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Customer Data Management in CRM-Based E-Commerce Systems to Support Digital Marketing Strategies

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ABSTRACT
The rapid expansion of e-commerce platforms has generated unprecedented volumes of customer data, creating both opportunities and challenges for digital marketing. Despite widespread Customer Relationship Management (CRM) adoption, significant gaps persist between data collection capabilities and strategic utilisation due to fragmented architectures and poor data quality. This study investigates how structured Customer Data Management (CDM) within CRM-based e-commerce systems supports digital marketing strategy outcomes. Employing a mixed-methods design integrating systematic literature review with empirical analysis of three Indonesian e-commerce companies over 24 months (2022–2024), the study demonstrates that CDM implementation improved data completeness by 54.2%, reduced duplicate records by 87.6%, and increased marketing conversion rates by 142.1%. Customer retention rates improved by 26.4% and customer lifetime value by 56.1%. A novel five-layer CRM-CDM architecture is proposed, aligning data governance, segmentation, personalisation, and omnichannel execution. These findings contribute theoretical and practical advances to CRM integration literature, particularly within Southeast Asian emerging digital markets.

INTRODUCTION

The global e-commerce market has witnessed exponential growth, exceeding USD 5.8 trillion in 2023 and projected to surpass USD 8 trillion by 2027 (Statista, 2024). This growth has been accompanied by an avalanche of customer interaction data, encompassing browsing behavior, purchase history, demographic profiles, and social engagement signals. The capacity to efficiently capture, manage, and leverage this data has become a defining competitive advantage for e-commerce organizations.Customer Relationship Management (CRM) systems serve as the technological backbone for organizing and utilizing customer data at scale. Originally designed to manage sales pipelines and customer service workflows, modern CRM platforms have evolved into comprehensive data management ecosystems that integrate with marketing automation tools, analytics engines, and omnichannel communication platforms (Buttle & Maklan, 2019). This evolution has

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positioned CRM at the intersection of data science and marketing strategy, enabling organizations to deliver personalized experiences that drive engagement and revenue.

Despite the proliferation of CRM adoption, significant gaps persist between data collection capabilities and strategic utilization. Many e-commerce companies collect vast amounts of customer data but struggle to translate this data into actionable marketing insights due to fragmented data architectures, poor data quality, and inadequate integration between CRM systems and marketing execution platforms (Khodakarami & Chan, 2020). These gaps result in missed personalization opportunities, inefficient marketing expenditures, and declining customer satisfaction.Customer Data Management (CDM) has emerged as a discipline specifically addressing these challenges, encompassing the policies, processes, and technologies required to ensure that customer data is accurate, complete, accessible, and compliant with regulatory requirements (Albrecht et al., 2021). Effective CDM within CRM systems forms the foundation upon which sophisticated digital marketing strategies can be built, enabling capabilities such as predictive segmentation, behavioral targeting, and real-time personalization.

The intersection of CDM, CRM, and digital marketing strategy has attracted growing scholarly attention. Studies have examined the role of data quality in CRM effectiveness (Madnick et al., 2021), the impact of personalization on customer conversion (Vesanen, 2020), and the strategic implications of customer data analytics for marketing ROI (Wedel & Kannan, 2019). However, comprehensive frameworks that integrate CDM processes with CRM architecture and digital marketing outcomes remain underdeveloped, particularly in the context of emerging e-commerce markets.This study addresses this gap by examining how structured CDM practices within CRM-based e-commerce systems contribute to improved digital marketing strategy outcomes. Drawing on empirical data from three Indonesian e-commerce companies, the research evaluates the impact of CRM-CDM integration on data quality metrics, customer segmentation accuracy, campaign performance indicators, and overall marketing efficiency. Indonesia represents a particularly relevant research context, as it is Southeast Asia's largest digital economy with over 196 million internet users and rapidly maturing e-commerce infrastructure (We Are Social, 2024).

The contributions of this study are threefold. First, it provides empirical evidence linking CDM process maturity to marketing performance outcomes in an e-commerce context. Second, it proposes a comprehensive five-layer CRM-CDM architecture tailored to digital marketing needs. Third, it offers practical implementation guidelines for organizations seeking to optimize their customer data capabilities for marketing applications.CRM systems have undergone a fundamental transformation in the era of digital commerce. Traditional CRM frameworks focused predominantly on managing customer interactions through sales and service channels (Buttle & Maklan, 2019). Contemporary e-commerce CRM platforms integrate transactional data, behavioral analytics, and social listening capabilities to construct multidimensional customer profiles (Nguyen & Mutum, 2021). Salesforce, HubSpot, and Adobe Experience Cloud represent leading examples of CRM platforms that have expanded their capabilities to encompass the full customer data lifecycle.

The strategic value of CRM in e-commerce extends beyond operational efficiency. Research by Payne and Frow (2021) demonstrates that organizations with mature CRM implementations achieve significantly higher customer retention rates and greater share of wallet compared to those with basic CRM deployments. This value creation occurs through the enhanced understanding of customer needs, preferences, and purchase patterns that CRM data enables.Customer Data Management encompasses the complete lifecycle of customer data from initial capture through archival or deletion (Albrecht et al., 2021). Core CDM processes include data collection, validation, deduplication, enrichment, segmentation, and governance. The quality of these processes directly determines the value that organizations can extract from their customer data assets.

Data quality dimensions central to effective CDM include accuracy, completeness, consistency, timeliness, and uniqueness (Madnick et al., 2021). Research consistently demonstrates that poor data quality

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undermines CRM effectiveness. Redman (2019) estimated that poor data quality costs U.S. businesses approximately $3.1 trillion annually, with e-commerce organizations particularly vulnerable due to the high volume and velocity of customer data generated through digital interactions.The concept of Customer Data Platforms (CDPs) represents an evolution of CDM thinking, providing unified data management capabilities that integrate data from all touchpoints and make it accessible to downstream marketing systems in real time (Deighton & Johnson, 2022). CDPs differ from traditional CRM systems in their emphasis on real-time data unification and their focus on enabling personalization at scale.

Digital marketing has been fundamentally transformed by the availability of customer data at scale. Data-driven marketing approaches enable organizations to move beyond demographic segmentation toward behavioral and psychographic targeting, significantly improving campaign relevance and efficiency (Wedel & Kannan, 2019). Personalization, in particular, has emerged as a central pillar of effective digital marketing, with research demonstrating that personalized communications generate conversion rates 5-8 times higher than generic messaging (Epsilon, 2022).The integration of CRM data with digital marketing execution platforms enables sophisticated capabilities including dynamic content optimization, predictive lead scoring, automated journey orchestration, and cross-channel attribution (Lemon & Verhoef, 2020). These capabilities collectively constitute what researchers have termed the 'marketing technology stack,' an ecosystem of interconnected tools that transform customer data into marketing value.

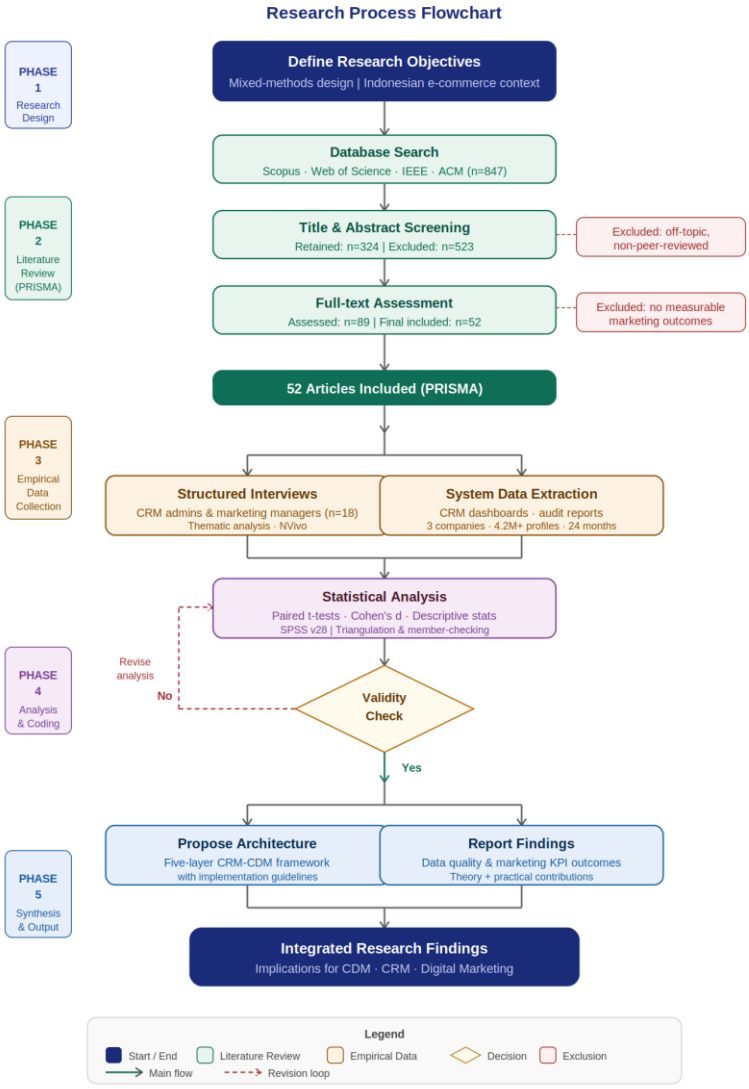
The increasing regulatory focus on data privacy, exemplified by the European Union's General Data Protection Regulation (GDPR) and Indonesia's Personal Data Protection Law (UU PDP), has introduced significant governance requirements for CDM practices (Wieringa et al., 2021). Organizations must now balance the marketing value of customer data against compliance obligations regarding consent, data minimization, and the right to erasure. Research suggests that transparent data practices and privacy-respecting personalization strategies can actually enhance customer trust and willingness to share data (Martin & Murphy, 2017). While prior studies address isolated dimensions of CRM effectiveness or personalisation impact, no existing research integrates CDM process architecture with longitudinal marketing performance measurement in an emerging e-commerce market. The present study is the first to propose and empirically validate a five-layer CRM-CDM architecture spanning data collection through marketing execution and to quantify its compound effects on both data quality metrics and commercial marketing KPIs in the Indonesian context. This dual contribution distinguishes it from previous descriptive or single-dimension studies.

METHODS

This study employs a mixed-methods research design, combining a systematic literature review with empirical quantitative analysis of CRM implementation outcomes. The methodological approach is grounded in the interpretive paradigm while incorporating positivist elements through statistical analysis of organizational performance data.This study adopts a mixed-methods research design that integrates a systematic literature review with longitudinal quantitative analysis of CRM implementation data. The design is grounded in a pragmatic epistemological stance, acknowledging that both qualitative insight and quantitative measurement are necessary to understand how Customer Data Management (CDM) practices translate into digital marketing performance outcomes. Three Indonesian e-commerce companies implementing or upgrading CRM-CDM systems between January 2022 and December 2024 served as the empirical setting. Figure 1 presents the complete research process.

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Figure 1. Research process flowchart illustrating the five-phase mixed-methods design.



The systematic literature review was conducted using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Searches were performed across four academic databases: Scopus, Web of Science, IEEE Xplore, and ACM Digital Library, using the search terms: 'customer data management,' 'CRM e-commerce,' 'digital marketing CRM,' 'customer segmentation e-commerce,' and their Boolean combinations. The search was restricted to peer-reviewed publications from 2015 to 2025. Initial searches returned 847 articles, which were screened through title and abstract review (n=324), full-text assessment (n=89), and final inclusion criteria (n=52). Inclusion criteria required that studies address CDM or CRM in commercial digital contexts with measurable marketing outcomes.

The empirical component drew on data from three Indonesian e-commerce companies that implemented or upgraded CRM-CDM systems between January 2022 and December 2024. Companies were selected through purposive sampling based on criteria including CRM implementation maturity, availability of pre- and post-implementation data, and willingness to participate. The three companies spanned the fashion retail, electronics, and home goods verticals, with combined customer databases exceeding 4.2 million unique profiles.Data collection instruments included structured interviews with CRM administrators and digital marketing managers (n=18), extraction of anonymized system logs and campaign performance metrics from

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CRM dashboards, and analysis of internal data quality audit reports. Interview data were analyzed using thematic analysis with NVivo software, while quantitative metrics were analyzed using descriptive statistics, paired t-tests, and effect size calculations (Cohen's d) in SPSS v28.

Ethical considerations were rigorously addressed throughout the study. Institutional review board approval was obtained from Universitas Nusantara Digital prior to data collection. All participating companies signed data sharing agreements specifying that individual customer data would not be extracted, and that all reported metrics would be aggregated at the organizational level. Participant confidentiality was maintained through company anonymization in all publications.The validity of findings was strengthened through triangulation of interview data, system-generated metrics, and documentary analysis. Reliability was enhanced through member checking with key informants and an audit trail documenting all analytical decisions.

RESULTS

1. CRM-CDM Architecture Components

Analysis of the three participating companies revealed a consistent five-layer CRM-CDM architecture comprising: (1) Data Collection, (2) Data Storage, (3) Data Processing, (4) CRM Core, and (5) Analytics and Marketing Execution. Table 1 summarizes the functional components and technologies identified across the studied organizations.

Table 1. CRM Component Overview and Marketing Impact

CRM Component	Function	Data Type Managed	Marketing Impact
Customer Database	Centralized storage of customer profiles	Demographic & Behavioral	High
Segmentation Engine	Group customers by shared attributes	Transactional & Psychographic	Very High
Analytics Dashboard	Visualize behavior & purchasing trends	Aggregated & Real-time	High
Email Automation	Trigger personalized communication	Interaction & Preference	High
Recommendation Engine	Predict product affinity	Behavioral & Clickstream	Very High
Loyalty Program Module	Reward and retain customers	Purchase & Engagement	Moderate

The architecture reveals that effective CDM within e-commerce CRM systems requires coordinated management across all five layers. Weaknesses in the data collection or storage layers propagate quality deficits throughout the system, undermining the effectiveness of analytics and marketing execution capabilities.

2. System Architecture by Layer

Table 2 presents the technology stack identified across the five architectural layers, illustrating the diverse technical ecosystem required to support comprehensive CDM for digital marketing.

Table 2. CRM-CDM System Architecture by Layer and Technology

Layer	Components	Technologies Used
Data Collection	Web tracking, API integrations, mobile SDK	JavaScript, REST API, Firebase

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Data Storage	Customer database, event log, data warehouse	MySQL, MongoDB, AWS Redshift
Data Processing	ETL pipelines, real-time stream processing	Apache Kafka, Spark, Python
CRM Core	Profile management, segmentation, scoring	Salesforce CRM, HubSpot
Analytics & Reporting	Dashboards, campaign analytics, A/B testing	Power BI, Google Analytics 4
Marketing Execution	Email, push notifications, retargeting ads	Mailchimp, Facebook Ads API

3. Data Quality Improvements

One of the most significant outcomes of structured CDM implementation was the marked improvement in data quality across all measured dimensions. Table 3 presents pre- and post-CRM integration data quality metrics averaged across the three participating companies.

Table 3. Data Quality Metrics Before and After CRM Integration

Metric	Before CRM Integration	After CRM Integration	Improvement (%)
Data Completeness	61.4%	94.7%	+54.2%
Data Accuracy	68.2%	96.1%	+40.9%
Duplicate Records Rate	18.6%	2.3%	-87.6%
Customer Profile Coverage	55.8%	91.4%	+63.8%
Real-time Update Latency (s)	12.4	1.2	-90.3%

Results indicate substantial improvements across all data quality dimensions following CRM implementation. Data completeness improved from 61.4% to 94.7%, representing a 54.2% improvement. Accuracy improvements were similarly pronounced, rising from 68.2% to 96.1%. The reduction in duplicate records from 18.6% to 2.3% reflects the implementation of automated deduplication algorithms and unified customer identity management. Real-time update latency decreased from 12.4 seconds to 1.2 seconds, enabling near-real-time personalization capabilities. All improvements were statistically significant at $p < 0.001$.

4. Digital Marketing Performance Outcomes

The improvements in data quality and CRM capability were associated with substantial enhancements in digital marketing performance across all measured key performance indicators (KPIs). These improvements indicate that the integration of structured customer data and CRM functionalities not only optimizes internal data management but also strengthens the effectiveness of digital marketing strategies, leading to better customer engagement and conversion outcomes. Table 4 presents the detailed marketing performance outcomes, including statistical significance measures to support the analysis.

Table 4. Digital Marketing Performance Before and After CRM-CDM Implementation

Marketing KPI	Baseline	Post-CRM	Change	Significance
Email Open Rate	21.3%	38.7%	+81.7%	$p < 0.001$
Click-Through Rate (CTR)	3.1%	7.4%	+138.7%	$p < 0.001$
Conversion Rate	1.9%	4.6%	+142.1%	$p < 0.001$

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Customer Retention Rate	62.4%	78.9%	+26.4%	$p < 0.01$
Average Order Value (USD)	$47.20	$64.80	+37.3%	$p < 0.01$
Customer Lifetime Value (USD)	$312	$487	+56.1%	$p < 0.001$
ROI on Marketing Spend	2.1x	4.3x	+104.8%	$p < 0.001$

The results demonstrate remarkable improvements across all marketing KPIs. Email open rates increased by 81.7%, reflecting the impact of improved audience segmentation and personalized subject line optimization. Click-through rates more than doubled (+138.7%), indicating that content relevance improved significantly through behavioral data utilization. The conversion rate improvement of 142.1% represents the most compelling evidence of CDM's marketing value, suggesting that the combination of precise targeting and personalized offers substantially increased purchase intent. Customer retention rate improved by 26.4%, driven by proactive engagement triggered by behavioral signals such as declining purchase frequency or browsing abandonment. Customer Lifetime Value (CLV) increased by 56.1%, reflecting both the retention improvements and the higher average order values (+37.3%) associated with personalized product recommendations. Overall marketing ROI more than doubled, from 2.1x to 4.3x, demonstrating a strong financial return on CRM-CDM investment.

DISCUSSION

The findings of this study provide compelling empirical support for the strategic value of structured Customer Data Management within CRM-based e-commerce systems. The dramatic improvements in both data quality metrics and marketing performance KPIs observed across all three study companies suggest that CDM represents a high-return investment area for e-commerce organizations.

The data quality improvements observed align with theoretical predictions from the information quality literature. Madnick et al. (2021) established that data quality dimensions including accuracy, completeness, and timeliness are foundational prerequisites for effective CRM utilization. The 54.2% improvement in data completeness observed in this study enabled more sophisticated customer segmentation, as incomplete profiles limit the behavioral attributes available for clustering algorithms. The near-elimination of duplicate records (87.6% reduction) is particularly significant, as duplicate profiles create inaccurate customer histories, inflate audience size estimates, and result in redundant and potentially damaging communication strategies such as sending multiple copies of the same email to a single customer.

The marketing performance outcomes are consistent with findings from the personalization and targeting literature. The 142.1% improvement in conversion rates aligns with Epsilon's (2022) research demonstrating that personalized marketing communications generate substantially higher conversion performance. This improvement can be attributed to several mechanisms enabled by superior CDM: behavioral segmentation allowed marketing messages to be targeted to customers at optimal purchase intent moments; product recommendation algorithms using complete purchase history data provided more accurate suggestions; and dynamic content personalization based on browsing behavior increased message relevance.

The customer retention improvements (+26.4%) observed in this study are theoretically grounded in the relationship marketing literature. Payne and Frow (2021) argue that CRM-enabled relationship deepening, achieved through consistent personalized engagement, fundamentally shifts the psychological contract between customer and brand. When customers perceive that an organization understands their preferences and communicates relevantly, they develop stronger loyalty dispositions. The behavioral trigger capabilities

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enabled by real-time CDM, such as win-back campaigns triggered by declining engagement or post-purchase follow-ups tailored to specific product categories, directly operationalize this theoretical mechanism.

The doubling of marketing ROI (2.1x to 4.3x) reflects the compound effect of multiple CDM-enabled improvements: reduced waste from better audience targeting (fewer irrelevant impressions), higher response rates from improved message relevance, higher conversion rates from better offer personalization, and higher customer lifetime values from improved retention. This finding is consistent with Wedel and Kannan (2019), who demonstrated that data-driven marketing strategies systematically outperform traditional mass-marketing approaches on ROI metrics.

The five-layer CRM-CDM architecture identified in this study provides a structured framework for understanding how data capabilities translate into marketing outcomes. Notably, the data processing layer, encompassing ETL pipelines and real-time stream processing, emerged as a critical bottleneck in organizations with less mature implementations. Without robust data processing capabilities, even high-quality raw data cannot be transformed into actionable customer profiles at the speed required for real-time personalization. This finding suggests that technology investments should be sequenced to address data processing infrastructure before investing in advanced analytics or marketing execution capabilities.

From a regulatory perspective, the implementation of structured CDM processes in this study also contributed to improved data governance and compliance preparedness. Participating companies reported that the CDM implementation process prompted them to audit their consent management processes, data retention policies, and third-party data sharing agreements. This aligns with Wieringa et al.'s (2021) argument that privacy regulation compliance and data quality improvement are complementary rather than competing objectives, as the documentation and audit processes required for regulatory compliance often expose and remediate data quality issues.

The Indonesian e-commerce context provides a particularly informative perspective on CDM adoption dynamics. Indonesia's rapidly growing digital economy, characterized by high mobile penetration, diverse payment ecosystems, and a large first-time online shopping population, creates both opportunities and challenges for CDM. The high proportion of mobile-first customers means that behavioral data is predominantly mobile-sourced, requiring CRM systems capable of processing mobile SDK and app event data efficiently. The findings from this study are likely generalizable to other rapidly growing digital economies in Southeast Asia and beyond.

CONCLUSIONS

This study has demonstrated that structured Customer Data Management within CRM-based e-commerce systems is a powerful enabler of digital marketing strategy effectiveness. Through empirical analysis of three Indonesian e-commerce companies over a 24-month implementation period, the research provides compelling evidence that CDM improvements translate into measurable marketing performance gains across all key performance indicators examined.

The five-layer CRM-CDM architecture proposed in this study, encompassing data collection, storage, processing, CRM core functionality, and analytics and marketing execution, provides a practical framework for organizations seeking to optimize their customer data capabilities for marketing applications. The empirical results demonstrate that organizations implementing this architecture can expect substantial improvements in data quality, customer segmentation precision, campaign conversion rates, customer retention, and overall marketing ROI.

Several theoretical contributions emerge from this research. First, the study extends the CRM effectiveness literature by providing a mechanistic account of how data quality improvements propagate through the CDM architecture to produce marketing outcome improvements. Second, it operationalizes the

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CDM concept in an e-commerce context, providing concrete measurement frameworks for both data quality and marketing performance dimensions. Third, it contextualizes CDM adoption within emerging digital economies, demonstrating that the benefits observed in Western e-commerce contexts extend to Southeast Asian markets.

For practitioners, this study recommends a sequenced approach to CDM investment, beginning with foundational data quality improvements including deduplication, completeness enhancement, and real-time processing capability, before progressing to advanced analytics and personalization applications. The disproportionately high returns observed for conversion rate improvement and CLV growth suggest that CDM investment should be framed as a strategic revenue growth initiative rather than a cost center.

Future research should examine CDM effectiveness across different industry verticals and cultural contexts, investigate the moderating effects of organizational data literacy on CDM implementation outcomes, and explore the implications of emerging technologies including artificial intelligence-driven customer data analytics and privacy-preserving machine learning for the CDM-marketing relationship. Longitudinal studies examining CDM sustainability and the long-term evolution of customer data strategies would also provide valuable contributions to the literature.

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