protocol were reviewed and approved by Kasetsart University's Research Ethics Committee under study code KUREC-CSC68-015 and ethics approval certificate number COE68/011. All participants joined the survey voluntarily and were informed that they could decline to answer any item or withdraw from participation without adverse consequences. The data were handled confidentially, analysed in aggregate form and reported without identifying any individual respondent or organisation.

ChatGPT and Grammarly were used only as language-support tools during manuscript preparation, including grammar checking, sentence refinement and improvement of academic clarity. All substantive content, analysis, interpretation and final wording were reviewed, revised and approved by the author, who accepts full responsibility for the accuracy, integrity and final version of the manuscript.

The author declares that no conflict of interest exists in relation to the research, authorship or publication of this article.

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Appendix

Table A1 Respondent and organisational profile

Profile variable	Category	Frequency	Percentage
Business type	Manufacturing business	200	33.3
	Trading business	200	33.3
	Service business	200	33.3
Length of business operation	Not more than 5 years	156	26.0
	6–10 years	142	23.7
	11–15 years	159	26.5
	More than 15 years	143	23.8

Note: n = 600.

Table A1 Respondent and organisational profile

<i>Profile variable</i>	<i>Category</i>	<i>Frequency</i>	<i>Percentage</i>
Main business operation pattern	100% offline	129	21.5
	100% online	101	16.8
	Mainly offline	108	18.0
	Mainly online	131	21.8
	Balanced offline and online operations	111	18.5
	Others	20	3.3
Main customer group	General customers	137	22.8
	Specific green or sustainable customer segments	155	25.8
	Corporate customers or other businesses	132	22.0
	Government agencies	154	25.7
	Others	22	3.7
Sustainability certification status	Already certified	146	24.3
	In the process of applying for certification	133	22.2
	Not yet certified, but planning to apply	169	28.2
	Not yet certified and no current plan to apply	152	25.3

Note: n = 600.

Table A2 Retained measurement items and measurement statistics in the final SEM model

<i>Indicator</i>	<i>Measurement item</i>	<i>Standardised loading</i>	<i>SMC</i>
GOC02	Systematically integrate online and offline channels to support environmentally responsible operations.	0.750	0.562
GOC06	Develop digital applications that support green marketing and customer service activities.	0.750	0.563
GOC10	Apply automated warehouse systems to reduce waste and unnecessary energy use.	0.717	0.514
GOC14	Promote digital communication channels to reduce paper and other consumable materials.	0.759	0.577
GOC18	Provide incentives for customers who choose ordering channels that reduce resource use.	0.727	0.528
GOC22	Manage distribution channels that reduce fossil fuel use in product transportation.	0.704	0.496
GOC25	Continuously evaluate and improve integrated channels to align with sustainability goals.	0.765	0.585
CGP01	Study customer needs for sustainability information to guide communication planning.	0.761	0.579
CGP04	Use online channels to communicate sustainability information about products and services.	0.726	0.527
CGP08	Design influencer-based communication to increase customer awareness of sustainability.	0.720	0.518

Note: Standardised loadings and SMC values were obtained from the final SEM model.

Table A2 Retained measurement items and measurement statistics in the final SEM model (continued)

<i>Indicator</i>	<i>Measurement item</i>	<i>Standardised loading</i>	<i>SMC</i>
CGP09	Communicate environmentally responsible production processes across customer touchpoints.	0.712	0.507
CGP12	Organise online activities that encourage customer engagement with sustainability issues.	0.752	0.565
CGP15	Produce video or multimedia content concerning brand sustainability.	0.750	0.562
CGP19	Evaluate customer awareness of sustainability through online surveys or feedback channels.	0.755	0.570
CGP23	Report sustainability communication performance to customers and the public on an ongoing basis.	0.790	0.625
GCB01	Study customer behaviour in selecting environmentally responsible products or services.	0.720	0.518
GCB03	Design motivational strategies that encourage customers to support green activities.	0.724	0.524
GCB07	Plan communication that encourages customers to shift toward sustainable consumption behaviour.	0.716	0.512
GCB11	Create campaigns that encourage customers to purchase through channels that reduce environmental impacts.	0.766	0.587
GCB13	Organise activities that promote the use of cloth bags, recycled bags or reusable packaging.	0.773	0.597
GCB17	Create online platforms that help customers track the environmental impact of their purchases.	0.719	0.516
GCB21	Use customer behaviour data to improve strategies that promote sustainable consumption.	0.760	0.577
GCB24	Use customer satisfaction feedback on green activities to improve sustainability-related strategies.	0.729	0.531
BLM01	Study customer expectations toward brands that prioritise sustainability.	0.741	0.549
BLM02	Develop brand loyalty strategies linked to sustainability principles.	0.760	0.578
BLM05	Plan customer relationship activities that strengthen awareness of brand sustainability.	0.723	0.522
BLM08	Use online channels to strengthen long-term customer relationships.	0.731	0.535
BLM09	Develop membership programmes that offer privileges to customers who support sustainability initiatives.	0.761	0.579
BLM13	Offer privileges or discounts to regular customers who demonstrate sustainable purchasing behaviour.	0.764	0.583
BLM16	Develop environmentally responsible online after-sales service systems for customers.	0.737	0.543
BLM20	Evaluate customer satisfaction and brand loyalty through multiple channels.	0.747	0.558

Note: Standardised loadings and SMC values were obtained from the final SEM model.

Table A2 Retained measurement items and measurement statistics in the final SEM model (continued)

<i>Indicator</i>	<i>Measurement item</i>	<i>Standardised loading</i>	<i>SMC</i>
BLM22	Track customer participation in brand activities designed to strengthen loyalty.	0.675	0.456
BLM25	Continuously improve brand loyalty strategies to align with future customer trends and behaviours.	0.738	0.545

Note: Standardised loadings and SMC values were obtained from the final SEM model.

Table A3 Supplementary regression results

<i>Dependent variable</i>	<i>Standardised beta</i>	<i>R²</i>	<i>F</i>	<i>p-value</i>	<i>Result</i>
Green omnichannel capability	0.719	0.517	640.152	<0.001	Significant
Customer green perception	0.656	0.431	452.765	<0.001	Significant
Green customer behaviour	0.666	0.444	476.772	<0.001	Significant
Brand loyalty management	0.065	0.004	2.565	0.110	Not significant
Overall management score	0.641	0.411	417.713	<0.001	Significant

Note: The independent variable was sustainability-oriented channel operations. The standardised beta was the standardised regression coefficient.

Table A4 Supplementary group-based analysis by business type

<i>Variable</i>	<i>Manufacturing mean (S.D.)</i>	<i>Trading mean (S.D.)</i>	<i>Service mean (S.D.)</i>	<i>Total mean (S.D.)</i>	<i>F</i>	<i>p-value</i>	<i>Interpretation</i>
Sustainability-oriented channel operations	3.952 (0.478)	4.049 (0.473)	3.951 (0.472)	3.984 (0.476)	2.840	0.059	Marginal, not significant
Green omnichannel capability	3.684 (0.469)	3.757 (0.483)	3.675 (0.461)	3.705 (0.472)	1.816	0.164	Not significant
Customer green perception	3.659 (0.472)	3.687 (0.486)	3.661 (0.453)	3.669 (0.470)	0.211	0.810	Not significant
Green customer behaviour	3.649 (0.470)	3.710 (0.487)	3.659 (0.435)	3.673 (0.464)	0.990	0.372	Not significant
Brand loyalty management	3.779 (0.475)	3.891 (0.519)	3.766 (0.569)	3.812 (0.525)	3.445	0.033	Significant overall difference
Overall management score	3.693 (0.379)	3.761 (0.402)	3.690 (0.375)	3.715 (0.386)	2.162	0.116	Not significant

Note: One-way ANOVA compared manufacturing, trading, and service businesses. Brand loyalty management showed a significant overall difference, but Scheffé post hoc tests found no significant.