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Digital Marketing, Logistics Coordination and Service-System Quality in E-Commerce Platforms: An Exploratory Analysis

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Abstract. The fast development of e-commerce has created a shift in digital marketing, as it is no longer a communication role but rather a service-system process of integration of customer communication, flow of information, platform infrastructure and logistics activities. This paper creates an ICT-enabled informatics and service-science framework of evaluating the role of digital technologies in supporting integrated e-commerce service systems. The study is dedicated to artificial intelligence, Big Data analytics, cloud computing, mobile technologies and marketing automation as the essential technological drivers of digital marketing and coordination of logistics. The methodology is based on systems analysis, business process modelling and exploratory index-based comparative analysis based on standardized company-level indicators. Data for the empirical analysis has been drawn from five of the most popular global e-commerce platforms, namely Amazon, Alibaba, eBay, Shopify and Etsy, and is standardized on a company level. Due to the importance of logistics and service-science, the revised framework not only considers e-commerce performance, but also logistics coordination and service-system quality. The results can be seen as exploratory and not statistically generalizable. They suggest that in the analysed five companies, AI and Big Data analytics have a positive relationship with predictive coordination, information-service flow processing and digital commerce performance. Cloud computing, mobile technologies and marketing automation also provide for operational scalability, omnichannel responsiveness and customer-service coordination.

Keywords: ICT; E-Commerce; Service Systems; Informatics; Digital Marketing; Logistics Operations; Information-Service Flows

1. Introduction

The fast evolution of the digital economy has radically altered the composition of the contemporary business systems, especially in the e-commerce sector. One of the major sources of this change is information and communication technologies (ICT), which allow organizations to increase the market reach, raise the efficiency of operations and increase customer engagement in the digital realm (Agrawal et al., 2019). The ever-expanding nature of international e-commerce, which is facilitated by digital platforms, data analytics and internet communication tools, has contributed greatly to the role of ICT as a strategic asset, and no longer as a technical one (Al-Ababneh, 2024). Here, ICT has ceased to represent automation or support of communication, and it is taking on a more and more definite role in the design, administration and coordination of digital service systems. In the contemporary age of digital transformation, the e-commerce platforms have ceased to be a single commercial system but become a multi-faceted system of services that combine digital marketing, customer interaction, data processing, platform infrastructure and logistics operations. In terms of service-science, value is created in such systems through synchronized interactions between the technological infrastructure, organizational processes and customers. Digital marketing as a communication-traditionally-speaking role turns out to be a more and more often a demand-generating mechanism that needs to be aligned with fulfilment, delivery responsiveness and customer experience management (Erevelles et al., 2016). Thus, the success of e-commerce companies is not only determined by the capacity to draw consumers to the Internet, but also the capacity to convert the digitally generated demand to trustworthy service deliverables through logistics alignment. Simultaneously, the advancement of the informatics has enhanced the importance of data-driven decision-making in e-commerce. The information flows in customer behaviour, transactions data, platform activity and logistics information provide continuous flows of information that need to be processed, integrated and interpreted analytically. Artificial intelligence, Big Data analytics and cloud computing technologies help companies to turn raw data into actionable insights to support personalized marketing strategies, demand forecasting, operational planning and customer-service coordination (Zhang et al., 2023). These functionalities underscore the value of ICT as a technology infrastructure, as well as an informatics-based system of integrating various elements of digital business systems.

E-commerce platforms also represent holistic service ecosystems, where customers, digital infrastructure, analytics and logistics contribute to the creation of value, from a service science perspective. Here, the need is to constantly align customer demand (generated by digital marketing) with supply of fulfilment capacity, inventory information, delivery speed and post-purchase satisfaction. As such, the ICT flows of information service are identified as the coordination mechanisms between the interaction with the customer and the execution of the operation and service continuity in platform-based commerce systems. Although the topic of digital transformation has been researched widely, ICT adoption and e-commerce development, the current studies are mostly disjointed in the realms of marketing, information systems and logistics. There are numerous papers that study the performance of digital marketing and customer interaction, and there are also those that study the optimization of supply chains, cybersecurity or logistics efficiency on its own (Singh and Kumar, 2021; Hoffmann and Trautmann, 2021). But these processes are intimately linked together in the actual e-commerce settings. The process of marketing generates demand, informatics systems process and interpret data, while logistics operations determine whether such demand can be fulfilled through coordinated service delivery. Lack of integrative analytical models to explain the role of ICT in synchronization of digital marketing and logistics processes with the flow of information-service is a major research gap. This paper fills this gap by situating e-commerce in the interdisciplinary context of logistics, informatics and service science. Logistically, the research looks into the ways in which ICT helps in the fulfilment of demand, coordinating deliveries and responsiveness of operations. Informatics-wise, it examines the flow of data that can facilitate integration of the system, decision-making and optimization of processes. Service-science approach to e-commerce explains the service system where value is co-created via

customer-customer, customer-digital technologies, and customer-organization interactions. In practice, the existing studies, however, tend to consider the performance of e-commerce only from a financial or marketing perspective and not adequately operationally measure logistics coordination and service-system quality as separate analytical constructs. This leads to a methodological gap: Logistics and service-science concepts are integrated with ICT maturity indicators rarely directly. This is a methodological gap as logistics and service-science concepts are often referred to in digital commerce research without being measured directly along with ICT maturity indicators. This positioning directly represents the necessity to examine e-commerce as a digital sales channel, but as a system of integrated services where marketing and logistics are linked with each other through ICT-based information streams. Based on this, the following research questions have led the study:

RQ1: What are the roles of the ICT components on the performance of e-commerce, logistics coordination and the quality-of-service systems in a platform-based digital commerce?

RQ2: What is the impact of artificial intelligence and the Big Data analytics on the information-service flow coordination in e-commerce platforms?

RQ3: How can operational scalability and service responsiveness be achieved with the help of cloud computing, mobile technologies and marketing automation?

RQ4: What is the role of the integration of digital marketing, informatics and logistics operations in coordinated service-system performance in the context of ICT-enabled e-commerce?

To answer these research questions, the research creates a model of informatics-based service-system that assesses the effect of the main ICT elements, such as artificial intelligence, Big Data analytics, cloud computing, mobile technologies and marketing automation, on the business performance indicators. The empirical section relies on standardized information of the most successful e-commerce companies in the world and uses systems analysis, business process modelling and exploratory comparative analytical assessment. This methodological design enables the ICT components to be viewed as not only as technological indicators, but as service-system performance drivers, coordination of information-service flows and logistics–marketing integration. This research has threefold contribution. First, it suggests a combined analytical framework that indicates the way in which ICT facilitates the coordination of digital marketing and logistics processes in the e-commerce service systems. Second, it provides exploratory analytical evidence regarding the role of ICT components in supporting e-commerce service-system coordination and platform performance. Third, it deepens the conceptual insight of e-commerce by showing that digital marketing is more of a process of coordination of a larger service-system and logistics and not a single communication role. On the whole, the research can be added to the body of research on logistics, informatics and service science by describing how information-service flows made possible by the use of ICT can be used to facilitate the enhancement of digital marketing and logistics operations. The offered model offers a foundation to evaluate the digital maturity, enhance operational responsiveness and enhance the competitiveness of e-commerce space in the more data-driven service environment. The study does not attempt to offer an econometric explanation of the performance of e-commerce in the world, which is statistically generalizable. Rather, it provides an explorative informational and service-science approach that relies on company-level indicators. The empirical intent is to establish tendencies in the data which can connect the e-commerce performance results to the concept of ICT maturity and logistics coordination and service-system quality. The study conceptualizes e-commerce platforms as integrated logistics–informatics service systems where customer value is co-created through synchronized digital marketing, operational coordination and information-service flows.

2. Literature Review

E-commerce and digital marketing have undergone rapid development that has elicited a lot of scholarly interest in various fields such as information systems, marketing science, logistics and service science. The use of information and communication technologies (ICT) is commonly regarded as the key factor

of this change, which allows companies to redesign their business models, increase their operational efficiency and develop new types of customer interaction (Agrawal et al., 2019). The growth of digital platforms and the rise of data available options has only intensified the role of ICT in the development of the competition dynamics of contemporary markets (Zhang et al., 2023). The current literature emphasizes the significance of artificial intelligence, Big Data analytics and cloud computing in enhancing the effectiveness of marketing, personalizing the customer and the decision-making process (Al-Ababneh et al., 2025). Meanwhile, the importance of digital technologies in improving the coordination of operations, inventory and delivery performance is highlighted in the studies of logistics and supply chain management (Singh and Kumar, 2021; Hoffmann and Trautmann, 2021). The contributions show that e-commerce development is a multidimensional issue, both in the front end and back end of business with the help of ICT. Nevertheless, the analysis is still disjointed, even with the body of literature. The research that is marketing oriented is more likely to be focused on customer engagement, conversion and communication strategies (Erevelles et al., 2016; Tiago and Veríssimo, 2014), and logistics-oriented researches are mostly concentrated on supply chain optimization and operational efficiency (Singh and Kumar, 2021). Informatics studies, on the other hand, discuss the processing of data and system integration yet are often not directly related to marketing and logistics results (Zhang et al., 2023). Consequently, the interaction of the ICT elements as an integrated service-system mechanism to coordinate digital marketing and logistics actions is poorly understood. This is a key gap in the case of platform-based e-commerce where the business performance needs to be tied to the demand generation, data processing, and fulfilment execution. A combined analytical framework that would unite the views of logistics, informatics and service science is thus clear. The subsections below critically review the literature on the topic of ICT-enabled transformation, informatics-based coordination and logistics integration of e-commerce service systems and outlines the gaps that remain unresolved and provide directions on the future research.

2.1. ICT-Driven Reconfiguration of Digital Service Architectures in E-Commerce Systems

The e-commerce revolution that has been brought about by ICT is a popular subject in the literature, where specific attention has been given to the areas of digitalization, automation and platform development. ICT can help companies to re-architecture old business models, incorporating digital communication, data analytics and customer engagement tools (Agrawal et al., 2019). Among the technologies that aid scalability, flexibility and real-time decision-making in digital environments, cloud computing, artificial intelligence and Big Data analytics are regarded as essential ones (Wanajma, 2024; Ferreira et al., 2023). Artificial intelligence is the key to this change as it allows predictive analytics, customer segmentation and automated marketing procedures. The systems based on AI enable companies to study the behaviour of customers, predict demand and optimize communication, thus enhancing conversion rates and customer interactions (Zhang et al., 2023). These features are enhanced by Big Data analytics, which offers the insights into large amounts of both structured and unstructured data, aiding in strategic decision-making and tailored marketing strategies (Erevelles et al., 2016).

Cloud computing also promotes the effectiveness of e-commerce systems in that it allows consolidation of various functional elements, such as marketing systems, customer relationship management systems and logistics operations. Cloud-based solutions are also flexible and can be scaled, which enables firms to adjust to changes in the market and save on the cost of infrastructure (Wanajma, 2024; Gupta and Khan, 2024). The use of mobile technologies and social networks is also important to increase the range of customers and enhance communication, especially within the framework of omnichannel strategies (Tiago and Veríssimo, 2014; Fan and Gordon, 2014; Gupta and Khan, 2024). In spite of these developments, there are a number of unanswered questions in the literature. To begin with, the bulk of literature is devoted to each of the technologies instead of the interaction of all the technologies on the system performance. Second, little focus is given to the incorporation of ICT elements in a cohesive service architecture. Third, analysis of the relationship between technological

adoption and business performance is usually done without the relationship of the mediating role of operational processes. All these restrictions suggest that a more comprehensive approach should take ICT as an integrated system as opposed to tools that are independent of each other. Critically, the literature available has been overly optimistic on the direct effect of ICT on performance and underestimates the significance of organizational alignment, data governance and process integration. This leaves a difference between what is theoretically discussed and practically realized where technological investments may not necessarily produce anticipated results. Future studies should therefore aim at coming up with merged models which can describe the interplay between ICT elements, organizational processes and customer behaviour. According to the analysis, transformation brought by ICT should be seen as a reconfigurative process of digital service architecture, as opposed to the mere implementation of new technologies. This view emphasizes the need to think at the coordination, integration and system-level to comprehend the role of ICT in e-commerce.

2.2. Informatics-Based Coordination of Information-Service Flows in Digital Marketing Ecosystems

Informatics is also a concept that is important in the role of ICT to support decision-making and coordinating in e-commerce systems. Informatics is concerned with the gathering, processing and analysis of data, converting raw information into useful information that informs business processes (Zhang et al., 2023; Ivanov and Dolgui, 2021). In digitally based marketing, informatics can help companies to study customer behaviour, discern patterns and streamline communication strategies on the fly. The main element of this process is big data analytics and artificial intelligence, which enables companies to process a significant amount of data of various sources: social media, websites, mobile applications and transaction systems (Kumar and Reinartz, 2018). These technologies facilitate individual marketing, focused advertisement and customer interaction and make digital communication much more effective (Erevelles et al., 2016). Nevertheless, the involvement of informatics is not limited to marketing. The flows of information link various elements of e-commerce systems such as marketing, customer service and logistics functions. These flows require proper coordination to make sure that customer demand that is created in the course of digital marketing can be matched with the operational capacity and service delivery (Zhang et al., 2023; Li and Wang, 2024). Such coordination demands the compilation of data systems, online information sharing and sophisticated analytical systems. In the study, information-service flows are considered as digitally mediated coordination processes in between customer demand generation, platform analytics, logistics execution and post-purchase service interactions processes. Therefore, information flows are not treated as a series of technical data streams but rather as service links, which are part of an operation and where value is co-created among service users, the digital platforms, analytics systems and logistics suppliers. The interpretation makes the connection between informatics processes and the coordination of customer service and operational fulfilment activities explicit and thus enriches the service-science side of the study.

The literature cites a number of challenges associated with coordination based on informatics. Data fragmentation, where the information is stored in different systems, and it cannot be easily integrated, is one of the primary problems. The complexity of data processing is another issue, as it involves the use of advanced analytical tools and qualified staff (Samieifard et al., 2024; Hassan and Ali, 2024; Ferreira et al., 2023). Moreover, the use of specific technologies is restricted by the concerns about data security and privacy, as well as influencing the level of trust among customers (Singh and Kumar, 2021). Critically, most research works revolve around the advantages of data analytics but do not touch on the dangers of the data quality, bias and ethical issues. The insufficiency of transparency in the AI-based systems and the possible abuse of personal information are major issues of both companies and the regulatory bodies (Zhang et al., 2023). Also, data analysis is not always considered as a component of a larger service system but as a separate task in the literature, which restricts its practical application.

Recent studies also emphasize that integrated digital coordination mechanisms improve platform responsiveness and customer-service continuity in e-commerce ecosystems (Park and Kim, 2024).

This analysis suggests that informatics is to be considered as a process of coordinating the flows of information-services instead of mere processing of data. This view highlights the need to integrate, interoperate and make real-time decisions within digital marketing ecosystems. Future studies need to be done to come up with models that identify the dynamic relationship between data flows, customer behaviour and operational processes.

2.3. Integrated Logistics–Informatics Service Systems and Hypothesis Development in ICT-Enabled E-Commerce Platforms

The success of e-commerce platforms is becoming more a matter of the level of integration with digital marketing, the informatics processes, and the logistics operations. With modern digital landscapes these elements cease to be discrete subsystems but create a single service architecture where value is created by coordinated information-service flows. The transformation in this way is a move that is based on fragmented digital solutions, and integrated ICT enabled service systems, where marketing activities generate demand, informatics systems process and interpret data, and logistics operations perform in order to ensure fulfilment and delivery performance (Singh and Kumar, 2021; Hoffmann and Trautmann, 2021; Nambisan et al., 2017). Logistically, ICT allows making major advancements in the fields of inventory management, demand forecasting, optimization of routes and real-time monitoring. Cloud computing, artificial intelligence and the Internet of Things are some technologies that contribute to a better view of the supply chain processes and their coordination, enabling firms to react better to demand fluctuations (Chen, 2020; Chaffey, 2021). Hence, logistics coordination assumes that it is a service-system outcome and not an operational background function and, specifically for this study, therefore treated separately. It offers visibility of inventory, coordination of deliveries, operational synchronization and responsiveness in fulfilment. The adjustment helps the empirical model to better capture the logistics orientation of the study and scope of the logistics, informatics and service science. Simultaneously, logistics performance is no longer measured at all with regards to the cost-efficiency or the speed of delivery. Rather, it is more and more associated with customer experience, reliability of the service and platform competitiveness (Verhoef et al., 2017; Lemon and Verhoef, 2016). This interpretation is consistent with Osei-Bryson and Barclay (2023), who argue that digital platform performance increasingly depends on the integration of operational visibility, customer-service continuity and data-driven coordination mechanisms across logistics ecosystems. This means that logistics processes should be attuned to digital marketing to make sure that customer expectations formed during online communication are fulfilled during the fulfilment phase. The informatics dimension is important in facilitating such integration. E-commerce sites yield voluminous amounts of data pertaining to customer behaviour, transactions and logistics processes. The tools of Big Data analytics and artificial intelligence help companies to convert this information into actionable insights, which help support decision-making and coordination between the various functional areas (Zhang et al., 2023). The informatics systems act as an intermediary between the marketing and logistics to guarantee the flow of information is continuous, timely and relevant. Digital marketing campaigns can create more demand than is possible through operational capacity without proper integration of the data, which will result in service failures and less customer satisfaction.

Although the significance of ICT is acknowledged, the literature demonstrates that there are still troubles in the effective integration. The fragmentation of systems, where marketing, data analytics and logistics functions are provided on different platforms with low interoperability is one of the key issues. This disintegration decreases the capacity of companies to organize processes and dynamically react to the market. The other difficulty is managing large-scale data flows and its complexity, which needs complex analytical tools and trained staff (Samieifard et al., 2024). Moreover, issues of data privacy and security limit the application of some technologies and affect the trust of the customers (Singh and

Kumar, 2021). Critically, most of the studies focus on the advantages of individual ICT components, but fail to sufficiently cover the circumstances under which the technologies create value. ICT effectiveness is also determined by the adoption but also the level of integration and alignment of various organizational processes. To illustrate, the artificial intelligence can be used to enhance demand forecasting, but unless it is accompanied by amendments in the logistics operations, the effect of artificial intelligence on the overall performance will be minimal. Equally, to the extent that marketing automation can improve the efficiency of communications, it could result in a mismatch of customer expectations without the proper data and operational support.

These constraints emphasize the fact that a systemic approach needs to be taken to ICT as an integrated service-system facility. In this context, the concepts of artificial intelligence, Big Data analytics, cloud computing, mobile technologies and marketing automation are not standalone tools but they are interdependent elements of each other, which have an overall impact on performance. The effects they have together establish the capacity of e-commerce platforms to organize demand generation, data processing/service delivery. According to this view, the connection between ICT and e-commerce performance can be conceptualized as a multi-dimensional interaction whereby all the aspects play a role in the coordination of information-service flow. The AIs facilitate predictive analytics and automation, allowing companies to forecast consumer demands and streamline resource utilization (Zhang et al., 2023; Li and Wang, 2024). The analytics of Big Data improves decision-making by giving information about customer behaviour and trends in their operations (Erevelles et al., 2016). Cloud computing is scalable and integrates systems, whereby various processes can operate, in a single infrastructure (Wanajma, 2024). Mobile technologies enhance accessibility and immediate interaction and enhance the bond between the customer and the platforms (Tiago and Veríssimo, 2014). Marketing automation can make the processes of communication and targeting more efficient (Al-Ababneh, 2024). Here, the synergistic effects of these ICT elements in determining the performance of e-commerce service systems are important as opposed to the isolated impacts they have. This research defines service-system coordination as the coordination of three measurable processes: customer-demand generation using digital marketing; information processing using ICT and analytics; and fulfilment responsiveness using logistics coordination. So, information-service flows are the operational bridge between the interaction with the customer and analytics and delivery execution on the platform. This brings the following hypotheses.

H1: ICT integration is expected to be positively associated with e-commerce service-system performance.

H2: AI is expected to contribute positively to predictive coordination and e-commerce performance.

H3: Big Data analytics enhances information-service flow coordination that can result in improved e-commerce.

H4: The integration of cloud computing has a positive impact on e-commerce performance through providing operation scalability and interoperability of the systems.

H5: Mobility technologies increase responsiveness of services and interaction with customers, which positively impacts on e-commerce performance.

H6: Marketing automation enhances the efficiency of processes and effectiveness of communication, which have a positive impact on the e-commerce performance.

H7: Logistics coordination and quality of service in the logistics system is a benefit of integrated ICT maturity, as it enables synchronized information-service flows between marketing and logistics operations (i.e. analytics and fulfilment).

H8: Logistics coordination and service-system quality conceptually mediate the relationship between ICT maturity and e-commerce performance. Due to the exploratory five-company dataset, this hypothesis is not formally tested and is retained as a conceptual proposition for future panel-data validation.

These hypotheses can be seen as the shift towards a service-system view of ICT, in which ICT is

viewed as a system of coordinating interactions between various elements of e-commerce platforms. This approach is new in the sense that it is concerned with integration and interdependence and that the value of ICT is created when it is able to bridge the marketing, informatics and logistics processes. The suggested conceptualization has a contribution to the literature, as it fulfills the gap between the fragmented studies of digital technologies and the necessity of models of e-commerce performance, which are based on their integration. It is also a based on an exploratory comparative analytical approach, which allows assessing the ICT parts as efficiency drivers of the service-system. The framework can be expanded upon in future studies by adding other variables, including sustainability, customer trust and regulatory factors, and dynamic modelling techniques to represent the dynamics of digital ecosystems.

3. Methodology

The methodological framework of this study is designed to assess the impact of information and communication technologies (ICT) in terms of performance of e- commerce service systems in the integrated environment of digital marketing, informatics processes and logistics activities. The methodology design is strictly connected with the research questions and hypotheses developed in the earlier sections and is indicative of the interdisciplinary character of the study, integrating the views of logistics, informatics and service science. The complexity of the contemporary e-commerce environments, in which the performance effects are determined by the interplay of a variety of technological and organizational factors, predetermined the decision to use an exploratory index-based comparative design rather than a full-scale econometric model. Within digital platforms, ICT components do not work alone, rather, they constitute a harmonious system that links the demand generation, data processing and the fulfilment of services. Thus, the methodological design should be able to measure the direct impact of individual technologies as well as the systemic impact of all technologies on the business performance. Service-science viewpoint suggests that e-commerce companies are seen as coherent systems of services where value is co-produced as a result of the interaction between customers, digital technologies and business processes.

The new methodology does not only measure e-commerce performance in terms of growth in revenue; to better focus the logistics and service-science aspect of the study, the two were separated. Rather, it proposes three constructs, which are complementary dependent: E-Commerce Performance Index, Logistics Coordination Index and Service-System Quality Index. This design enables the measurement of ICT as an enabler for commercial results, logistics synchronisation and service-system quality focused on customer needs. Digital marketing creates demand by creating a personalized communications and engagement system, informatics systems handle vast amounts of data and convert them into an actionable insight, and logistics processes establish order fulfilment of customer orders and service delivery. Artificial intelligence, Big Data analytics, cloud computing, mobile technologies and marketing automation are the elements of information-service flow coordination that connects all of these processes into a single frame of operation (Zhang et al., 2023). The empirical foundation of the research consists of standardized data of the of the most popular global e-commerce companies: Amazon, Alibaba, eBay, Shopify and Etsy, which are the various models of platforms and the digital maturity. The application of this data is in line with proven methodologies in the study of platform-based economies and digital transformation, where large scale companies are taken as a reference to assess the technological and operational performance (Agrawal et al., 2019; Chaffey, 2021). These companies are a solid foundation on which to evaluate the effect of the use of ICT because they are highly using developed technologies and also because they are major players in the international digital markets. This combination improves the transparency and comparability of the exploratory assessment, although it does not ensure statistical generalizability. Moreover, the methodology will have references to the previous studies on digital marketing, data analytics and logistics integration to assure the consistency with the existing theoretical frameworks (Erevelles et al., 2016; Singh and Kumar, 2021).

3.1. Exploratory Analytical Modelling of ICT-Enabled Service-System Performance in E-Commerce Platforms

The methodological approach used, however, is an explorative index based comparative analysis, standardized indicators of the ICTs, descriptive correlation interpretation and mapping of services-systems. If anything, findings obtained are known as explorative analytical tendencies that are not statistically generalizable causal relationships (Li and Wang, 2024). The model represents one of the holistic natures of digital platforms because of their technological factors which effect the business outcomes. The dependent constructs are EPI, LCI and SSQI. Note that the growth of revenue is considered only one metric of EPI and is not considered the only outcome measure.

Table 1. Operationalization of ICT, Logistics and Service-System Constructs

Construct	Code	Measurement logic	Methodological role
E-Commerce Performance Index	EPI	Revenue growth, platform scalability and commercial efficiency	Dependent variable
Logistics Coordination Index	LCI	Fulfilment responsiveness, inventory visibility, delivery coordination and operational synchronization	Dependent variable
Service-System Quality Index	SSQI	Customer responsiveness, omnichannel continuity, customer support efficiency and interaction quality	Dependent variable
Artificial Intelligence	AI	Predictive analytics, recommendation systems and intelligent automation	Independent variable
Big Data Analytics	BDA	Data integration, customer analytics and operational analytics	Independent variable
Cloud Computing	CLOUD	Infrastructure scalability, interoperability and platform integration	Independent variable
Mobile Technologies	MOBILE	Mobile commerce accessibility and real-time interaction	Independent variable
Marketing Automation	MA	Automated communication, customer orchestration and targeting systems	Independent variable

EPI, LCI and SSQI are not considered as externally observed market indicators, but as a standard analytical construct created for exploratory comparison. This is important to note as the dataset is a mixture of published company-level data (that can be interpreted publicly) and author-constructed standardized scores. The revised empirical framework does not restrict the focus to just the revenue outcomes of ICT-based service systems, but takes three constructs as complementary constructs, e-commerce performance, logistics coordination and service-system quality. The revised empirical framework evaluates ICT-enabled service-system performance through comparative interpretation of three complementary constructs: E-Commerce Performance Index (EPI), Logistics Coordination Index (LCI), and Service-System Quality Index (SSQI). The updated specification also enables the study to investigate the role of ICT as a coordination mechanism affecting logistics synchronization as well as the service-system quality provided to customers (Al-Ababneh, 2025). Hypotheses H1-H7 are explored through comparative interpretation of ICT maturity patterns and service-system analytical relationships.

Table 2. Standardized Dataset for ICT, Logistics and Service-System Assessment

Company	AI	Big Data	Cloud	Mobile	Marketing Automation	EPI	LCI	SSQI
Amazon	0.95	0.93	1.00	1.00	1.00	0.80	0.94	0.91
Alibaba	0.92	0.90	0.83	0.91	0.97	1.00	0.88	0.89
eBay	0.80	0.78	0.39	0.48	0.33	0.00	0.62	0.68
Shopify	0.85	0.83	0.56	0.70	0.75	0.86	0.72	0.82
Etsy	0.70	0.68	0.00	0.00	0.00	0.48	0.58	0.74

The use of Logistics Coordination Index and Service-System Quality Index directly addresses logistics and service-science issues of e-commerce systems. LCI is related to fulfilment coordination and operational responsiveness and SSQI is related to the continuity of the service that is given to the customer and quality of interaction (Zhang et al., 2023), whereas the Big Data analytics aids with information processing and strategic decision-making (Erevelles et al., 2016). Cloud computing yields

scalability and integration (Wanajma, 2024) and customer experience is the integrated result of the marketing and logistics integration (Lemon and Verhoef, 2016). By designing the model econometric, we have an analytically coherent and well-organized framework to study the impact of the ICT elements on the performance of the e-commerce service systems. The selection of these variables is related to the multi-dimensional nature of the digital platforms, which are characterized by the presence of artificial intelligence, Big Data, cloud computing and customer experience as the key variables affecting the efficiency and coordination of the system. The exploratory analytical framework enables comparative interpretation of ICT maturity patterns across e-commerce platforms and supports service-system evaluation of logistics coordination, information-service flows, and digital interaction processes. Meanwhile, the model does not only reflect the individual effects but the combined effect of technologies, which is the integrated essence of digital marketing, digital processes and logistics operation of informatics. The standardized data also help to make the results comparable between companies and to enhance the transparency and comparability of exploratory interpretation. In sum, it may be concluded that the modelling approach is suitable for the analysis of information and communication technology-based service systems and provides a structured exploratory analytical basis for the ensuing explanations of results from the empirical study regarding logistics, informatics and service science.

3.2. Data Validation, Multicollinearity Diagnostics and System Integration Analysis in ICT-Based E-Commerce Service Systems

The consistency of the exploratory analytical framework in Section 3.1 is supported through descriptive comparative interpretation and exploratory correlation assessment. Such measures are necessary to make sure that the model is effective in reflecting the influence of ICT elements on the e-commerce service-system performance and gives a sound foundation to test the hypotheses, H1-H7. The validation is performed using the standardized dataset that is provided in Table 3 and makes the comparison between firms possible to eliminate distortions caused by scales. Based on this data, the initial step of analysis is to analyze the relationships between variables by correlation analysis. A correlation analysis is performed to give a preliminary evaluation of the connections between the aspects of ICT and e-commerce performance. This is necessary to determine the strength and the direction of the associations between variables and to determine the possible interdependencies before formal multicollinearity diagnostics. This knowledge of these relationships can be used to better interpret the findings and make sure that the model captures the underlying structure of ICT-enabled service systems. The findings of the correlation analysis are represented in Table 3, which sums up the pairwise correlation between all the variables that were considered in the model.

Table 3. Correlation Matrix of ICT Components and Performance

Variable	AI	Big Data	Cloud	Mobile	Marketing Automation	E-Commerce Performance Index (EPI)
AI	1.00	0.91	0.88	0.85	0.87	0.93
Big Data	0.91	1.00	0.86	0.83	0.85	0.90
Cloud	0.88	0.86	1.00	0.82	0.84	0.87
Mobile	0.85	0.83	0.82	1.00	0.88	0.84
Marketing Automation	0.87	0.85	0.84	0.88	1.00	0.86
E-Commerce Performance Index (EPI)	0.93	0.90	0.87	0.84	0.86	1.00

The correlation table shows that there are positive strong relations between ICT variables and performance; This delivers preliminary evidence of a positive correlation between more ICT integration and e-commerce performance in the analysed dataset. Because the empirical sample includes only five observations, formal multicollinearity diagnostics were not conducted. Correlation coefficients are interpreted descriptively and serve only as exploratory indicators of possible ICT interdependence. The exploratory analytical interpretation of the standardized dataset indicates relatively consistent ICT maturity patterns across the analyzed e-commerce companies. The outcome of the analyses offers preliminary exploratory analytical support for H2–H6. The results are interpreted as exploratory evidence rather than as a confirmation of hypotheses, however, due to the limited sample size and the fact that the indicators are partly built, the results should be interpreted as such. Artificial intelligence and Big Data analytics have the greatest influence, and contribute to the hypotheses H2 and H3 on predictive coordination and information processing. Cloud technology brings in system integration (H4), mobile technology and marketing automation add interaction and efficiency (H5-H6). The methodological value of this subsection is that it combines exploratory analytical and service-system interpretation. This study is different from conventional studies which consider ICTs individually. In conclusion, the validation results provide preliminary exploratory consistency regarding ICT maturity patterns and integrated service-system coordination (Osei-Bryson and Barclay, 2023). The findings have served as an empirical basis for the subsequent results and discussion, so that the analysis in the research can support the research objectives and test of the research hypothesis. In this study, a methodological framework has been developed, which offers an extensive and theoretically sound methodology for analysing ICT-enabled e-commerce service systems. The analysis is conducted and combined with data standardization, multicollinearity diagnostics and statistical testing procedures, providing structured exploratory interpretation of ICT maturity patterns. The applied methods enable exploratory analytical assessment of hypotheses H1–H8. Importantly, the methodology corresponds to the digital platforms system nature – digital marketing, informatics and logistics processes are interconnected, thus providing a solid ground for interpretation and discussion of the results in the next step. The empirical framework contains five observations of the companies, which precludes the use of formal estimation and inferential statistical diagnostics from a methodological point of view. In light of this, the research adopted descriptive comparative interpretation and exploratory analytical assessment of e-commerce maturity patterns regarding the maturity of ICTs use. Hence, the study used descriptive comparative interpretation and exploratory analytical assessment of patterns of e-commerce maturity to understand the maturity of the use of ICTs across e-commerce platforms. Only analytical tendencies are interpreted from pairwise correlations and not as statistically generalizable relationships. Thus, the results obtained must be taken as indicative rather than causal econometric evidence of services systems.

4. Empirical Results, Interpretation, and Discussion

The structure and content of the analysis is developed to manifest not only the exploratory analytical influence of ICT components, but also the influence of the ICT components on creation of integrated logistics–informatics–service systems. The findings are based on macro-level evidence of the development of ICTs and firm-level exploratory analytical evidence at Amazon, Alibaba, eBay, Shopify and Etsy. The empirical logic of the section is a two-fold one. The study starts with an examination of the global and regional evolution of ICT as a context to better appreciate the importance of artificial intelligence, Big Data, cloud computing, mobile technologies and automation becoming key pillars of digital commerce. Secondly, the section provides interpretation of the firm-level results, multicollinearity diagnostics and results in relation to the hypotheses (H1- H7). This allows for the transfer of results from a descriptive analysis to the presentation of value of the flow of information-service provided by ICT in digital marketing, logistics coordination and customer experience.

4.1. Macro-Level Dynamics of ICT Development and Their Role in E-Commerce Service-System Transformation

The first part of the results is related to the historical and structural developments of ICT as basis for digital commerce. The evidence presented here demonstrates that the use of ICTs has undergone a number of technological stages, and each of these stages has had an impact on the logic of business communication, market access, and operational coordination. It is important for the study because in the modern e-commerce it isn't simply caused by the use of a single online marketing tool, but a process of technological accumulation, which brings together computing, networking, mobile access, data analytics and automated service delivery.

Table 4. Structuring of key stages of development and characteristics of ict implementation in the world

Period	Key technologies	Key achievements	Impact on business and communications
1940–1970	First computers, transistors	Emergence of computers and telephone networks	Beginning of automation and first telecommunication systems
1970–1990	Personal computers, local area networks, TCP/IP	Mass adoption of PCs and development of protocols	Creation of networks, beginning of data exchange and first business applications
1990–2000	Internet, World Wide Web	Commercialization of the Internet and first e-commerce projects	New sales channels and first digital marketing tools
2000–2010	Mobile devices, broadband Internet, CRM systems	Spread of smartphones and social networks	Mobile access, omnichannel marketing and higher customer engagement
2010–present	AI, Big Data, cloud computing, IoT, 5G	Automation, big data analytics and scalable services	Hyper-personalization, process optimization, new service systems

As revealed in Table 4, the current phase of the development of ICTs is qualitatively different from the previous phases. The previous phase of the adoption of ICTs was concerned primarily with communicating and automating, but the present one is focused on intelligent, data-driven and scalable service systems. This is in accordance with H1 which states that the use of ICT improves the performance of e-commerce service systems. Advanced analytics, logistics visibility, and real-time customer interaction are essential for e-commerce companies to succeed in their efforts to become more intelligent because of its transition from basic automation to AI-driven, cloud-based digital ecosystems (Agrawal et al., 2019; Al-Ababneh et al., 2025; Zhang et al., 2023). The main technological directions that are shaping modern ICT-enabled e-commerce ecosystems are shown in Figure 1. It visually illustrates the main focus of the modern ICT development – Artificial Intelligence, Big Data, Cloud Computing, Internet of Things, 5G, Cyber Security and Process Automation. These directions are not technological trends on their own, but rather they are the backbone of the combined e-commerce service system. For instance, the analytical layer of the system is supported by AI and Big Data, the cloud layer is for integration, and the interaction layer is for firms and customers supported by mobile and 5G technologies. The results also show that there is a regional variation in the rate of ICT transformation. This is especially relevant for grasping the extent to which e-commerce is scalable worldwide and the ongoing digital divide.

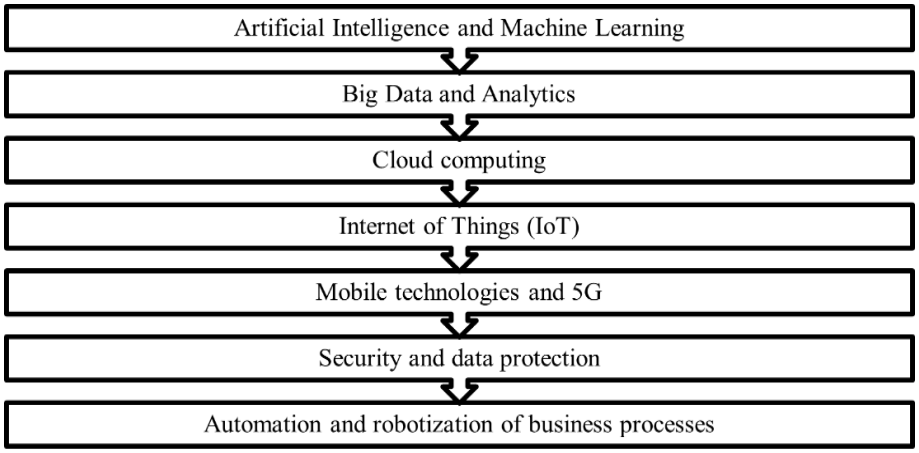
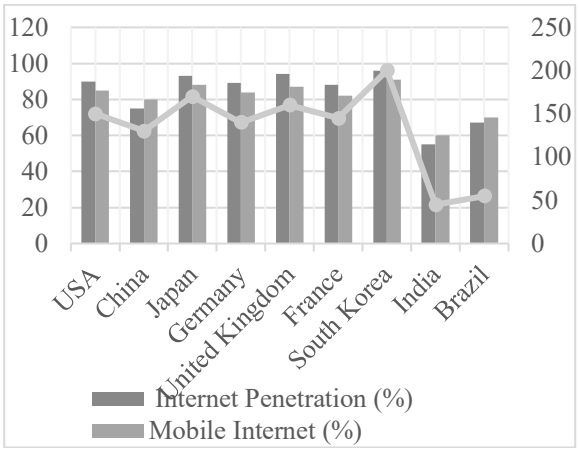
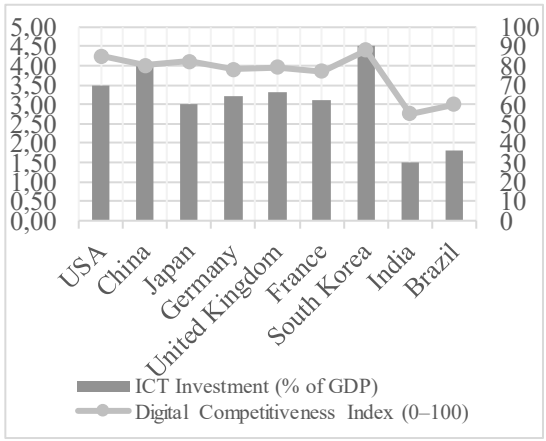


Fig.1: Modern trends in the development of ICT in the world: technologies and directions

The complexity of digital marketing and logistics systems will depend on the region due to the different penetration of the Internet, ICT investments, and infrastructure maturity and knowledge of AI.



a- Internet penetration and digital infrastructure



b - ICT investments and digital competitiveness

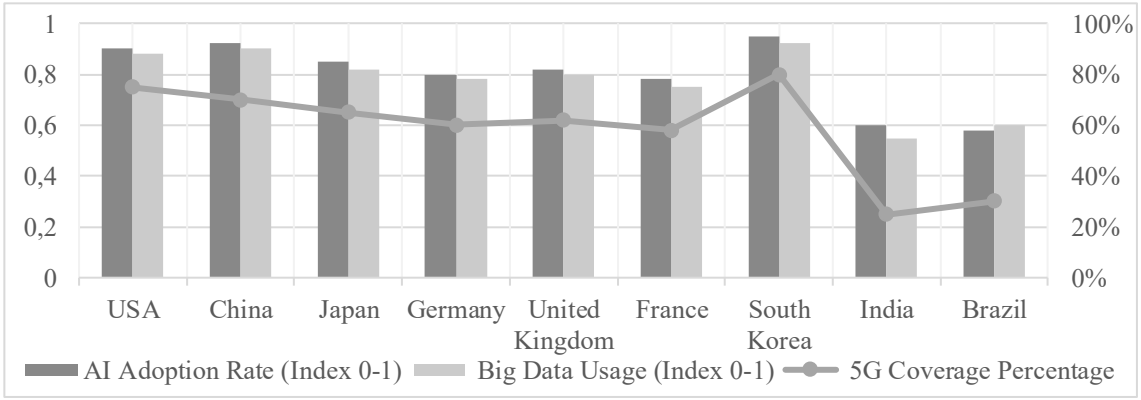


Fig. 2: Structuring the dynamics of ICT implementation in the world in the context of the development of e-commerce and digital marketing: the regional aspect as of 01.01.2024, in % (a- Internet penetration and digital infrastructure; b - ICT investments and digital competitiveness; c- Implementation of innovative technologies)

All these findings are reflected in Figure 2, which shows that the developed economies have better digital infrastructure, more Internet penetration, more investment in ICTs and more advanced use of AI, Big Data and 5G. Countries like USA, South Korea, Japan, Germany and United Kingdom have higher digital maturity indicators in different dimensions as opposed to countries like India and Brazil that have lower digital maturity indicators in some dimensions. This reflects overall understanding of H1 and H7: Infrastructure, investment and innovation capacity are complementary and interconnected in the strongest integration of ICTs (Brynjolfsson and McAfee, 2014).

Logistics-wise, the level of maturity in the region affects the implementation of real-time tracking, demand forecasting, route optimization and inventory visibility. From the informatic angle, it is a question of whether or not it is possible to gather a significant amount of data, process it, and turn it into operation decisions.

It is significant to customers' experience from the service science perspective, as it can impact service continuity across all service touchpoints. So, the figure of 2 is not just a context, but provides an explanation of the uneven development of ICT-enabled e-commerce systems in markets. The following result is related to the company level implementation of ICT of the top e-commerce companies. This is shown in the original article in the form of Figure 3.

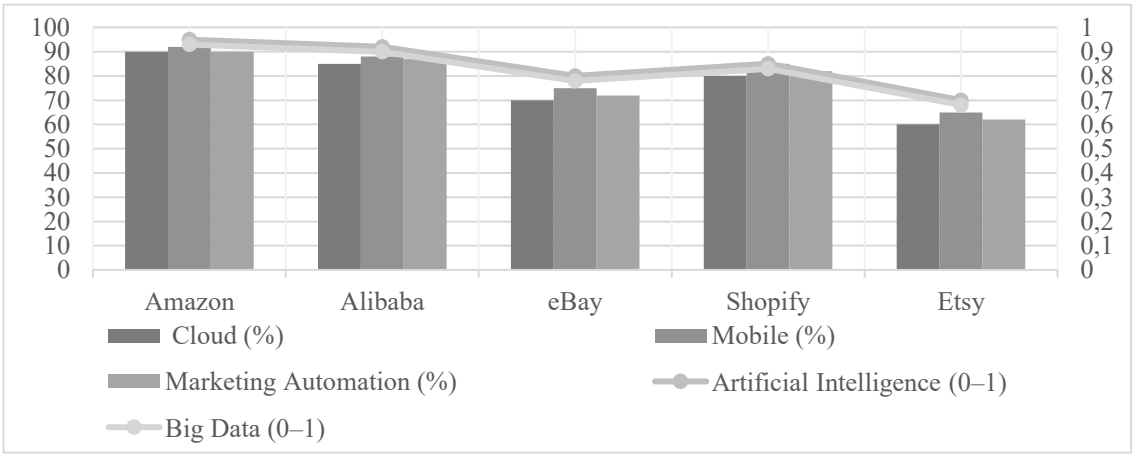


Fig. 3: The Level of ICT Implementation in the World's Leading Companies: Technologies and Directions

It can be seen in Figure 3 that there are differences in the intensity and structure of the use of ICTs among the largest e-commerce platforms. Amazon and Alibaba are the most technologically advanced companies, especially in the areas of AI, Big Data, cloud computing, mobile technology and automation. The platform-based infrastructure of Shopify for SMEs also has a relatively strong profile, whereas eBay and Etsy have more moderate indicators, as they have marketplace models and fewer operational configurations. This company-level differentiation is made possible by the methodological premise that it is possible to measure the maturity of ICT empirically using standardized indicators. It further suggests the importance of ICT integration for service coordination between firms, which is stronger within those that have deeper integration of ICT.

This aligns with the work of Ransbotham et al. (2017), which highlights the role of AI and digital technologies in restructuring business operations in relation to decision-making and customer engagement processes. Table 7 further illustrates the results interpretation by explaining how the ICT trend relates to the customer and operational aspects of e-commerce. AI and Big Data are directly relevant to the achievement of H2 and H3 as it pertains to prediction, segmentation and information processing. Cloud computing enables system integration, a key requirement for H4.

The mobile and 5G technologies are helping to enhance customer interaction with H5. Automation aids H6 by helping to optimize operations. Lastly, together all trends support H7, as the overall performance of e-commerce is not determined by the separate use of the individual tools, but on the coordinated technological architectures. Table 5 provides a more detailed description of the functional effects of current trends in ICTs on ecommerce and digital marketing as seen in the general trends in Table 5 and Figures 1–3.

Table 5. Current trends in ICT and their influence on digital marketing and e-commerce of contemporary enterprise

ICT trend	Features of impact on digital marketing and e-commerce
Artificial Intelligence and Machine Learning	Processing large volumes of data, automating segmentation, forecasting consumer behaviour and optimizing advertising in real time
Big Data and Analytics	Collecting and processing data from social networks, websites, mobile apps, CRM systems and IoT devices to improve targeting and personalization
Cloud Computing	Providing flexibility, scalability and integration of marketing, customer and operational systems
Internet of Things	Supporting real-time data collection, logistics visibility, supply chain transparency and service monitoring
Mobile and 5G	Enabling real-time interaction, mobile commerce, AR/VR services and low-latency customer engagement
Data Security and Privacy	Protecting customer information and maintaining trust in digital transactions
Automation and Robotization	Reducing processing time, improving inventory management and supporting omnichannel communication

In total, the macro-level outcomes show that ICT development provides the technological prerequisites for the transformation of a service-system for e-commerce. The results corroborate the fact that the performance of digital commerce relies on multifaceted infrastructure, data and analytics, as well as logistics and customer interactions. This is the basis for the exploratory firm-level analytical results that will be discussed at the firm-level in the following sub-section.

4.2. Firm-Level Exploratory Results, Hypothesis Assessment and Integrated Service-System Interpretation

The second stage of the results focuses on firm-level evidence. The empirical model uses standardized data from five leading e-commerce companies: Amazon, Alibaba, eBay, Shopify and Etsy. These companies represent different levels of ICT maturity, platform structure and digital business models. The updated version gets rid of the restriction on revenue growth in the firm level assessment. Besides logistics co-ordination, there is an analysis of service-system quality metrics to make it suitable for the logistics and service-science focus of the article. The purpose of this stage is to evaluate how ICT components relate to e-commerce performance, logistics coordination and service-system quality. Table 6 shows the revised standardized data for an empirical analysis. The revised model version includes the assessment of logistics coordination and quality of services, in addition to the assessment of revenue related outcomes, to enhance the logistics–informatics–service science approach of the study.

Table 6. Standardized key business data for assessing the role of ICT in the development of e-commerce and digital marketing of modern companies

Company	Artificial Intelligence (AI)	Big Data Analytics (BDA)	Cloud Computing (CLOUD)	Mobile Technologies (MOBILE)	Marketing Automation (MA)	E-Commerce Performance Index (EPI)	Logistics Coordination Index (LCI)	Service-System Quality Index (SSQI)
Amazon	0.95	0.93	1.00	1.00	1.00	0.80	0.94	0.91
Alibaba	0.92	0.90	0.83	0.91	0.97	1.00	0.88	0.89
eBay	0.80	0.78	0.39	0.48	0.33	0.00	0.62	0.68
Shopify	0.85	0.83	0.56	0.70	0.75	0.89	0.72	0.82
Etsy	0.70	0.68	0.00	0.00	0.00	0.48	0.58	0.74

Revenue growth is complemented in the revised dataset with two new elements: Logistics Coordination Index (LCI) and Service-System Quality Index (SSQI). In this sense this adjustment is directly responding to the logistics and service-science aspect of the study. LCI demonstrates the responsiveness,

visibility of inventory, synchronisation of delivery and operational coordination of fulfilments, and SSQI shows how continuity of an experience is ensured with the customer in their service journey, through digital service environments, with high responsiveness and quality of interaction. This is because, ICTs are not only evaluated as a technological solution to drive the commercial performance but as a measure of coordination having an effect on integrated e-commerce service systems. Results from the analyses shown in Table 6 reveal that logistics coordination and service-system quality measures are also correlated with the higher the level of integrated ICT maturity of the firms. Amazon is a model of balanced ICT integration, both in terms of analytical and infrastructural functions and in terms of customer interaction. Amazon is a model of balanced ICT integration, both in the analytical and infrastructural functions and in the interaction with the customer. The cloud-based ecosystem architecture of Shopify shows relatively high scalability of the platform and the response of the service. In contrast, eBay and Etsy show less cloud integration, mobile interaction, and logistics coordination, resulting in less overall coherence in their service-system structures. The results of this study offer exploratory evidence on the interpretation of the integration of ICTs beyond the technological aspect to also understand it as a coordination mechanism that connects the marketing and informatics and logistics activities carried out in the platform-based e-commerce. The exploratory analytical interpretation provides preliminary support for H1 that states that the integration of ICT positively affects the performance of the service system of e-commerce. Companies with more even ICT-usage are more performant or have a higher potential of scalability. This is consistent with Erevelles et al. (2016), who highlight the significance of Big Data analytics in digital commerce and Zhang et al. (2023), who demonstrate that AI-based marketing enhances engagement and decision-making processes. This is also a significant analytical subtlety, however, as can be seen by Table 7: one technology is not sufficient to determine performance. For instance, revenue growth that is based solely on AI without data, cloud, mobile interaction and automation does not fully explain the high AI score.

This provides preliminary exploratory support for H7, according to which integrated ICT application strengthens the alignment between marketing and logistics operations.

Table 7. Exploratory ICT contribution assessment in e-commerce service systems

ICT component	Analytical role in service-system coordination	Exploratory interpretation
Artificial Intelligence	Predictive coordination, recommendation systems, demand forecasting	Strong exploratory contribution
Big Data Analytics	Information-service flow processing and customer analytics	Strong exploratory contribution
Cloud Computing	Infrastructure scalability and interoperability	Medium–strong contribution
Mobile Technologies	Real-time interaction and omnichannel responsiveness	Medium contribution
Marketing Automation	Communication orchestration and process synchronization	Medium contribution

The table summarizes exploratory analytical interpretation of ICT maturity patterns across e-commerce companies. Artificial Intelligence demonstrates the strongest exploratory contribution within the analyzed service-system framework, particularly in predictive coordination, recommendation systems, demand forecasting, and customer interaction management. The impact of AI can be understood through the application areas of demand forecasting, recommendation systems, customer segmentation, automated customer support and logistics planning. AI has been identified as a critical tool for customer engagement and making predictive decisions, which aligns with the findings of Zhang et al. (2023). Big Data analytics demonstrates strong exploratory contribution through customer analytics, operational coordination, dynamic pricing, and information-service flow processing. This result is consistent with (Erevelles et al., 2016; Wanajma, 2024).

The effects relate to customer access, mobile buying, real-time communication and multi-channel engagement. Marketing automation supports communication orchestration, process synchronization, and operational responsiveness in platform-based commerce systems. This aligns with Tiago and Veríssimo (2014) and Fan and Gordon (2014) who stress on the mobile and social media channel's importance in digital marketing. The result of this variable is that there is a business impact of automated communication, campaign management and customer journey orchestration and triggered interactions. In e-commerce environments with tight deadlines, like having to respond to inquiries within a few hours, this effect is even more pronounced, as it can impact the conversion quality depending on how fast the response is, and the quality of the content delivered. Purcărea (2024) also emphasizes that customer-response speed and synchronized digital communication significantly influence customer trust, conversion continuity and post-purchase interaction quality in platform-based e-commerce environments.The result supports H1, and shows that the integration of ICTs is not merely a secondary, but a key element of the performance of e-commerce. The key findings of the empirical analysis can be summarized by means of a combined hypothesis validation matrix to reinforce the interpretation.

Table 8. Exploratory Hypothesis Assessment Matrix

Hypothesis	Exploratory analytical basis	Exploratory interpretation
H1	Comparative ICT maturity patterns	Exploratory support
H2	AI-enabled predictive coordination	Exploratory support
H3	Big Data information-service processing	Exploratory support
H4	Cloud-based scalability and interoperability	Partial exploratory support
H5	Mobile responsiveness and interaction	Partial exploratory support
H6	Marketing automation and communication efficiency	Partial exploratory support
H7	Integrated ICT-service coordination	Exploratory support
H8	Conceptual mediation logic	Conceptual support only; formal mediation testing is not performed.

This is a standardised 5 company data set and the hypotheses are given preliminary exploratory support. The results show the analytical consistency between ICT maturity and logistics coordination and quality of service system; however, they should not be interpreted as causal confirmation. The results reveal that the ICT components can have an impact on the performance of ecommerce not only as standalone technologies, but also as part of an integrated service system architecture. The analytical backbone is AI and Big Data, integration is cloud computing, interaction is via mobile and execution efficiency is via marketing automation. All of these make up the information-service flows that link digital marketing with logistics operation. The following scheme can be used to represent the service-system logic (Purcărea, 2024). The findings suggest that ICT may function not only as a technological tool. It is a coordination mechanism that attempts to link up market-related and operational processes. This is the main finding to be obtained for the scope of the journal as it brings together informatics, logistics and service science in a single empirical model. The overall results suggest that e-commerce companies are more successful in developing balanced ICT capabilities than they are in relying on a single technology. AI and Big Data are the most powerful, and the best performance is achieved when they are enabled by cloud integration, mobile interaction and marketing automation.

5. Discussion

The discussion of results focuses on interpreting the empirical findings within the broader context of digital transformation, service-system theory and ICT-enabled e-commerce development. Unlike the previous section, which concentrated on exploratory analytical interpretation and hypothesis assessment, the present section emphasizes the theoretical, managerial and systemic implications of the obtained results. In addition

to the direct influence of the integration of ICT on e-commerce performance, the results indicate that there is also an influence on the reconfiguration of flow of information services and cooperation and communication processes with customers. The first study evaluates the strategic potential of new analytical tools such as artificial intelligence and Big Data in the digital commerce ecosystem. In the second part, the mechanisms of integration between marketing processes, informatics and logistics processes, as well as the use of cloud technology and automation technologies for their integration, are considered. Thirdly, the effects of service architectures around ICTs on the adaptability, resilience and competitiveness of the organizations is analysed. This facilitates the understanding of empirical results in a broader interdisciplinary perspective, which corresponds to the scope of work of logistics, informatics and service science. The obtained results demonstrate that ICT maturity should not be interpreted only as technological sophistication, but also as the organizational capability to coordinate interconnected service-system processes across marketing, analytics and logistics operations.

5.1. Strategic Dominance of Artificial Intelligence and Big Data in ICT-Driven E-Commerce Ecosystems

The empirical results highlight that AI and Big Data Analytics are the major technological trends influencing today's e-commerce systems. The analytical contribution observed in the statistics shows that the analytical skills are becoming more and more crucial for digital competitiveness, alongside transactional efficiency and/or marketing communication in traditional media. This discovery is an extension of the new digital business rationale in which information processing and predictive co-ordination are important assets of the organization. How businesses manage uncertainty is the biggest catalyst of performance, driven by AI. Traditional digital marketing approaches were based on analysis that was retrospective and a one-size-fits-all segmentation of the customers. AI systems, on the other hand, have the ability to analyze behavioral data and produce predictive insights in real-time, continuously. This allows companies to predict their customers' needs, maximize their advertising budgets, and ensure their systems are in balance with demand (Zhang et al., 2023). The discussion thus supports the interpretation that AI should be seen as a means of strategic coordination, rather than just a tool, linking marketing analytics, inventory management and customer service processes. This interpretation is an additional piece of evidence of the implications of the Big Data analyses. The findings show that firms that could transform unstructured customer and operational data to useful knowledge, have superior performance. The economic value of Big Data is only gained when they are able to develop analytical skills that allows them to translate information to a decision-making process; this is the view of Erevelles et al., (2016). In the e-commerce field, Big Data enables increased market responsiveness, more personalized and adaptive pricing and communication strategies.

The results of the research have a significant cross-over importance, namely that of the interdependence of AI systems and of Big Data systems. The study shows that the power of prediction provided by AI is directly linked to quality, quantity and availability of data. Without considering larger data systems, it is not possible to judge the effectiveness of AI. This relationship creates a technological pyramid that is built out of data infrastructure and is used for intelligent decision-making systems. The 'integration' of these service architectures and of architectures that depend on ICT is evident from the interdependency of the components and is confirmed by the fact that companies that do not have the data systems connected may not be able to achieve the desired outcomes of digital transformation. The results also indicate that analytical technologies have the same impact on logistics processes as are functions. Inventory management and route planning and synchronisation with the supply chain is optimised through AI-based forecasting, while transparency and visibility of operations is enhanced through Big Data analytics. This finding lends weight to the interdisciplinary approach of the study as it shows that digital

marketing and logistics must not be considered as separate areas. Instead, both functions are embraced in one single information-service system, which is based on continuous information exchange. One more aspect to consider is scalability. Technologically sophisticated companies get cumulative benefits from AI and Big Data systems as they grow larger, with increased data volumes. This presents a competition problem, especially for small businesses who don't have the big data analysis infrastructure. Therefore, along with being a financial inequality, analytical skills may be emerging as another major determinant of ecommerce digital inequality. The results overall reinforce the fact that AI and Big Data are the analytical backbone of the ICT empowered e-commerce ecosystem. They help in optimizing operations but also have a direct impact on adaptability, responsiveness and long-term competitive positioning. The impact of AI and Big Data has to be understood outside the context of the other technologies that have emerged. Their value comes into play when predictive insights are aligned with logistics execution, inventory management and customer service and delivery responsiveness. So analytical technologies should be viewed as enablers to be used in a coordinated fashion across a whole service system, not as revenue levers to pull on their own.

5.2. Integration of Marketing, Informatics and Logistics Processes Through ICT Service Architectures

The results show that the combination of technological components as a service architecture rather than just an operational tool is the way to maximum efficiency in ICT-enabled e-commerce systems. The finding is interesting because it highlights the structural aspect in the synchronisation of the flows of information services between digital marketing and data processing and logistics operations. The discussion is no longer limited to technological acceptance, but also on the organizational logic of the integration of digital. Cloud computing is the critical integration mechanism that is formed in this architecture. Although in practical terms AI and Big Data are more effective in statistics, the results indicate that the role of cloud infrastructure is a simple coordination. Cloud systems provide the interoperability required to connect customer-facing applications, analytical platforms and logistics management systems and thus create one digital environment (Wanajma, 2024). Similar conclusions regarding ICT interoperability and coordinated digital infrastructures were reported. In this scenario, the information created in the course of digital marketing activities can't be properly fed into the decision-making processes of operations. The major value added of the proposed framework is the service-science interpretation and explanation of how the flow of information through ICTs enhances value co-creation between customers and logistics operations and the digital platform. There are signals being continuously generated by customers, signals being processed with AI and Big Data tools, signals being converted into fulfilment operations by logistics systems, and signals being converted into communication, feedback and post-purchase interaction with customers by customer-service interfaces, all of which complete the service cycle. The logistics contribution of the study is concentrated in the Logistics Coordination Index, which captures fulfilment responsiveness, inventory visibility, delivery synchronization and operational coordination. Therefore, logistics is not treated merely as a background process, but as a distinct service-system outcome influenced by ICT maturity.

The findings have several implications, including integration of marketing and logistics functions. Marketing was billed as a communication task and logistics as a fulfilment process, in traditional business structures. But the framework remains exploratory due to the limited empirical sample, yet the results show that. Any demand placed by a customer from targeted advertising, social media interaction, or personalized suggestions should instantly affect inventory, order processing and even the co-ordination of delivery. ICT systems are thus real-time translation systems which translate market signals into actions for the system to take. In this integration, marketing automation technologies come into play, such as: Automated systems

enable communication with customers and ensure that the inventory and delivery to the customer is coordinated. Automated systems enable to synchronise communication with the customers and service's responsiveness when the inventory gets delivered to the customer. This helps in the smooth functioning of operations and improving the customer experience. So, automation not only can be a marketing optimization tool but also an operational tool for coordinating operations within service-systems. The angle of integration increased by the value of the mobile technologies. Mobile platforms enable users to interact with the brand on a platform other than digital, and enable constant communication environments where the users are always linked into various e-commerce platforms. This ongoing interaction creates a huge amount of behavioural data that are passed to analytical systems that shape marketing strategies and logistics planning. The mobile technologies are therefore used simultaneously as communication interface, data generation system and coordination channel. The results in a service-science context indicate that more and more the quality of the interaction between the different parts of a system is a key factor of value creation than the efficiency of the individual system technologies. It aligns with the existing service-system theory which emphasizes on value co-creation between the organization and/or the technologies and the customer. Hence, the empirical results suggest that the assessment of the implementation of the ICT should be done based on its ability to support the coordination of the service processes rather than on the technological measures. Another crucial implication is related to the organization structure. The results indicate that companies that have adopted ICT as solutions in individual departments are less successful than the companies that have adopted ICT in a more integrated manner. It means a need for the organization to undergo a redesign, including coordinating mechanisms across functions and a common data governance, to achieve digital transformation. Digital transformation can thus be defined as a technological process as well as an organizational transformation process. Overall, it can be concluded that the service architecture will be altered at bottom, as is illustrated in the discussion, because of the interaction between the functions of marketing and informatics/ logistics through the use of ICT. Pursuing digital commerce systems with the quality of integration and coordination is becoming more and more successful, and not with single investments in technology.

5.3. Organizational Adaptability, System Resilience and Long-Term Competitiveness in ICT-Enabled Digital Commerce

The study results show that the use of ICT not only impacts on the immediate level of operational performance, but organizational level performance related to adaptability, resilience and sustainable competitiveness as well. This is relevant in the context of the rapidly changing digital environments that are characterized by market volatility, technology uncertainty, and changing expectations of consumers. The results of this research have broad implications, especially for the relationship between the integration of ICTs and adaptability of organisations to changes in customer behaviour and market conditions. organisations that are more analytical, integrative and automated are more responsive to changes in customer behaviour and market conditions. This flexibility is achieved because of the functionality of ICT systems that enable the continuous monitoring of demand patterns, speedy information processing and real-time decision making. Thus, an organization can then make adaptive and not reactive changes in marketing strategies, logistics operations and process of interaction with the customers (Park and Kim, 2024). The need of ICT to enhance organizational resilience is also highlighted. Ecommerce systems are subject to many disruptions, from instability in the supply chain, to cyber threats, to consumer demand and infrastructure challenges. The results indicate that the ability of the system to be resilient to these disruptions is improved by the use of integrated ICT architectures, which improve the visibility, coordination and flexibility during the operation of the system. System stability is achieved through the use of cloud-based

systems that increase scalability, AI that makes more accurate forecasts, and automation that improves response time. Information continuity is an important aspect of resilience. Data flow between consumers and analytical platforms, and between consumers and operations is vital to digital commerce systems. Through ICT integration there is a decrease in fragmentation and increase in synchronization, which decreases the chances of delays, errors and coordination failures. It is important to grasp the concept of 'resilience' in the context of digital commerce as being more about informational resilience, rather than physical or logistics resilience. In the new interpretation, resilience is seen as not only technological stability, but also as the ability of the service system related to e-commerce to maintain coordination between customer demand, logistics fulfilment and the responsiveness of the service in the face of uncertainty. This interpretation reinforces the logistics/science in service contribution of the research.

The results also show that the adaptability with ICTs brings about competitive advantages on a cumulative basis. Companies that have the ability to learn about the information from their customers and the feedback of their operations over time are better able to make decisions accordingly. Such learning effects give rise to feedback effects that lead to more efficient and responsive advanced businesses. This is one other instance of dynamic capabilities: sustainable competitive advantage depends on the ability to integrate, reconfigure and renew resources in the organization when there are changes. The other analytical contribution is on the customer experience and trust. By combining AI, automation, and mobile interaction technologies, highly personalized and responsive service environments can be created. It also suggests that privacy, transparency and the customer's perception of the degree of relying on automated systems can also be risks. Therefore, future ICT strategies should be able to balance the efficiency of the ICTs with ethical governance and management of trust of customers. From a strategic perspective, the findings support the assertion that it is no longer just a question of adopting individual technologies, but also whether it is possible to develop adaptive digital ecosystems. Interoperability, data governance, cyber security and organizational flexibility are thus Secondary to technological innovation which needs to be given priority for enterprises. It goes on to propose that digital transformation is not an one-off implementation initiative, but rather a strategic process that needs to be repeated continually. In general, the results show that the introduction of service systems supported by ICT is positively correlated with the adaptability of the organizations concerned and sustains the competitiveness of organizations in the digital commerce environment in the long term. Through this discussion, it is demonstrated that the operational efficiency is not the only strategic value of ICT and it is a new method of the operation of the organization in a new system of e-commerce.

5.4. Limitations and Directions for Future Research

The study has a few methodological and empirical restrictions that should be noted. First, the empirical base is only five leading global e-commerce companies; thus, the results obtained should be seen as exploratory and not necessarily generalizable to all digital commerce systems. Second, some indicators were standardized and partially constructed using company level analytical assessments, and information about the process of scoring is limited when directly reproducing the indicators. Third, although the revised framework includes the Logistics Coordination Index and Service-System Quality Index to further strengthen the logistics and service-science part of the study, both of these are still summative measures rather than operational measures from the internal enterprise systems. Fourth, the framework explains analytical relationships between key performance measures of e-commerce and the maturity of ICT, but it will not necessarily explain dynamic and analytical relationships between ICT, organizational and customer-related processes. The empirical sample should be expanded in the future, panel-data methods

should be used and direct measures of logistics service quality should be included in the analysis, as well as causal mediation processes between the introduction of ICT, logistics service quality, operational coordination, and platform competitiveness.

6. Conclusion

The study results further validate the fact that the world of e-commerce and digital marketing has become a system based on information and communications technologies as its key structural component. Empirical results show that the use of ICT has a analytical contribution on the business, enhancing business analytical skills, operational coordination and customer interaction processes. As opposed to previous views on digital technologies as standalone tools, the outcomes of this research highlight the key role of the integration between Artificial Intelligence, Big Data analytics, Cloud Computing, Mobile and Marketing Automation in determining the effectiveness of ecommerce systems. The outcomes are preliminary support for the proposed hypotheses in the analyzed sample of five global e-commerce platforms. These technologies are at the heart of the analysis in the service systems that are supported by ICTs, enabling organizations to analyze immense amounts of information, anticipate customer behaviour, and optimize operations in real-time. With the use of cloud computing, marketing, analytics and logistics systems can be made interoperable; using mobile technologies and automation systems, customers can be engaged, communications can be made faster, and processes can be made more efficient. A significant contribution of the study is the fact that it shows an impact of ICT not only on marketing activities but also on logistics coordination and service-system architecture. The results confirm that digital marketing, data processing and logistics activities are becoming more and more information-service flows interconnected. The interdisciplinary approach goes beyond the traditional understanding of e-commerce to incorporate the theory of informatics, logistics and service science in a common analysis. The Logistics Coordination Index is an exploratory analytical construct developed for comparative interpretation of ICT-enabled coordination patterns rather than a direct operational KPI derived from proprietary logistics datasets. The study also finds that companies that are more ICT mature are more adaptive, have greater operational resilience and competition stability. By integrating ICT architectures into organisations, they can be more responsive to market uncertainty by being able to take advantage of predictive analytics, automation and real-time coordination. Thus, the companies need to build adaptive ecosystems, increasingly driven by data, rather than only by one technological solution to become competitive in the digital world is becoming imperative. The results show there is need for integrated ICT strategies focusing on interoperability, analytical ability and service coordination for practice. In vain, investments will be made in individual technologies, which will not give lasting competitive advantages unless they can be part of a larger structure. Instead, it is necessary to create a common digital ecosystem that would enable companies to synchronise the customer interaction, information processing and implementation of operations. There are some limitations to this study as the model is very explanatory. The empirical analysis is based on a limited sample of leading e-commerce companies. In addition, the structure of the framework primarily accounts for analytical relationships between ICT components and service-system indicators. The model can then be extended for further research by incorporating panel data analysis, machine learning tools and/or dynamic system modelling tools. The updated framework shows that the effectiveness of integrated service systems in coordinating the activities of the various services involved in e-commerce must be considered as an indicator of the performance of the ICT-based e-commerce. The incorporation of logistics coordination and service-system quality constructs enhances the interdisciplinary contribution of the study to the research in logistics, informatics and service science.

In conclusion, the study reveals that the use of ICT is not just a passing phenomenon, but a mechanism of transformation of the e-commerce and digital marketing systems. The results add to the body of

knowledge that will be needed for implementing interdisciplinary strategies for digital transformation, and offer theoretical as well as practical understanding of how to manage service ecosystems with ICT. The exploratory analytical findings indicate that integrated ICT maturity is associated with stronger e-commerce service-system coordination, logistics responsiveness, and customer interaction quality. Due to the limited number of observations, the findings should not be interpreted as statistically confirmed causal relationships. The focus of the study is methodological and conceptual, which is more important than confirmatory. It suggests an exploratory model that correlates ICT maturity with e-commerce performance and logistics coordination/service-system quality. The results can be treated as initial tendencies of analysis that should be verified in future studies with the help of wider panel data and direct logistics-performance indicators. Future research should expand the empirical dataset through panel-data structures and longitudinal observations to enable formal econometric testing and mediation analysis.

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