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E-Commerce 2.0

Transforming E-commerce Architectures for the Digital Age

Afonso Miguel Celestino da Fonseca

Master Thesis

presented as partial requirement for obtaining a Master's Degree in Data-Driven Marketing

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
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Transforming E-commerce Architectures for the Digital Age

by

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Master Thesis presented as partial requirement for obtaining the Master's degree in Data-Driven Marketing, with a specialization in Data Science for Marketing

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism, any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

Afonso Fonseca

Porto, Portugal, July 10, 2024

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ABSTRACT

E-commerce is defined as the exchange of goods and services over an electronic network. This kind of commerce has evolved significantly, becoming a vital component of the global economy. This thesis identifies the limitations of traditional e-commerce architectures, such as lack of flexibility and scalability addressing these problems by developing a flexible and scalable e-commerce architecture that can integrate easily with current and emerging technologies available in the market.

The developed architecture has cloud computing, headless commerce, and API's as the foundations, technologies like Big Data, Artificial Intelligence and Generative AI are used to improve customer engagement, conversion and operations within the business.

The research methodology includes a literature review that starts with an overview on e-commerce concepts and e-commerce itself and ends with technologies by exposing current and emerging technologies. After this review, a new architecture is proposed to fix problems with the current architectures. This new architecture supports omnichannel strategies, integrates advanced analytics for personalized marketing and uses advanced technologies to help both business and customer.

This proposal is then validated through expert interviews and a practical case, which demonstrates the potential to enhance customer experience, operational efficiency, and business agility.

The findings of this research indicate that adopting this kind of architecture can improve the adaptability and performance of e-commerce platforms.

KEYWORDS

E-commerce, E-commerce Structures; Digital Transformation; Marketing Applications; Omnichannel; Customer-centric

Sustainable Development Goals (SDG):

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LIST OF ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
API	Application Programming Interface
AR	Artificial Reality
B2A	Business to Administration
B2B	Business to Business
B2C	Business to Consumer
BC	Blockchain
BD	Big Data
C2A	Client to Administration
C2B	Customer to Business
C2C	Consumer to Consumer
CC	Cloud Computing
CDP	Customer Data Platform
CDPI	Customer Data Platform Institute
CPS	Cyber Physical System
CPU	Central Processing Unit
DSR	Design Science Research
EDI	Electronic Data Interchange
ETF	Electronic Fund Transfers
ETL	Extract Transform and Load
FaaS	Function as a Service
GAI	Generative Artificial Intelligence
GPS	Global Positioning System
HTML	Hypertext Markup Language

IaaS	Infrastructure as a Service
IoT	Internet of Things
ML	Machine Learning
MR	Mixed Reality
MV	Metaverse
NLP	Natural Language Processing
PaaS	Product as a Service
RNN	Recurrent Neural Networks
SA	Software Architectures
SAP	System Applications and Products
SOA	Service-oriented Architecture
UI	User Interface
UX	User Experience
VR	Virtual Reality
XR	Extended Reality

1. INTRODUCTION

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

For Jain & Arya & Malviya, (2021), E-commerce can be defined as the exchange of goods and services over an electronic network (primarily the internet), these exchanges are possible using electronic data interchange (EDI) and Electronic Fund Transfers (EFT).

With this definition in mind, e-commerce is much more than an online store, it is a dynamic ecosystem that incorporates technology, infrastructure, and processes to give customers the best online experience possible. (Chen & Sun & Chen, 2020)

The year 2000 was the year where most technologies started widespread, one of them being E-commerce, becoming an important part of the global economy (Chen et al., 2020). This allowed companies to reach people on a global scale with 24/7 availability, reducing operational and communication costs (Bravo, Segura, Temowo & Samaddar, 2022). E-commerce also enabled customization through segmentation and digitalization of product and processes (Bravo, Segura, Temowo & Samaddar, 2022). With the rise of e-commerce, the amount of data that businesses were able to get from their customers had a deep impact on marketing, reshaping the way businesses approached this channel and allowing them to use data-driven decision-making, personalization, and customer-centric approaches (Chen et al., 2020).

The main e-commerce system functionality for a B2C is storefront (Turban et al., 2002 cit in D'souza & Joshi, 2019). This functionality has a merchant server architecture which offers product presentation possibilities, and diverse options to deliver information from a virtual catalog or order entries (Treese & Stewart, 2002 cit in D'souza & Joshi, 2019).

When we fast-forward 23 years, we can see that the technological landscape has evolved tremendously and e-commerce has had a continuous growth in the market. (Blauw Research,2013 cit in Aulkemeier, Schramm, Iacob & Van Hillegersberg, 2016). Apart from this growth, e-commerce has remained stuck in the same architectural framework relying on monolithic structures (all-in-one system) that aggregate multiple software components, from a simple search for a product to a transaction or payment. This architectural type makes it challenging to modify or add services to the software that is already in place. The lack of flexibility of monolithic architectures is not a recent problem, as such, there have been new developments, that address these issues (R. Merrifield, J. Calhoun & D. Stevens, 2008 cit in Aulkemeier et al., 2016).

A well-designed platform built on the customers experience, will provide a positive online shopping experience, leading to a greater customer satisfaction and consequently to future purchases (Chen et al., 2020). The following step is to adopt recent technologies like artificial intelligence, machine learning, big data and data science, these technologies and the integration of social media elements in e-commerce (S-commerce), enable mass

customization, growth on the number of potential customers, along with enhanced productivity and revenue generation of the overall businesses. (Thakur, 2021 & Attar, Almusharraf, Alfawaz & Hajli, 2022). There are also customer facilitator technologies that can provide and innovative, efficient and effective e-commerce experiences such as, chatbots for customer support voice assistants for task implementations like product search, filtering or sorting (Scupids Tech, 2020 cit in Attar et al., 2022), augmented and virtual reality techniques to enhance user's experience while shopping on an e-commerce platform, Blockchain technology or E-wallets for simplifying the payment processes (Attar et al., 2022).

With all this technology available in the digital world, it becomes hard for monolithic architectures to work, rising concerns about Scalability (infrastructure), Flexibility (introduction to changes), maintenance and most importantly, the limitations regarding omnichannel and customer-centric approaches (Aulkemeier et al., 2016).

1.2. OBJECTIVES

The goal of this research is to develop a new e-commerce architecture where businesses can easily reach customers in a more flexible and effective way, using the newest technologies available.

To achieve this goal, the following intermediate objectives were defined:

- Framework the e-commerce problematic.
- Study the current available technologies.
- Propose a new e-commerce architecture.
- Build a use case.
- Validate the architecture by conducting expert interviews.

1.3. IMPORTANCE AND RELEVANCE

The outcome of this research would impact technology, cybersecurity/privacy, economy, omnichannel, information systems, human resources, and marketing. In detail, it would contribute to:

Technology: In the last few years, e-commerce has become an integral part of the global economy. E-commerce has changed the retail environment relying on major customization of information systems and business processes to provide the best online customer experiences possible (Chen et al., 2020). The current study will help to incorporate modern technologies in the current e-commerce architectures.

Cybersecurity/Privacy: E-commerce systems typically collect large amounts of data, as such, there is the need to ensure that their data is always protected information (Barkatullah, 2018 cit in Ahi A, Sinkovics N, Sinkovics R, 2023) and private (Datoo, 2018 cit in Ahi et al., 2023). The current research will shed light on the type/volume of information that gathered by business, enhancing the need for a strong privacy and cybersecurity policy.

Economy: According to Jain V et al., (2021) a transition is being witnessed in the world's economy, through online technologies, companies are transforming into information-based operations at an exponential pace. E-commerce is no exception, making significant shifts in the economic environment and impacting all areas of industry. This study will help economies understand the importance of updating old architecture to new ones that offer better and faster solutions.

Omnichannel: Technological and digital advances not only make borders between physical and digital channels blurred but also the boundaries between retailers and manufacturers. The appearance of new "omnichannel retail environments requires reconsideration of customer value creation along the entire supply chain" (Brynjolfsson, Hu, & Rahman, 2013 cit in Reinartz W, Wiegand N, Imschloss M, 2019). This research will enable all channels to be intertwined in customer data, allowing a more precise contact with the customer.

Information systems: The traditional monolithic architecture is no longer suitable for the needs of scalability and rapid development, organizations need to create scalable applications that can impact new forms of production and business organization (Tapia F, Mora M, Fuertes W, Aules H, Flores E, Toulkeridis T, 2020). The current study will help to diffuse importance of using new architectures and how they can help the business

Human resource management: Artificial intelligence in e-commerce will result in a copious amount of information, as such, the demand for people in data science, computer learning, and engineering is greater due to the need of developing and maintaining the systems or programs. However, this can have a detrimental effect on individuals with a limited set of skills

who may face unemployment (P G, 2021). The current research aims to empower workers with technology that can improve their results.

Marketing: Businesses are investing in data analytics, thereby gaining real-time insights on customer's purchase patterns and behavior, which allows them to offer personalized user experiences. Understanding the consumer needs and requirements is key when it comes to defining marketing strategies (Thakur, 2021). This study aims to improve the status quo of marketing analytics by using multiple technologies that allow a personalized and real-time approach.

This study also aims to aggregate the knowledge and techniques that are available nowadays in e-commerce, data science and marketing to create a conceptual architectural framework for the new age of e-commerce.

2. LITERATURE REVIEW

2.1. ONLINE COMMERCE CONCEPTS

E-business can be defined as “The transformation of an organization’s processes to deliver additional customer value through the application of technologies, philosophies and computing paradigm of the new economy” (Khurana et al., 2011 cit in Issa N, Hoong Lee A, 2020).

For Pearson (2000 cit in Issa N et al., 2020) **E-commerce** is defined as “the use of the Internet and the Web to transact business. More formally, digitally enabled commercial transactions between and among organizations and individuals.”

With these two definitions in mind, we can see that e-commerce operates within the broader range of e-business.

Issa N et al., (2020) simplifies e-commerce as the sale of goods and services while keeping up with emerging technologies. These emerging technologies allowed the surge of other ways of doing e-commerce to emerge. (Rahman et al., 2022; Li L, Zhang J, 2021).

I-commerce: Characterized by transactions between the business itself, isolating the internal network. These transactions can be storing and sharing internal information, as well as maintaining internal communications (Li L, Zhang J, 2021).

M-commerce: The user makes transactions through mobile devices, such as smartphones and tablets (Rahman et al., 2022).

E-marketplace: According to Gund H & Daniel J (2023) and HelmyA, Farouk G, S. Abd A (2022) e-marketplace is an online platform (third party) where sellers list their products or services. The sellers are responsible for marketing, payments, and distribution.

S-commerce: E-commerce is enabled by social networks and online social relationships, this is another type of E-commerce that has gained popularity in recent years (Rahman et al., 2022).

Q-commerce: Focuses on providing fast and efficient delivery of goods to consumers, it uses advanced technology and logistics systems to offer products within hours or even minutes. The goal is to provide a frictionless shopping experience (Gund H & Daniel J, 2023).

2.2. E-COMMERCE

2.2.1. OVERVIEW

A Business-to-Consumer (B2C) model typically applies to retail trade, retailers sell not only products but also services, these services play a crucial role in customer experience by giving information, offering product assortment, promoting location accessibility, creating ambiance, ensuring timely product delivery and ensuring utility to the customer. Most of the time, these services come within the product price and when not included, some customers are willing to pay extra for them. Although there are customers that are willing to do the services themselves if it gets them a lower price. (Betancourt, Chocarro, Cortinas, Elorz, and Mugica, 2016 cit in Gauri D, Jindal R, Ratchford B, Fox E, Bhatnagar A, Pandey A, Navallo J, Fogarty J, Carr S, Howerton E, 2021)

The retail industry has evolved significantly throughout the ages, and Gauri D et al. (2021) selects the following dates as the key points in retail history:

Middle of the nineteenth century: Starting with the small, family-owned general stores where clerks would bring out the products that the customer asked for, followed by an haggle of the price.

1852: With the establishment of Marshall Field's there was a transition to larger general stores and department stores, they offered multiple products in under the same roof, with fixed prices.

Early twentieth century: Supermarkets emerged, shortly after retail formats started to have great performances. With the first mall opening, shoppers had access to a variety of stores under one roof.

1946: The first convenience store (7-Eleven) opened, providing extended hours of operation (from 7 a.m. to 11 p.m.) to customers. Soon after, discount stores were birth, with Walmart opening in 1962, and Kmart and Target following.

1974: Universal product codes in technology started to play a prominent role in retail.

1985: Home Shopping Network technology-based non-store format outside brick-and-mortar stores granting users the possibility of buying though TV.

1995: The great point of turn for retail was when Amazon sold their first book online, putting pressure on old retailing formats to evolve (Braun, 2015 cit in Gauri D et al.,2021).

Second half of the twentieth century: Discount stores and category killers (large retail chain of a product category) won the market, cutting-edge department stores were now struggling to match the prices due to better economies of scale.

E-commerce created important threats for all offline retailers by providing huge product assortment and convenience of purchase (Gauri D et al.,2021;Gupta S, Kushwaha P, Badhera U, Chatterjee P, Gonzalez E, 2023). Consequently, department stores remodeled aesthetics, curated their product assortments, invested in value adding services to attract customers, and introduced new concepts such as store-within-a-store (Lahart, 2020 cit in Gauri D et al.,2021). Discount stores and category-killers had to start to invest in online retailers to mitigate the threat (Gauri D et al.,2021).

On the other side of the spectrum, to improve customer experience and speed of product acquisition, many online retailers are now investing in physical stores. All this investment in omnichannel retailing is increasing costs for bigger players which opens space for smaller, independently owned companies with a heavy reliance on technology. (Gauri D et al.,2021)

The e-commerce term began to be used in abundance with the appearance of the internet, since then, there has been a massive development of information & communication technology and the evolution of electronic computer systems, resulting in a considerable development of e-commerce and its uses (Helmy A et al., 2022). Some of these uses being web-based stores, mobile apps, digital customer touchpoints and the merge of physical and online worlds (Palmié M, Miehé L, Oghazi P, Parida V, Wincent J, 2022).

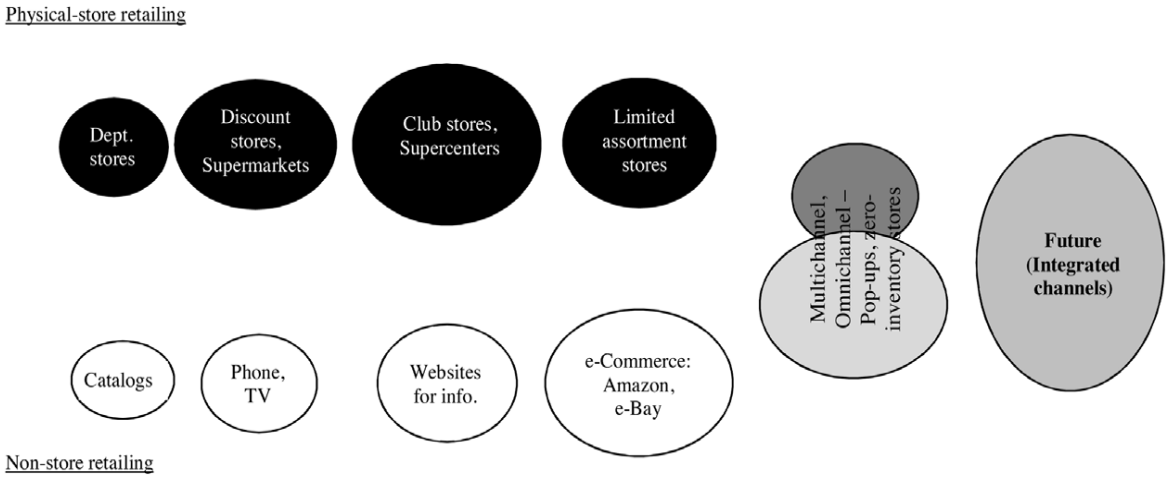

Figure 2. 1 – Evolution of Retail Formats – Source: Gauri D et al. (2021)

The surge of digitization has significantly propelled the e-commerce market over the past years, with substantial growth (Thakur, 2021).

For businesses, e-commerce lowered operational expenses associated with running a retail location such as rent, utilities, a variety of bills, and the wages of staff. Al these costs are eliminated by doing all the companies operations via an internet platform, it also removes the geographical barrier, enabling people to make orders from any point of the world to their addresses (Gupta S, Kushwaha P, Badhera U, Chatterjee P, Gonzalez E, 2023). On the customers side, Chakraborty et al., (2022 cit in Gupta S et al.,2023) stated that online purchasing provides consumers with the option of creating a unique shopping experience.

With internet access a customer may scroll through many different items to find the one that meets their needs at any time of the day (Gupta S et al., 2023).

E-commerce played a vital role in COVID-19 pandemic (Thakur, 2021) since the virus first appeared, e-commerce has been increasingly popular (Alwan SY et al., 2023 cit in Huy P, Phuc V, 2023). The spread of this virus improved e-commerce as a medium for trade between businesses (Alwan S, Hu Y, Al Asbahi A, Al Harazi Y, Al Harazi A, 2023), consumers and merchants since they had to stay at their homes. (Yuan J et al., 2021 cit in Huy P, Phuc V, 2023).

E-commerce was able to make transactions while spliting physically seller from buyer through internet networks and electronic applications (Rosenthal SS et al., 2021 cit in Helmy A et al., 2022), they were also able to deliver products and goods to the doors, taking preventive measures and using electronic payment as it was safer and less likely to transmit the virus (Helmy A et al., 2022).

After the epidemic, e-commerce grew astronomically (Huy P, Phuc V, 2023; Palmié M et al., 2022). Seeing the advantages and opportunities that the internet brought, most businesses felt the need to establish a digital presence (World Bank, 2021 cit in Huy P, Phuc V, 2023), although customer acquisition cost will be higher for these brands when comparing with those that have already established a presence in the industry (Huy P, Phuc V, 2023).

Today's e-commerce main facilitators are internet, payment gateways, analytics and social media (Jain V et al., 2021) this allows businesses to have a huge set of tools to reach out to consumers, some of them being search engine marketing, display advertisement, email campaigns and social media marketing (Huy P, c). Software applications are also one of the main key components in e-commerce (Mohdhar A & Shaalan K, 2021). All these tools impact not only functions and activities of the commercial system but also societal, political, cultural, and legal matters (Mohdhar A & Shaalan K, 2021).

Advancing with digital consumers and businesses has generated a wave of high-performance technology in commerce, this impacts not only physical commerce, but all domains in the supply value chain where innovative omnichannel (Verhoef P et al., 2015 cit in Mohdhar A, Shaalan K, 2021) systems interoperate with hardware and software solutions across the electronic commercial ecosystem. This creates a greater demand for those applications and Industry 4.0 comes to meet this demand (Hermann M et al., 2015 cit in Mohdhar A, Shaalan K, 2021) with smart digital dynamics, easing customer reach in applications and devices to their comfort. This commerce adoption has upgraded the supply chain to diverse Cyber Physical System (CPS) (Wan K et al., 2015 cit in Mohdhar A, Shaalan K, 2021) capabilities allowing real time computations and connections with multiple systems across the networks, channels and organizations, providing essential attributes in operating, collecting consolidating as well sharing information across the chain (Mohdhar A, Shaalan K, 2021).

E-commerce is becoming an essential part of businesses strategy. Advancements and incorporation of recent technologies such as artificial intelligence and big data, offer mass

customization, while increasing the number of potential customers, along with enhanced productivity, and revenue generation. (Thakur, 2021)

The e-commerce industry is expected to have exponential growth due to several factors, growing Internet services with hi-speed bandwidth, unprecedented smartphone penetration, market stability, product personalization and declining internet charges (Thakur, 2021).

2.2.2. TYPOLOGIES

The advancement of technology and innovation allowed e-commerce to constantly expand itself in the process of continuous development, generating multiple models along the way (Li L, Zhang J, 2021; Attar et al., 2022). The following are the most common types (Ahi et al., 2023).

Business-to-Business (B2B): For Ahi et al., (2023) this model comprises transactions between businesses. Li L, Zhang J, (2021) adds that these transactions can be goods, information, and services. This model makes up for almost 80% of all e-commerce (Gupta A, 2014 cit in Rahman et al., 2022). An example of this would be a deal between a manufacturer and a wholesaler (Rahman et al., 2022).

Business-to-Consumer (B2C): This model has a focus on relationships and transactions between businesses and end-customers (Thakur, 2021). Typically, this model applies to the retail trade on an online platform (Li L, Zhang J, 2021).

Consumer-to-Consumer (C2C): Li L, Zhang J, (2021) states that this model allows customers to make transactions between one another through a platform that acts as an intermediary. Rahman et al., (2022) adds that C2C is the most rapidly expanding sort of e-commerce.

Business-to-Administration (B2A): This model refers to the transaction between public administration and organizations (Ahi et al., 2023; Thakur, 2021). These transactions may be of a commercial nature or more administrative such as social security, fiscal and legal entities (Thakur, 2021).

Thakur, (2021) goes further and adds two more types of e-commerce to this list, C2A and C2B.

Consumer-to-Administration (C2A): This model focuses on the transactions between public governance and individuals. The main transactions of this model are inquiring about the zoning codes, paying taxes, or fines.

Consumer-to-Business (C2B): In this model the consumers make transactions with business, these transactions can be different services or goods. Some examples of this model are freelancing and consulting.

2.2.3. BUSINESS MODEL

Business models link the technological, physical and economic domain of a business (Pieroni et al., 2019 cit in Palmié M et al., 2022). To profit from digital technologies, merely acquiring them is not sufficient, for the use of these technologies, companies must develop business models (Gassmann et al., 2014; Parida et al., 2019 cit in Palmié M et al., 2022).

To innovate their business models, digital technologies provide companies with opportunities (Broekhuizen developing et al., 2021; Soluk et al., 2021 cit in Palmié M et al., 2022) for value creation through convenience, customer experience, customer satisfaction or system performance (Hokkanen et al., 2020; Rachinger et al., 2019 cit in Palmié M et al., 2022). A Business model articulates how the organization will convert resources into economic value (Teece, 2010 cit in Palmié M et al., 2022). It is useful in planning, structuring, communicating, and analyzing how businesses work (Geissdoerfer et al., 2018; Zott et al., 2011 cit in Palmié M et al., 2022).

Palmié M et al., (2022) defines the following areas as the main areas of a business model:

- Targeted customers.
- Value proposition offered to the customer.
- Value-creation and -delivery activities that produce the value proposition.
- Value-capture activities that manage the financial aspect of the business model, by generating revenue and controlling costs related to value proposition (e.g., Boons et al., 2013; Dentchev et al., 2018; Geissdoerfer et al., 2018; Palmi´e et al., 2021a cit in Palmié M et al., 2022).

These areas can be impacted by digital technologies (Frank et al., 2019; Soluk et al., 2021 cit in Palmié M et al., 2022) and when they are significantly enabled by them, we have a “digital business model”.

Digital business models can become rapidly uncompetitive and obsolete (Paiola and Gebauer, 2020; Parida et al., 2019 cit in Palmié M et al., 2022), hence the urgency both new and adapted business models (Broekhuizen et al., 2021; Caputo et al., 2021 cit in Palmié M et al., 2022).

2.2.4. CHALLENGES AND OPPORTUNITIES

Today's businesses have multiple touchpoints to reach the customer, from browsers to apps or even voice devices (Alexa). This change brings complexity and investment in outdated plug-and-play technologies, bringing also the constant need to change requirements (Silicon, 2020 cit in Heinemann, 2023). Microservices and Headless Commerce comes to the rescue, with their flexibility that allows the development or reconstruction of a commerce portal without limitations, while also bringing limitless design possibilities (Heinemann, 2023).

In terms of flexibility and consistent integration of all channels and touch points, microservices play a significant role in headless commerce. This represents a philosophy of decoupling and enhancing flexibilization. (Heinemann, 2023)

Headless commerce provides agile solutions that can enable a uniform shopping experience across a wide range of channels and touch points, optimizing adaptability and performance. Users can also use Headless Commerce to choose the best components that fit their goals, by creating a HTML service and thus benefit from those APIs for their individual requirements. (Heinemann, 2023)

Changes to the front-end can be made quickly, flexibly, and easily, removing any design constraints in the front-end. Developers no longer need to adjust the database or change the check-out processes on the slightest change. However, this requires an API-first and content-first approach. (Silicon, 2020 cit in Heinemann, 2023)

API-First Approach: An API becomes essential, depending on the significance of user experience (UX) in user interfaces (UIs). API-First design prioritizes user-friendly design over backend processes, this separates API implementation from UI and backend service development, creating a collaborative environment among everyone involved in the API definition. (Heinemann, 2023)

Content-First Approach: This approach marks a shift in the traditional commerce centric model, acknowledging the growing significance of content. APIs enable the logistic management and commerce in the back-end while at the same time, content and items can be easily posted to all touch points. (Silicon, 2020 cit in Heinemann, 2023)

2.3. TECHNOLOGIES FOR E-COMMERCE

2.3.1. SOFTWARE ARCHITECTURES

Re-architecting monolithic systems with Microservices-based architecture is a common trend (Auer F, Lenarduzzi V, Felderer M, Taibi D, 2021), but what are monolithic systems? ´

An SOA ("Service-oriented Architecture") Monolithic Systems try to represent all company's applications with a model and specifying all the service levels from it, thus representing a monolithic architecture where the entire code of the software is within an executable main file (Heinemann, 2023).

This monolithic approach has some limitations associated, when there is a high number of applications, troubleshooting, testing, and updating become a challenge, easily creating a matrix with more than a million data points to be executed, especially if all the code is buggy. In addition, every small update or change requires a new version of the application to be created. (Heinemann, 2023)

Because of this, developing and managing a monolithic application always brings an immense workload and tends to lead to a flexibility trap. It is usually limited by design constraints that arise from front-end development due to its high dependency on backend code and infrastructure. To ensure that the customer experience is not affected, changes made in one place must always be made for all other touch points as well (Heinemann, 2023).

Monolithic architectures are hardly scalable. In this respect, this SOA world, tends to think "top-down", which leads to an extremely high degree of standardization and poses obstacles to innovation, making it difficult to attract talent that looks for modern programming languages and frameworks that can be integrated into existing architectures. An SOA embodies a traditional e-commerce approach that predominantly uses classic enterprise platforms such as SAP Hybris or Salesforce Demandware. (Computerwoche SOA, 2017; Computerweekly Microservices, 2020, cit in Heinemann, 2023)

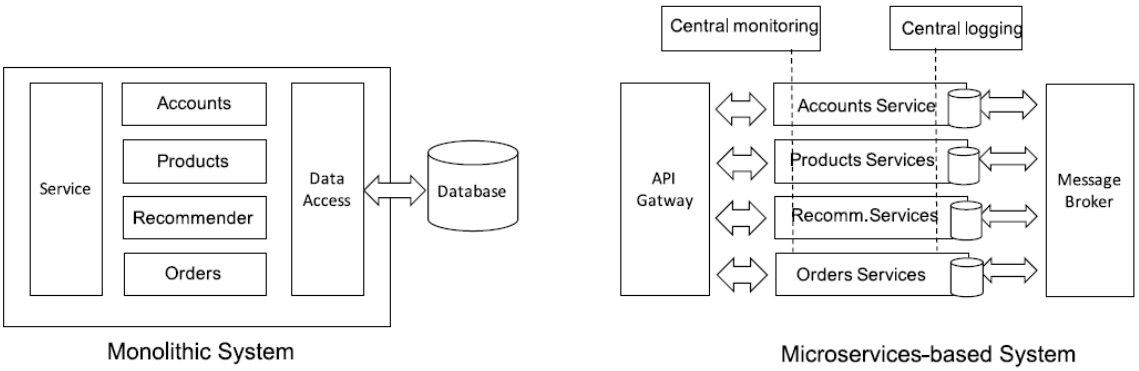

Figure 2. 1– Comparation between Monolithic and Microservice Architectures – Source: (Auer F et al.,2021)

Microservices allow developer teams to work each service independently, providing decentralized freedom to create software. If a program does not work properly, the problem is easier to trace back to a specific service, which can then be individually tested and restarted (Auer F et al.,2021; Heinemann, 2023). Due to this and their size, they are easier to maintain and more fault-tolerant (Auer F et al.,2021) since, bugs can be isolated and handled without having to regress into a testing stage. This approach makes it easier for online retailers to test and implement changes, contrary to a monolithic approach (Heinemann, 2023).

Microservices increase business agility, allowing independent scalability from other services, faster software development in different programming languages and deployment on the needed hardware (Auer F et al.,2021). On the other hand, architecture management becomes more complex than SOA one due to service separation. Because of this, Monitoring and management are key, they track availability and performance of all components required for the application. Apart from this, there is also the need to design communication between services, which when used heavily often lead to latency times. (Computerweekly Microservices, 2020 cit in Heinemann, 2023).

According to an analysis made by Auer F et al., (2021) on the characteristics and measures adopted when migrating to a microservice:

Performance is slightly reduced in Microservices due to a higher number of CPU instructions needed to process a client request, resulting in higher CPU utilization.

Regarding Scalability Microservices in general outperform monolithic systems in terms of resources needed (scaling is easy and precise = only the necessary number of resources is used). The amount of money spent on resources will be better delivered to microservices which give more throughput.

Availability of Microservices-based system can be affected by the higher number of moving parts. However, as it is fault tolerant, the system will still be available. (Soldani J, Tamburri D.A. 2018; Taibi D et al., 2017 cit in Auer F et al.,2021)

Maintenance is considered easier, yet more expensive. Testing becomes much more complex in Microservices (Kratzke N, Quint P.C, 2017 cit in Auer F et al.,2021) due to developments made in different programming languages and the need for orchestration increasing the overall maintenance effort (Auer F et al.,2021).

Cost-related, the development effort of Microservices is higher than the development of monolithic systems (Camargo A et al., 2017 cit in Auer F et al.,2021). However, Microservices are usually lower on infrastructure costs (Villamizar M, 2015; Villamizar M, 2016 cit in Auer F et al.,2021).

2.3.2. CLOUD COMPUTING

"Cloud computing is a model for quickly enabling convenient access to networks and applications through a common set of configurable computing resources (e.g., servers, networks, applications and storage) operating with little or no interference from the service provider to deliver it immediately". (Wang D, 2013 cit in Abdulkadim & Alasadi, 2022)

Cloud computing involves shared ownership of infrastructures and applications that provide a cloud-based environment over the Internet. It leverages the internet and remote servers to store user's information and applications. It also allows the usage of applications without installation and file/information access from any part of the world. (Kanaan Q et al., 2018; Lai S, 2013 cit in Abdulkadim & Alasadi, 2022)

2.3.2.1. CLOUD COMPUTING DEPLOYMENT MODELS

Public Cloud: Using a service provider, you can make apps, store information, and other resources available to the public. This is a third-party service where providers own, host, and run public clouds, companies "pay as you go". Everyone uses the same infrastructure, with only minor differences in settings, information security and reliability amongst clients. It allows scalability and resource sharing, making it the best for web servers and development systems. (Abdulkadim & Alasadi, 2022)

Private Cloud: Information technology products are provided across an essential infrastructure for the exclusive use of a single enterprise. A private cloud provides the same benefits of cloud computing, while assuring control and security. This model suits businesses with predictable workloads or customization needs and businesses in regulated industries. (Fellows J, 2019 cit in Abdulkadim & Alasadi, 2022)

Hybrid Cloud: A hybrid cloud mixes a private cloud with public cloud services, with one or more points of contact between the two. The goal is to establish a uniform, predictable, and very good computing environment by combining data and services from several cloud models. (Aktas MS, 2018 cit in Abdulkadim & Alasadi, 2022)

2.3.2.2. SERVICES OF CLOUD COMPUTING

Cloud computing has "pay-as-service," which supplies consumers with services on demand. Cloud leads to the new service styles such as "Infrastructure as a Service", "Platform as a Service", and "Software as a Service" (Talib A, 2011 cit in Abdulkadim & Alasadi, 2022).

Infrastructure as a Service: Enables businesses to transfer their on-premises or data center infrastructure to the cloud, managed by a cloud-service provider. This includes computing facilities, network, storage systems, and several other hardware and software components. In

this environment customers are clients of services, paying for the resources they use. The use of IaaS is mostly beneficial for example, when a business has its own app or has the internal resources to develop it. (Abdulkadim & Alasadi, 2022)

Platform as a Service: Services that are used in the development and management of modern applications. It requires the infrastructure and middleware characteristics that enable programmers, IT administrators, and end users to develop, integrate, migrate, deploy, secure, and manage web and mobile apps. Provides infrastructure and middleware components, making it easier to build and maintain software and hardware. This kind of platforms is not intended to be an alternative for enterprise-wide information technology infrastructure and software development workflows. (Abdulkadim & Alasadi, 2022)

Software as a Service: Runs and maintains software applications, operating system, and other resources. It provides different applications over the Internet. The user can run these applications using a web browser because there is no need to purchase licenses, install, upgrade, maintain, and run software on his computer, the software is provided remotely (Abdulkadim & Alasadi, 2022).

Function as A Service: In FaaS, the provider enables access to the application container, language, operating system, and hardware, providing a global virtual development environment, so that the developer can code (Abdulkadim & Alasadi, 2022).

2.3.3. BIG DATA

Artificial Intelligence and Big Data technologies are expected to reshape the e-commerce industry, it is expected that these will make it easier for the retailers to provide seamless, streamlined, and optimized services to the users, allowing them to gain a competitive edge in the market (Thakur, 2021).

Big Data is the acquisition, screening, storage, and analysis of large kinds of data through mega database storage and fast information processing, with the ability to quickly mine valuable information from a variety of data. The five major characteristics are hugeness, richness, value, speed, and accuracy. (Li & Zhang, 2021)

Big Data focuses on being a productive source of analysis for historical data and present trends to gain enhanced consumer satisfaction, playing a significant role on value creation to the businesses. The application of “Big Data” in problem solving solutions enables business to work on their efficiency with the accessibility to larger amounts of data, streamlining the operational processes, converting the growth into revenue, and expanding their customer base. This technology allows businesses to create a 360˚ view of users by merging offline/online transactions, product reviews, and social media feedback, creating a seamless and optimized consumer experience. (Thakur, 2021)

Thakur (2021) mentions a few big data solutions which can lead to the rise in the e-commerce businesses:

Recommender Systems: Personalized web page to the user, the moment they visit a website which enables the retailers to understand the user needs, boosts user satisfaction, as well as increases the overall sales of the companies.

Optimizing the Customer Experience: Identification of the browsing history, and consumer behavioral patterns, creating an opportunity for re-targeting the consumers by recommending the products based on recent purchases or product which the user showed interest.

Optimizing the Pricing of Products: Usage of real-time analytics in big data enables the retailers to offer best prices for goods by tracking via historic data.

Enhance the Decision-Making on Micro-Moments: Most sales are made via the smartphones. By being connected with the latest technologies related to big data analytics business can improve micro-moment decisions (Bibrainia, 2020 cit in Thakur, 2021).

According (Li & Zhang, 2021) there are 5 main steps in a big data processing flow:

Data collection: collecting data to a specified location, called data collection.

Data preprocessing: collected data that is preprocessed by cleaning dirty data, sorting data formats, filtering out dirty data, etc.

Data storage: pre-processed data will be imported into the corresponding tables in the database.

Data analysis: develop ETL analysis reports based on needs and obtain various statistical results.

Data Presentation: data obtained from the analysis in a visual manner.

2.3.4. ARTIFICIAL INTELLIGENCE

The term “artificial intelligence” was created by John McCarthy in 1956, defining it as the science or engineering capable of creating intelligent machines (Mueller & Massaron, 2018 cit in Schmiegelow & Melo, 2023).

It wasn´t until 1980s that logical and mathematical reasoning emerged, becoming the main trend in artificial intelligence. With a gradual improvement in the processing capacity of computers, studies in this area reached a new level (Meske et al., 2022 cit in Schmiegelow & Melo, 2023), Although, technological limitations persisted, making it impossible to carry out

human-machine interactions through images, sounds, languages and the simulation human thought process (Halverson et al., 2021 cit in Schmiegelow & Melo, 2023).

Only after nearly twenty-five years of research on neural networks, researchers were able to effectively obtain significant results. The great power of deep learning networks today, combined with the extremely high processing capacity of computers, made the classification of images with very high precision possible (Minh et al., 2022 cit in Schmiegelow & Melo, 2023).

Despite these advancements, organizations that are looking to adopt artificial intelligence face many challenges, such as, lack of knowledge and lack of skills (Lee & Qiufan, 2021 cit in Schmiegelow & Melo, 2023).

Artificial Intelligence is characterized as an innovative technology that complements a company's strategy, it uses several technologies capable of executing tasks that need human intelligence (Haleem et al., 2022).

This computer science technology teaches computers to comprehend and emulate human communication and behavior. AI can do highly technical and specialized activities such as robotics, speech and picture recognition, natural language processing, problem-solving, (Haleem, Javaid, Asim Qadri, Pratap Singh, Suman, 2022) machine learning, deep learning, computer vision and many others (Haleem et al., 2022).

Most AI applications in marketing use ML to personalize product suggestions, help discovering the most successful promotion channels, estimate churn rate or customer lifetime value, or even building superior customer groups. (Tiwari et al., 2020; Schiessl et al., 2021 cit in Haleem et al., 2022)

AI-based systems and services can majorly be used to harness and investigate large volumes of data available online and with the help of machine learning develop a data-driven marketing strategies that impacts the digital marketing environment (Bughin et al., 2017 cit in Anayat & Rasool, 2022; Haleem et al., 2022).

2.3.5. Artificial Intelligence in Marketing

AI can play a critical role in all three strategic marketing stages, (research, strategy, and action) when using AI intelligence to leverage it. The realm of AI, it can be designed to have multiple intelligences for different tasks, these include mechanical, thinking, and feeling AI intelligences in their applications (Huang & Rust, 2020)

Huang and Rust, (2020) defines those AI Intelligences as:

Mechanical AI: This type of AI is designed for automating repetitive and routine tasks such as remote sensing, machine translation, classification algorithms, clustering algorithms, and dimensionality reduction.

Thinking AI: Processes data to generate new insights or make decisions, particularly when handling unstructured data. It is used for recognizing patterns and regularities in data, including text mining, speech recognition, and facial recognition. The current methods used to by thinking AI involve Machine learning, neural networks and deep learning (neural networks with additional layers).

Feeling AI: This AI is characterized by a two-way interaction involving humans, and/or for analyzing human feelings and emotions. Natural language processing (NLP), text-to-speech, recurrent neural networks (RNN), chatbots for mimicking human speech, virtual agents for human interactions, and robots sensing affective signals are some of the examples of this AI (McDuff and Czerwinski, 2018 cit in Huang & Rust, 2020).

True feeling AI is not available, we use thinking AI to analyze emotional data and interactions. This type of data is distinct from the cognitive one, its contextual, individual-specific, and typically multimodal (speech, gestures, and language). Some applications may have elements of multi-intelligence, for instance, facial recognition may try to identify someone (thinking AI) or figure out somebody's emotional state (feeling AI). (Huang & Rust, 2020)

Table 1 A strategic framework for AI in marketing

AI intelligence Strategic decision	Mechanical AI	Thinking AI	Feeling AI
Marketing research	*Data collection* Automate continuous market and customer data sensing, tracking, collecting, and processing	*Market analysis* Use marketing analytics to identify competitors and competitive advantages	*Customer understanding* Use emotional data and customer analytics to understand existing and potential customer needs and wants
Marketing strategy (STP)	*Segmentation* Use mechanical AI to identify novel customer preference patterns	*Targeting* Use thinking AI to recommend the best target segments	*Positioning* Use feeling AI to develop positioning that resonates with customers
Marketing action (4Ps/4Cs)	*Standardization*	*Personalization*	*Relationalization*
Product/Consumer	Automate the process and output of meeting customer needs and wants	Personalize products based on customer preferences	Understand and meet customer emotional needs and wants
Price/Cost	Automate the process of price setting and payment	Personalize prices based on customer willingness to pay	Negotiate price and justify the cost interactively
Place/Convenience	Automate customer access to product	Personalize frontline interactions	Personalize experience for customer engagement
Promotion/Communication	Automate communication with customers	Customize promotional content for personal communication	Tailor communication based on customer emotional preferences and reactions

Figure 2. 2 – A strategic framework for AI in marketing – Source: (Huang & Rust, 2020)

2.4. EMERGING APPROACHES

Marketers are now empowered by AI, this new technology allows them to gain deeper consumer insights, understand better how to segment them and push them to the next step in their journey, providing frictionless experience. It also allows personalization of their websites, emails, social media posts, videos, and other materials to better respond to customer demands. (Haleem et al., 2022)

Due to numerous AI applications in marketing, contextual marketing has emerged. Contextual marketing is when businesses provide details catered to the consumers to make them relate to the business. As a result, AI can deliver market data from many platforms to the organizations, for example, online networking, the IoT, or other outside sources (Wang et al., 2017 cit in Anayat & Rasool, 2022). It could provide helpful information to develop efficient marketing tactics and enhanced product/service innovation (Han et al., 2021 cit in Anayat & Rasool, 2022).

There are eight technologies that are pointed as essential for the future, those are augmented reality (AR), Blockchain, drones, Internet of Things (IoT), robotics, 3D printing, virtual reality (VR) and Artificial Intelligence (AI). Consequently, both businesses and governments have started to adopt artificial intelligence-based technologies in multiple sectors to navigate the challenges of the comprehensive digital transformation process (Khoa, B. T. ,2021 cit in Ljepava, 2022).

2.4.1. GENERATIVE ARTIFICIAL INTELLIGENCE AND E-COMMERCE

Generative artificial intelligence (GAI) is transforming the landscape of e-commerce industry. Both E-commerce giants, startups and grocery delivery platforms are now using GAI applications to optimize their offers. (Nir Kshetri, 2024)

GAI can evaluate customer data to tailor product recommendations and offers. This involves multiple processes, such as designing personalized shopping journeys, offering discounts based on past interactions or even generating content that appeals to each customer. GAI tools such as ChatGPT can better customer experience providing the best personalized answers to various queries on time. (Nir Kshetri, 2024)

In the absence data for tailored customization, buyers will deal with many unrelated product options and repetitive information, GAI-based solutions came to address this issue. One of the most notable applications was in June 2023, when Carrefour announced three solutions based on OpenAI's GPT-4 and ChatGPT. These solutions included 1) an advice robot to help with shopping on carrefour's website, 2) detailed description sheets for every product on its website and 3) support for purchasing procedures. (Nir Kshetri, 2024)

The GAI integration in e-commerce transactions addresses various challenges not only on the buyer's side, but also on the sellers. (Nir Kshetri, 2024)

Online shoppers have multiple uncertainties when buying, some of them being the vendor, product characteristics or even product fit. (Y. K. Hong & P. A. Pavlou, 2014 cit in Nir Kshetri, 2024) GAI solutions can help reduce these uncertainties, by providing users with a clearer understanding of the product. (T. Sandle, 2023 cit in Nir Kshetri, 2024)

GAI also facilitates communication between customers and experienced sales associates, enhancing the shopping experience. GAI solutions can also drastically reduce consumer's search efforts by offering tailored recommendations, providing conversational search assistance, and improving visual search. (Nir Kshetri, 2024)

GAI also offer the possibility of doing real-time tests of promotions, including two-for-one deals, to determine their effectiveness (Nir Kshetri, 2024).

Previous studies have noted that there is the need to reduce the cognitive costs associated with decision-making (S. M.Shugan , 1980 cit in Nir Kshetri, 2024). This can be done by using a virtual assistant and telling it what and why they need it, their budget or other relevant variables. With this information, GAI can give back recommendations on the product that the customer shows interest in but also on other products, services, or even related content. (B. Allen, 2023 cit in Nir Kshetri, 2024)

For a company, GAI is an opportunity to cut costs associated with positions such as content creators, copywriters, and ad editors. This allows businesses to craft customer-centric features that are highly appealing while maintaining a low cost. (Nir Kshetri, 2024)

2.4.2. METAVERSE

Due to recent technological innovations and advancements, Metaverse has gained significant attention in recent years. Originating from Neal Stephenson's 1992 book "Snow Crash," the Metaverse, also known as meta universe or beyond-universe represents a virtual universe that is parallel to the physical world. People can experience any activity of their physical lives by interacting with their avatars, blurring reality and virtuality. (Kır, 2023)

This universe can be accessed through Virtual Reality (VR) equipment or Augmented Reality (AR) glasses which enable users to immerse themselves in this universe. These types of equipment are in constant evolution, offering new possibilities of interactions and exploration in each release. (Baltacı, 2023 cit in Kır, 2023)

Augmented reality blends computer-generated data such as graphics, video, audio, GPS with our physical surroundings to create immersive experiences. This technology overlays virtual elements onto real-world objects, enhancing consumer engagement and interaction. This can be used to gamify consumption and take user experience to the next level (Yengin & Bayrak, 2018 Kır, 2023). Augmented reality is considered as the first step into the virtual world (Kır, 2023).

On the other hand, Virtual reality is a technology that transports users to entirely virtual environments through technological glasses or other technological equipments, this technology is currently used by museums and brands. The Louvre Museum is an example of these applications (Tanrıkulu & Karagöl, 2021 cit in Kır, 2023).

Metaverse is the convergence of many technologies including digital twinning and avatar creation, bridging the gap between the physical and digital worlds (Özenir, 2022 cit in Kır, 2023). Extended Reality (XR) which includes AI, VR, AR and MR (Mixed Reality (AR+VR)), sets the communication between physical and digital worlds, playing a crucial role in simulating physical environments (Atiker, 2022).

The experience that the Metaverse world will give to the user is only possible with the development of Web 3.0. which is characterized by a decentralized and global blockchain-based version of the internet. Web 3.0 and Metaverse technology emerged by supporting each other. (Kır, 2023)

Guven Celikkaya, emphasizes the importance of augmented and virtual reality, claiming that it is gradually improving. Web 1.0 (Text-based internet) evolved to Web 2.0 (image-based) and now to Web 3.0 with its three-dimensional technology. Guven Celikkaya also states that three-dimensional contents sell more and has less refund rates. (Kır, 2023)

Each day that passes the target audience creates different expectations, companies should be aware of this situation and start working in parallel with this technology. By following these innovations, companies can sustain their success, while also making improvements in businesses. (Aslan & Kolancı, 2019 cit in Kır, 2023)

2.4.3. BLOCKCHAIN

The pursuit of green energy can receive a big boost though the utilization of digital technologies. Adopting such technologies will aid in energy consumption reduction and help build cleaner energy resources. Blockchain technologies emerge as a potential to grow the pace of adoption. Experts affirm that blockchain can be used to address many sustainability challenges when managed correctly and with the right mindset (Friedman & Ormiston, 2022; Khan, Razzaq, et al., 2021; Leng et al., 2020 cit in (Ghobakhloo, Iranmanesh, Mubarik, Mubarak, Amran, Khanfar, 2024).

Blockchain operates on a decentralized model, ensuring that no particular group of users has complete control over data, operating on the peer-to-peer (P2P) networking of data, eliminating third-party roles for security and authenticity of information (Howson, 2020; Li et al., 2018 cit in Ghobakhloo et al., 2024). These Peers are linked using cryptography (Di Vaio & Varriale, 2020 cit in Ghobakhloo et al., 2024), making data immutable. When data is filled in blocks chronologically and chained to other consecutive blocks, it becomes irreversible and tamperproof (Zutshi et al., 2021 cit in Ghobakhloo et al., 2024)

Overall, blockchain brings features like safety, transparency, traceability, security, and decentralization characteristics, which offer practical implications for advancing sustainable development (Parmentola et al., 2022 cit in Ghobakhloo et al., 2024). Regarding traceability and transparency, blockchain, can be a major enabler of environmental accountability within industrial supply chains (Agrawal et al., 2021; Centobelli et al., 2022 cit in Ghobakhloo et al., 2024) giving a clear vision on socio-environmental performance of raw materials, operations, and products to supply partners and stakeholders. (Venkatesh et al., 2020). Traceability and transparency features address old sustainability concerns of supply chains, such as child labor, harmful emissions, or compliance issues (Guo et al., 2020 cit in Ghobakhloo et al., 2024).

Improving operational efficiencies is another benefit of blockchain (Khanfar et al., 2021 cit in Ghobakhloo et al., 2024), businesses can optimize their distribution of products/materials and create efficiency in inventory management and order fulfillment (Ho et al., 2021 cit in Ghobakhloo et al., 2024). When integrated with other Industry 4.0 technologies like Internet of Things (IoT) and machine learning, blockchain enables cognitive manufacturing systems, enhancing sustainable manufacturing performance in terms of material efficiency, waste reduction, and emission prevention (Leng et al., 2020 cit in Ghobakhloo et al., 2024).

Blockchain can also play a pivotal role in circular economy due to its transparency, smart contract, trust, and traceability, by using reverse supply chain processes such as remanufacturing and recycling (Centobelli et al., 2022; Nandi et al., 2021 cit in Ghobakhloo et al., 2024).

2.4.4. CUSTOMER DATA PLATFORM

The main objective of a customer data platform (CDP) is to provide maximum value to the customers, for this, companies need to know their customers and use that information to stand out from their competitors. However, obtaining this information is not easy. The entire customer journey relies on data, meaning that having access to high-quality and diverse datasets is vital to understand the needs of the customer, thus creating exceptional experiences. (Earley, 2018)

According to the Customer Data Platform Institute (CDPI) cit in Earley, 2018, a CDP is “a marketer-managed system that builds a unified, persistent customer database that is accessible to other systems.”

To provide a 360-degree view of the customer, CDPs aggregate data from multiple sources. Platforms like this, are designed for marketers allowing the creation of customer profiles, develop of marketing campaigns, test marketing strategies effectiveness, and predict customer behaviors based on the information of multiple systems. A CDP includes logs of customer interactions, such as purchases, social media engagement and website events

(actions that the user make within the website, more than just purchases also known as electronic body language).

Data, that tracks the user's journey through a website, can be rich in information and storing website behavior in a CDP is essential, this creates a large dataset with many components that change depending on time and context, creating the need to analyze and interpret data. (Earley, 2018)

According to Earley, (2018) the Main functions of a CDP are:

Ability to Summarize Data or Surface Trends: A CDP can summarize several types of data to show trends or characteristics allowing businesses to make offers, promotions, show content that similar users find valuable, or other relevant signals.

Integration of Varying Data Formats and Structures: Another function is their ability to integrate different data types and formats that might have vary in structure and naming convention.

Data might flow into the CDP through a live feed (API/web service layer) or with a batch basis through file transfer. Within this transfer, data might have different formats, structured (purchase data) or unstructured (chat bots). This data is then transformed so that it can be easily interpreted by a marketer or acted upon by other systems without the need for manual repetition of the process.

Ability to Cleans and Process Data: Data might have redundant records and content, missing details or contain incorrect. Depending on the source of the dataflow, only certain values can be updated. There are rules for cleansing, enriching, appending, and correcting data. By using automating, the cost and complexity of data hygiene is reduced.

Exposing Data for Use by Other Systems: A critical function of CDP's is to act as a centralized location for other systems to access and utilize customer data. CDP's take the outputs of customer applications, process it, convert them to the right format, and export it or make it available via an API to other systems.

3. METHODOLOGY

According to Vom Brocke J, Hevner A, Maedche A, (2020), Design Science Research (DSR) develops human knowledge through the creation of innovative artifacts. These artifacts solve problems and improve the environment in which they are instantiated. Newly designed artifacts and design knowledge (DK) are the results of a DSR, they provide a fuller understanding of why the artifacts enhance/disrupt the application contexts via design theories.

Based on this definition, and as the objective of this study is to develop a new e-commerce architecture, adopting a DSR approach will enable us to gain a comprehensive understanding of how the proposed architecture enhances or disrupts existing e-commerce paradigms.

3.1. DESIGN SCIENCE RESEARCH

The DSR process has six distinct steps: problem identification and motivation, definition of solution objectives, design and development, demonstration, evaluation, and communication. There are also four potential entry points into this process: problem-centered initiation, objective-centered solution, design and development-centered initiation, and client/context initiation (Vom Brocke et al., 2020).

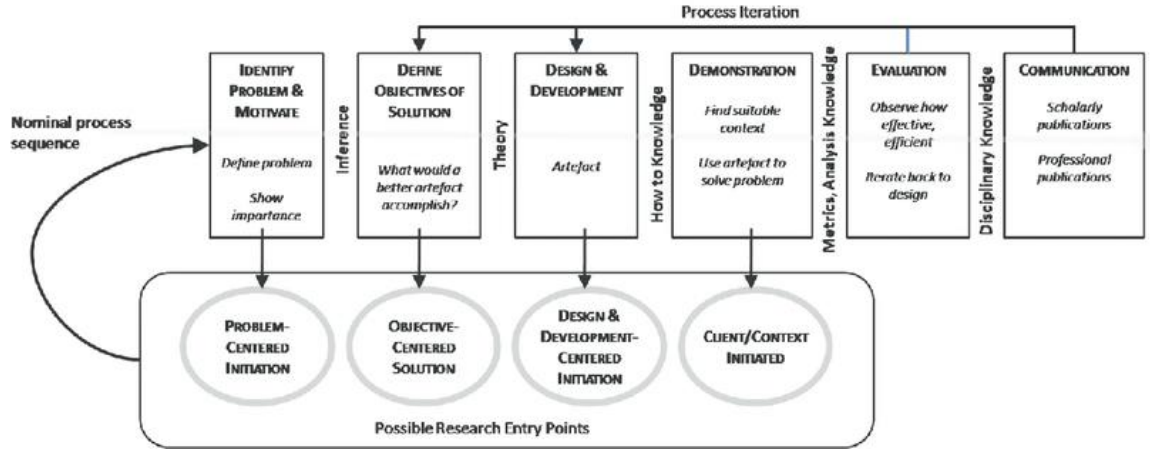

Figure 3. 1 – Design Science Research Framework – Source: (Vom Brocke et al., 2020)

Vom Brocke et al., (2020) defines the six phases of DSR model as:

1. **Problem identification and motivation**: In this phase, researchers define the research problem and explain why it is important to find a solution. Through the justification of the solution's value, the researcher and the audience become motivated to pursue the solution and it also shows that the researcher has a good understanding of the problem. To carry out

this phase effectively, researchers need knowledge of the state of the problem and the importance of its solution.

2. **Define the objectives for a solution**: Only after problem definition and obtaining knowledge of what is possible and feasible, can the objectives of a solution be determined.

These objectives can be either quantitative in which a desirable solution would be better than current ones, or qualitative on how a new artifact will support solutions to the problems. It is important that these objectives are inferred rationally from the problem specification.

3. **Design and development**: In this phase the artifact is created. "A DSR artifact can be any designed object in which a research contribution is embedded in the design" (Vom Brocke et al., 2020). In this activity it is required to determine the artifact's desired functionality, its architecture and then create the artifact.

4. **Demonstration**: In this phase, the artifact is demonstrated to show how the artifact solves one or more instances of the problem. This may involve experimentation, simulation, case studies, proof, or other relevant activities.

5. **Evaluation**: This phase measures how well the artifact supports a solution to the presented problem. In this activity, the solution's objectives must be compared to the observed results from the artifact. Evaluation methods can vary depending on the nature of the problem and the artifact. In the end, the researchers can decide to retract and try to improve the effectiveness of the artifact or to continue to communicate and leave further improvement to future projects.

6. **Communication**: In the final phase, researchers communicate all aspects of the problem and the designed artifact to the stakeholders. The communication methods depend on research goals and the targeted audience, which may include practicing professionals.

3.2. RESEARCH STRATEGY

1. **Problem identification and motivation**: As seen before, section 1.1 lays the groundwork to understand e-commerce as a multifaceted ecosystem driven by technological advancements, it enhances the importance of the role of e-commerce in the global economy since 2000 and highlights the challenges that monolithic architectural frameworks pose. One of the most important things that is also mentioned is the importance of integrating innovative tech, such as artificial intelligence and machine learning, to better the customer experience and operational efficiency. This sets the stage for the next phase of the research (objective definition).

2. **Define the objectives for a solution**: In section 1.2, the objectives and research questions for this study are described. Those objectives focus on developing of an e-commerce

architecture that facilitates more flexible and effective customer engagement through the utilization of cutting-edge technologies.

3. **Design and development**: At this phase, the focus shifts towards creating the artifact. Understanding the desired outcomes is fundamental to design an effective assessment tool. Therefore, it becomes imperative to have extensive research on the state-of-the-art of e-commerce architectures and technologies. To summarize the existing knowledge in this area and intersect it with other areas it is necessary to conduct a literature review.

To create a structured literature review with the best quality, a search was conducted for the best publishers available, investigating each one of them in search of credibility and reputation.

The literature review unfolds into three phases. First, the major concepts of commerce are set, after, we dive into e-commerce addressing typologies, business models, challenges, and opportunities. In the third part we focus on technologies in e-commerce such as software, cloud, big data and artificial intelligence.

Once the literature review written and with the insights generated from this review, a model (artifact) for implementing and evaluating e-commerce architectures can be crafted.

4. **Evaluation**: After designing and developing the artifact, it needs to be challenged by talking to experts from scientific and practical fields of e-commerce, data and technology.

This evaluation will be done based on an interview with specialists on the area to validate the design of artifacts and gather feedback on their efficiency and effectiveness, to later reevaluate the architecture and try to apply those changes.

5. **Communication**: Lastly, the results of this research and its contributions will be shared not only with the academic committee for evaluation but also with the public by publishing the work.

4. PROPOSAL OF A NEW E-COMMERCE ARCHITECTURE

4.1. PROPOSAL OF A NEW E-COMMERCE ARCHITECTURE

Based on what was studied on the literature review, about e-commerce, technologies, and emerging approaches, it was defined and mapped on table 4.1 that for an e-commerce to be technologically competitive in the next years, it should:

Table 4. 1 – Technologically Competitive Business

			Businesses		
			Enablers	Touchpoints	Supply chain
Technologies	Software Architectures	Software Architectures	A	K	E
		Cloud Computing	B/C/H/A/L/M		E
		Big Data	H/A		
		Artificial Intelligence	H/A		
	Emerging Approaches	Generative Artificial Intelligence	H/A	G	E
		Metaverse	H/A	F/G	E
		Blockchain	H/A	G	
		Customer Data Platform	H/A	D/G/I	E

A. Embrace microservices-based architecture for improved scalability, flexibility, and limitless design possibilities (Heinemann, 2023).
B. Use cloud computing to quickly enable access to networks and applications. (Wang D, 2013 cit in Abdulkadim & Alasadi, 2022)
C. Use applications without installation and file or information access from any part of the world (Kanaan Q et al., 2018; Lai S, 2013 cit in Abdulkadim & Alasadi, 2022).
D. Create a 360˚ view of users by merging offline/online transactions, product reviews, and social media feedback (Thakur, 2021), for both marketing and data analysis (a CDP) (Customer Data Platform Institute cit in Earley, 2018)
E. Invest in the supply chain to keep up with high-performance technology in e-commerce. (Verhoef P et al., 2015 cit in Mohdhar A, Shaalan K, 2021)
F. Explore emerging technologies such as AR and VR to create immersive shopping experiences for better customer engagement (Kır, 2023).
G. Keep up with emerging technologies (Issa N et al., 2020)
H. Use mechanical, thinking, and feeling AI for different marketing tasks (Huang & Rust, 2020).
I. Feed the CDP with different data formats and sources for better customer insight (Earley, 2018).
J. Explore extended reality technologies as a bridge between the physical and digital world (Atiker, 2022).
K. Adopt Headless commerce to provide agile solutions that can enable a uniform shopping experience across a wide range of channels and touch points (Heinemann, 2023).

L. Allow supply value chain systems interoperate hardware and software solutions across the electronic commercial ecosystem (Verhoef P et al., 2015 cit in Mohdhar A, Shaalan K, 2021)
M. Make sure that the supply chain has capabilities that allow real time computations and connections with multiple systems across channels and organizations functional capabilities, providing attributes when collecting and sharing information across the chain (Mohdhar A, Shaalan K, 2021).

Thus, as shown in table 4.2, for e-commerce to be strategically competitive through the use of technologies, it should:

Table 4. 2 – Strategically Competitive Business

			Customer			
			Touchpoints	Personalization	Value Creatior	User info
Technologies	Current	Software Architectures		B	F	
		Cloud Computing		N	F/C/K	G
		Big Data	L	N/J	F/I/K	G
		Artificial Intelligence	L	M/N/J	F/K	G
	Emerging	Generative Artificial Intelligence		O	F/A	
		Metaverse			F	
		Blockchain			F/E/P	
		Customer Data Platform	D		F/H	G

A. Use GAI to reduce uncertainties and create better communication with the customer (Nir Kshetri, 2024).
B. Offer to their customers a personalized experience in their websites, emails, social media posts, videos, and other materials to better respond to their demands (Haleem et al., 2022), creating a unique shopping experience. (Chakraborty et al., 2022 cit in Gupta S et al.,2023).
C. Provide seamless, streamlined, and optimized services to the users (Thakur, 2021).
D. Have technologies that offer consistent integration of all channels and touch points to reach the customer on browsers, apps or even voice devices (Silicon, 2020 cit in Heinemann, 2023).
E. Use blockchain to promote transparency, traceability, efficiency (Kır, 2023).
F. Use digital technologies to create value through convenience, customer experience, satisfaction, or system performance (Hokkanen et al., 2020; Rachinger et al., 2019 cit in Palmié M et al., 2022).
G. Leverage the internet and remote servers to store users' information and applications. (Kanaan Q et al., 2018; Lai S, 2013 cit in Abdulkadim & Alasadi, 2022).
H. Be able to gain deeper consumer insights and understand better how to categorize and drive customers to the next step in their journey, providing the best possible experience.

I. Implement Big Data technologies to analyze large volumes of data for enhanced consumer satisfaction and business value (Thakur, 2021).
J. Use recommender systems to personalize user experience and increase sales (Thakur, 2021).
K. Optimize pricing strategies by using real-time analytics and historic data (Thakur, 2021).
L. Enhance decision-making with AI-powered solutions like machine learning and deep learning (Bibrainia, 2020 cit in Thakur, 2021).
M. AI in marketing to personalize product suggestions and create effective promotion strategies (Tiwari et al., 2020; Schiessl et al., 2021 cit in Haleem et al., 2022).
N. Create tailored content/offers to their customer, using contextual marketing (Huang & Rust, 2020).
O. Invest in generative AI to personalize product recommendations, content generation, optimizing offers and improving shopping experience (Nir Kshetri, 2024).
P. Use blockchain as a major enabler, giving a clear vision on socio-environmental performance of raw materials, operations, and products to supply partners and stakeholders. (Venkatesh et al., 2020).

4.2. ARCHITECTURE

To simplify the readability of the next part of the document, table 4.3 connects the name of the technologies to the acronym. The acronyms are used on the end to specify the technologies that are used.

Table 4. 3 – Technologies and their Acronyms

Technologies	Ancronym
Software Architectures	SA
Cloud Computing	CC
Big Data	BD
Artificial Intelligence	AI
Generative Artificial Intelligence	GAI
Metaverse	MV
Blockchain	BC
Customer Data Platform	CDP

This architecture is an API-based architecture, making it scalable, flexible, and open to many possibilities. [SA; CC; BD; AI; GAI; MV; BC; CDP]

Starting with the first step, the supply chain systems are connected directly to the headless commerce for product to supply management. [CC; BC]

Headless commerce, enables multiple shopping experiences across various channels and touch points (Online/Offline) [SA; CC; BD; AI; GAI; MV; BC; CDP]

These touch points send customer data in various formats. [GAI; MV; CDP]

After data is cleaned and selected, it will feed a CDP, contributing to a 360˚ view of the user in multiple touchpoints. This data can also be sent to a real-time repository for further analysis. [CC]

AI Marketing enables the company to use multiple AI and Big Data Models that can be applied in real time or in a later interaction. [BD; AI; GAI; MV; CDP]

If the result of the interaction directly impacts the supply chain, each touchpoint sends information regarding its nature. [CC]

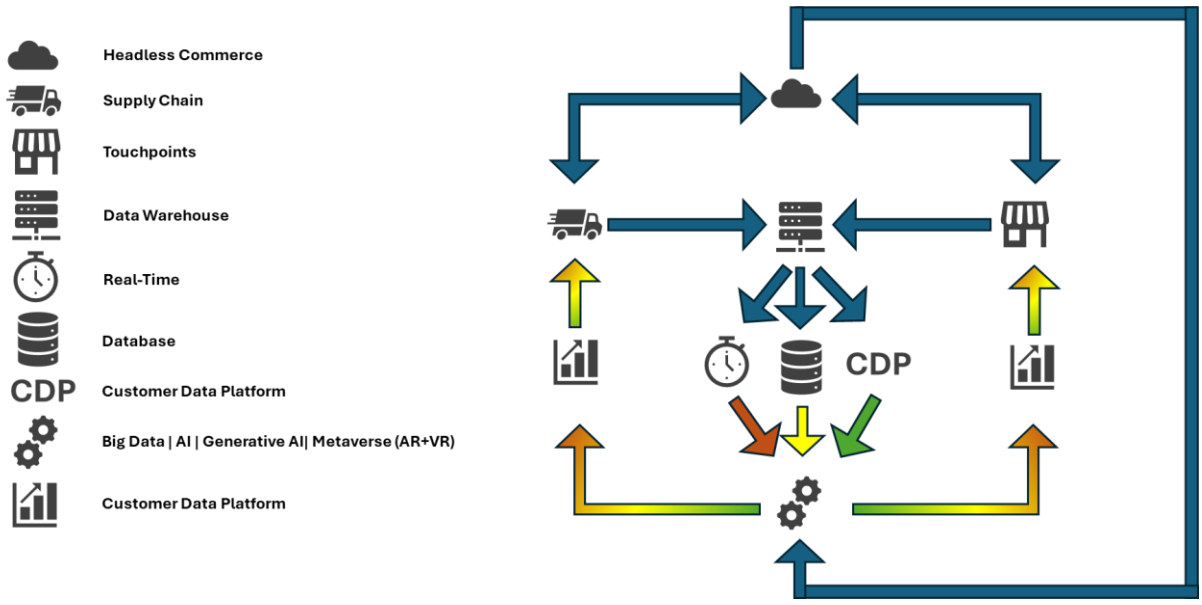

Figure 4. 1– New E-commerce Architecture (own Illustration)

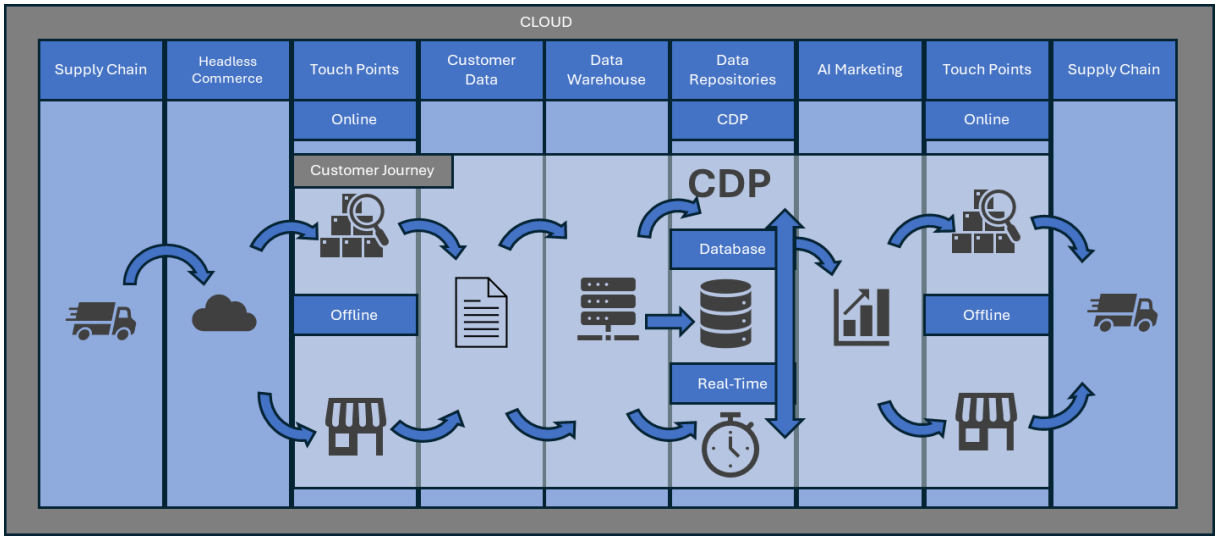

Figure 4. 2– New E-commerce Customer Journey (own Illustration)

There are many uses for the technologies that are used in this architecture as they can be used in different parts of it. Adapting every one of them to a business would impossible, as such, this architecture was made as broad as possible so that anyone might be able to look into it and see how this new architecture could impact a business in the multiple stages.

By analyzing each section of the architecture, we can have a much better understanding of how these new technologies can be used to improve the business.

Supply Chain:

A. Software Architectures: Through an API-based architecture, the supply chain can easily communicate to any point of the architecture creating multiple possibilities.

B. Cloud Computing: A Cloud-based supply chain, offers high scalability, and computing power, enabling real-time tracking and analytics.

C. Big Data: Inventory optimization, forecast demand, and ensure that products are delivered on time and in the most cost-effective manner are some of the applications that Big Data can have at this stage.

D. Artificial Intelligence: AI can automate processes, keep track of the storage through image recognition. When combined with robotics, AI can handle material (ex: loading and unloading)

E. Generative Artificial Intelligence: This can be an extremely helpful tool for supply chain management.

F. Metaverse:

- Artificial Reality can be used by workers to know relevant information in real-time. This information can be both macro and micro level (ex: in's/outs of the warehouse; when is this package going to be shipped)

- Virtual Reality enables virtual training and simulation of supply chain processes.

G. Blockchain: Blockchain ensures transparency and traceability in the supply chain.

H. Customer Data Platform: With the access to customer behavior, product demand, when integrated with CDP, supply chain systems become more responsive.

Headless Commerce:

A. Software Architectures: The separation of front-end from back end enables flexibility across multiple channels.

B. Cloud Computing: Hosting headless commerce in the cloud allows business to be scalable, having global reach to any front-end.

G. Blockchain: Ensures secure and transparent transactions, protecting customer data and streamlining payments.

The usage of Headless commerce enables a world of possibilities, especially when using BD, AI, GAI, MV and CDP.

Touch Points: (1º time user; Tailoring user's needs based on similar needs or behavior)

A. Software Architectures: An API-based architecture can handle more than one dataflow from multiple touchpoints enabling real-time updates.

B. Cloud Computing: Cloud services can support both online and offline touchpoints, making it a great tool for omnichannel interaction.

C. Big Data: Can be used to analyze user behavior, comparing it to other customers to find out what are the user's needs and preferences, optimizing touchpoint performance.

D. Artificial Intelligence: AI can be used on both Online and Offline Touchpoints, but for a first interaction the main uses should be as a support using chatbots and virtual assistants to find out, what are the customer needs.

E. Generative Artificial Intelligence: GAI can provide the customer with full details on products and their availability, it can also recommend similar products or cross sell products that go along with the product that is being shown.

F. Metaverse: Creation of new shopping and social experiences with the brand.

Both Artificial Reality and Virtual Reality have multiple applications, the only difference is that one is based on the real world and the other is on a virtual one. It is possible to look and interact with the products from all angles, have all its information, if it is the best option for the customer, it can also recommend and cross sell other products.

G. Blockchain: The Customer can easily know where the product passed, from the exploration of the materials to the user.

H. Customer Data Platform: Based on other user's profile, tries to tailor new user behavior and needs

Customer Data:

A. Software Architectures: Due to being able to handle more than one dataflow an API-based architecture also enables effective data wrangling, cleaning, and integration as it is sent by batches.

B. Cloud Computing: Provides secure and scalable storage for substantial amounts of customer data.

C. Big Data: Fast cleaning and selection of multiple data sets from multiple touchpoints

D. Artificial Intelligence: AI can automate data cleaning processes ensuring high-quality customer data.

E. Generative Artificial Intelligence: Can fill in missing customer data, based on other alike creating a better profiling (this information would be adjusted based on user interaction).

F. Metaverse: Process AR/VR Data to enrich customer profiles.

G. Blockchain: When used on data, blockchain can ensure data integrity and security, making a record of customer interactions.

H. Customer Data Platform: Creates a 360º view of the customers by centralizing and organizing customer data from all sources.

Data Repositories:

A. Software Architectures: API architectures enable functions like real-time data processing and analytics, improving the overall experience of the user.

B. Cloud Computing: Provides secure and scalable storage for large amounts of customer data.

C. Big Data: Supports the storage and analysis of enormous amounts data, both daily and on real-time basis.

G. Blockchain: Blockchain can ensure data integrity and security, making a record of customer interactions.

AI Marketing:

A. Software Architectures: Data repositories can connect directly with Api's to AI marketing tools to optimize customer experience.

B. Cloud Computing: Cloud platforms offer solutions that allow scalability on marketing campaigns, when dealing with large volumes of data

C. Big Data: Big Data analytics can help identify both segment and target audiences by analyzing both customer behavior data.

D. Artificial Intelligence: AI marketing can easily optimize campaigns and personalize them to each customer, generating more engagement.

E. Generative Artificial Intelligence: Can generate dynamic content based on customer data.

F. Metaverse: Provides a new point of contact with the client enabling immersive and interactive campaigns.

H. Customer Data Platform: Provides a unified view of customer data, enabling an omnichannel analysis of the customer.

Touch Points: (1º/2º time user; Tailoring user's needs based previous interactions)

C. Big Data: Helps by personalizing shopping experiences by making analysis based on customer journeys and interactions across various touchpoints.

D. Artificial Intelligence: When Using AI for chatbots, personalized recommendations, and real-time support both customer interaction and conversions become easier.

E. Generative Artificial Intelligence: Generation of content tailored specifically to a certain user or device.

F. Metaverse: Introduces new touchpoints into play, by adding new realities, one that complements physical space, and another that uses virtual space.

H. Customer Data Platform: All touchpoints are able read a user "file" from this unified view with all the information on that user, making it possible to approach the client more effectively.

4.3. USE CASE

This subchapter will illustrate the use of the artifact presented in the previous section. As a real case will not be possible to demonstrate due to the complexity of the implementation of all these technologies and lack of resources, to demonstrate the applicability of the artifact, a fictional case is described.

Due to being a fictitious case, and an application of an architecture to specific business, some technologies, might not be implemented.

However, taking the design science research approach in mind, this fictional case should be viewed as an initial test to the artifact's applicability, which can be tested later in real-world case study in future research. Furthermore, the expert interviews that will be conducted will help to confirm the artifact's overall validity.

Fictional Example of Coffee Company.

"**The Coffee Company**" is a coffee company nationally recognized for its high quality, it sells coffee for both business-to-business and business-to-consumer. Physically, it operates 2 factories, has a few warehouses and some stores spread across the country. Digitally, it has an e-commerce website and it is active in the digital environment through social media.

With the covid crisis and the e-commerce boom that came with it, and the new emerging technologies, the managers started to see their competitors adopting innovative

technologies, realizing that there is an immense potential on a digital actualization of the business.

To help them make this digital actualization, they hired an IT agency,

Step 1: Diagnosis

After doing a diagnosis on the tools that were used, the following was found:

1. Each environment (warehouse, shop, website) would operate by itself, having only reactive connections between each other
2. Each environment had different systems
3. The stores could only read/write transactional data about the customer
4. Website only provided basic data about the customer
5. Website had no real interaction with the customer (only the customer had interactions with the website)
6. Marketing campaigns were not dynamic

To sum up, there was not a clear technological business model, as such, only essential data was collected.

Step 2: Technological Business Model Definition

Objectives:

- Value Creation
- Process optimization.

For this digital actualization, they used the artifact presented in this thesis. This implementation will have flexibility, scalability and computational power as its pillars.

Step 3: Technological Implementation

Firstly, we need to have a single source of truth of business-related data (product, customer details, orders, content) this being “headless commerce.”

This single source of truth when connected to website, store and warehouse systems will allow a quicker flow of information in any part of the architecture. This headless option allows a greater customization of a platform with multiple sources of data, making it the perfect solution for each environment.

Secondly, we need to create data warehouses and customer data platforms to receive and send information both from the business and from the client for the different touchpoints

After having all this implemented, we can start thinking about enabling Big Data analysis, Artificial Intelligence and Generative AI. This can be done easily due to being cloud based, as the resources are already available in the cloud environment. When connecting these technologies with headless commerce, we can enable effectiveness, engagement and optimization in the different touchpoints.

When the basis of the architecture is implemented, can tools like AR and VR be considered. These touchpoints should also have connections with headless commerce, CDP, Big Data, Artificial Intelligence and Generative AI.

Blockchain technology must be implemented when tracking both customer data, product data, and order related data ensuring Integrity, security, transparency and traceability at all moments.

Step 4: Implementation impact on Business

Supply Chain (start):

- By having a supply management system combined with Big Data there would be used for inventory optimization, forecast demand, and ensure that products are delivered on time and in the most cost-effective manner.
- Artificial Intelligence will be used to keep track of the storage through image recognition. Create a model for process mining where the AI can evaluate the current processes and show how they can be more efficient.
- Generative Artificial Intelligence would have access to all information regarding warehouse operations, so that it can generate information on multiple endpoints (operations or management). This some endpoints would have permissions to execute actions on the business (ex: send emails, enable/disable operations)
- Blockchain would be used at this stage to keep track of the product, what processes did it suffered, where, by whom and how it came to the current phase.
- With the usage Artificial Reality combined with the supply management system, workers can have relevant information on real-time on in’s/outs of the warehouse or even have detailed information on a certain package.

Touch Points:

The main pillars in all touchpoints for this implementation are headless commerce, Big Data, AI and CDP, these contain all info of the product and user that can be processed in real-time for user impact later for other purposes.

In this case VR will be treated only as a touchpoint and AR as a tool that assists a touch point

(1º Interaction):

Stores | Digital Touch Points:

- Big Data would analyze user behavior, comparing it to other customers to find out what are the user's needs and preferences. This approach would help on the conversion (notoriety, follow-up or even a purchase)
    - Store: Through video processing behavior analysis, we could gather information such as, this type of person generally prefers this type of product and often buys with this product. With the support of the store employees, who would have a screen with this information about each user, they would approach the customer with much more information.

    - Site: Appearance of pop-ups with products similar to those viewed, from the viewed category, or related products.

- Generative Artificial Intelligence: GAI can provide the customer with full details on products and their availability, it can also recommend similar products or cross sell products that go along with the product that is being shown (in the case of a store, this would happen with the access of an AR device or “The coffee company” mobile’s application)
- Blockchain would be used at this stage to keep track of customer and order data.

Stores:

- Big Data would be used for inventory optimization and forecast demand.

Digital Touch Points:

- The creation of a Virtual Reality environment would enable the user to interact with the brand. These interactions can be by purchasing, or even interacting with the product in the distinct phases of product making.
- Generative AI would oversee chatbots and prompt searches.

(2º Interaction):

The 2 interaction has the same benefits as the 1ºst one, although, with the usage of a

CDP we can tailor personalized experiences based on user's profile.

Stores | Digital Touch Points:

- Big Data analytics can help identify both segments and target audiences by analyzing both customer behavior data.
- As we have seen in the supply chain, Artificial Intelligence would create a model for process mining where the AI can evaluate the customer journey and find out what is the next step that it should be made to improve conversion.
- Customer Data Platform allows all touchpoints to read/write a user "file" from this unified view with all the information on that user, making it possible to approach the client more effectively.

Digital Touch Points:

- With the help of CDP, AI and Headless commerce, we can design these touchpoints according to the user's preferences as soon as he enters.
- AI marketing can easily optimize campaigns and personalize them to each customer, generating more engagement and higher conversion.
- Generative Artificial Intelligence: Can generate dynamic content based on customer data.

Implementing the architecture will generate a lot of data, requiring business to have a an high level of digital maturity for a successful implementation,

4.4. Results and Discussion

Three experts from diverse backgrounds and of different occupations were interviewed to evaluate the proposed architecture. These interviews were structured in their nature.

All the experts in these interviews work closely with e-commerce. One expert works as Head of Data, the second one as a Senior Digital Analytics Consultant and the last one, was an Analytics and Strategy Manager.

Table 4.4 gives a brief overview of the background of each participant, both on an academic and work point of view. By selecting experts in the area, we can validate the suggested architecture by including their perspectives. This qualitative approach intends to complement the scientific research that has been developed so far and fill eventual gaps in the architecture that is being presented.

Table 4. 4 – Participants of the expert interviews

Expert	Backgound	Domain
E1	Bachelor's degree in Informatics Engineering; Currently working as Head of Data on a Retail Business	Industry
E2	Master's degree in Data Science Engineering; Currently working as Senior Digital Analytics Consultant	IT Consulting
E3	Bachelor's degree in Business Administration and Management; Currently working as Analytics and Strategy Manager on a Retail Business	Industry

These Interviews were conducted with each expert individually in July 2024 using Microsoft Teams.

Each participant agreed to be recorded so that the interview could be transcribed. They also agreed on the usage of these interviews for this master's thesis (Appendix B until Appendix D)

During the interviews, there were four questions that were made to each participant, those were:

Q1: Do you consider the proposed architecture as useful? Yes or No? and Why?

Q2: Do you have any criticism towards the proposed architecture? It can be both positive and negative.

Q3: Would you consider implementing the proposed architecture? why/ why not?

Q4: Do you have any recommendation or suggestions for further improvements of the proposed architecture?

The questions provided helped to guide and motivate experts to evaluate the architecture critically.

Overall, the proposed architecture was considered useful by all experts.

Expert 1 points out that the centralization of data from various touchpoints, supply chain and physical store generates information that can be used by a CDP, machine learning algorithms for decision making and analysis. For Expert 2 the architecture is useful due to addressing retail challenges such as logistics integration, stock updates, and trend analysis. It provides an holistic view of the business and supports real-time insights.

Expert 3 says that the architecture is well thought out and that it covers all touchpoints throughout the customer journey.

As for criticism, expert 1 and 3 share concerns about real-time information flow, arguing that it is a difficult to archive stock in real time (expert 3) and that to impact customers in real time we need both fast processes of data cleaning and a quick flow of that info on the various stages (expert 1)

Experts 1 and 2 also share concerns about the usage of the architecture due to digital maturity and investment capabilities.

Expert 3 says that the stock and warehouse management aspects need more elaboration.

When asked about if they would recommend the implementation all the experts say that they would, expert 1 said that the architecture is like the one he is implementing in its company, expert 2 highlights the reduce of human error and real-time access to information. Expert 3 points out that architecture keeps information always updated, impacting the value chain positively.

Finally, on the last question, the answers were divergent, expert 1 says that the architecture should be able to deal not only with API's but also with files, because when dealing with other businesses that do not have API's, the architecture must be able to integrate that information too. For expert 2 there are no recommendations to be made, just add-ons to make the architecture better.

Expert 3 affirms that there should be use cases that would help to demonstrate the architecture, and that the part of the supply chain needs to have additional work.

4.5. Revised Architecture

Considering all the recommendations and criticisms made by the experts, the architecture presented initially is now updated.

This new architecture deals with some of the problems that were presented by experts.

Regarding real-time and the concerns that were presented by the experts, after pondering about them, the architecture was redesigned on the connections that exist between headless commerce, touchpoints, supply chain and data warehouse. In this new architecture touchpoints and warehouses do not send information directly to the headless commerce, every information is sent to the data warehouse.

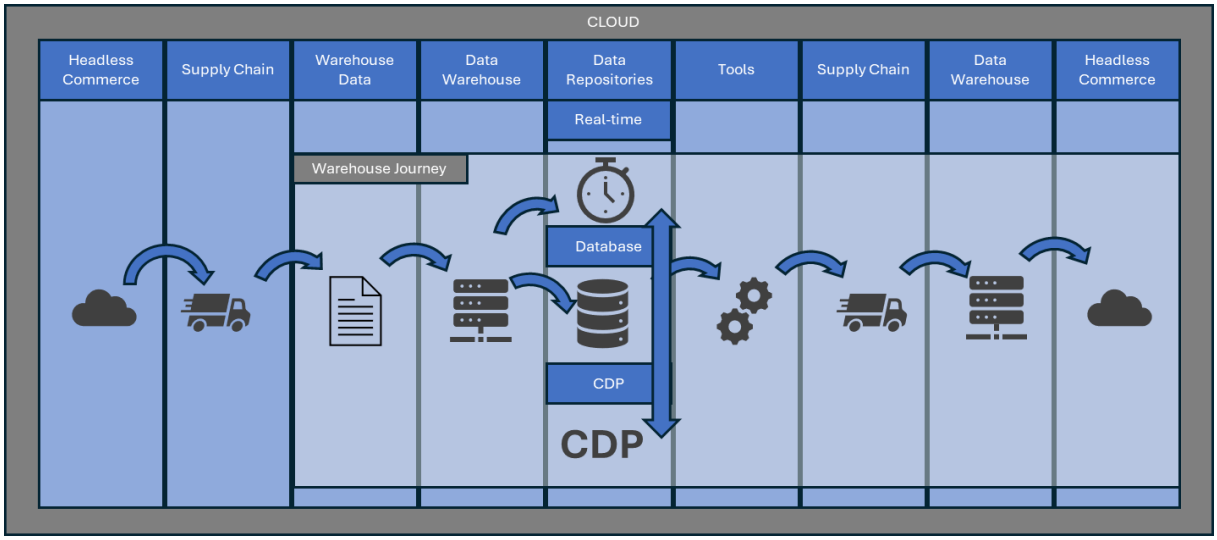

Figure 4. 3 – Revised E-commerce Warehouse Architecture (own Illustration)

Once the data is integrated in the data warehouse, depending on its kind, its cleaned and then sent to headless commerce, or other repositories (database, real-time database, CDP). This way, there is only one source that is sending data to the headless commerce, this data would be sent in batches of short time between each other.

By doing this, the systems are not overloaded with operations and data is cleaned quicker.

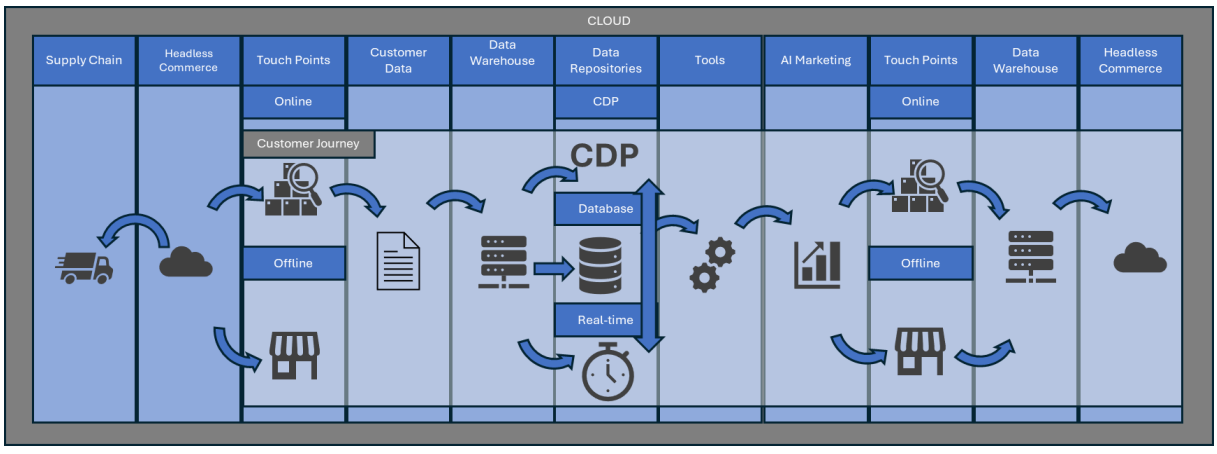

Figure 4. 4 – Revised E-commerce Customer Architecture (own Illustration)

Expert 1 pointed out two problems with the architecture, A CDP must be able to connect to a touchpoint directly, to impact the customer on a simpler form, for example the subscription of a newsletter generates a discount code that is sent to the user immediately by email.

To address the second problem of being an API architecture, the connection between data warehouse and headless commerce was created. The structure is still API based but has the possibility of integrating new types of dataflows into the architecture.

In image 4.5 we can see the fully revised architecture with all the changes proposed by the experts. This architecture is now stronger.

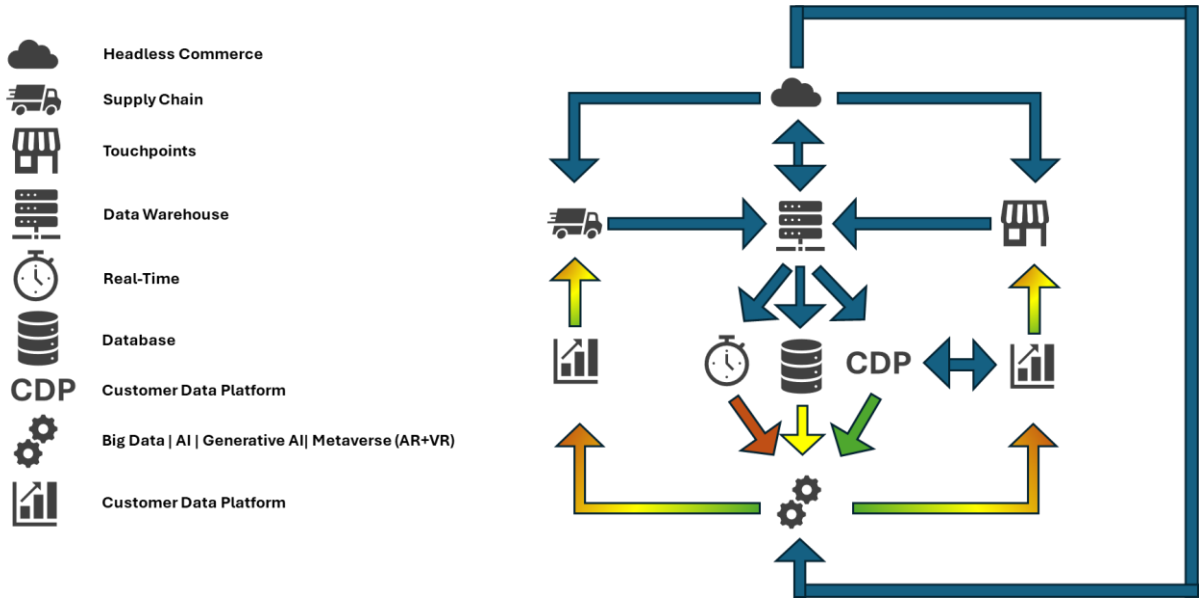

Figure 4. 5– Revised E-commerce Architecture (own Illustration)

5. CONCLUSIONS AND FUTURE WORK

5.1. SYNTHESIS OF THE DEVELOPED WORK

To archive the resulting architecture, there were multiple steps that needed to be taken. To validate this architecture, there was conducted a literature review, a case study, and expert interviews.

Firstly, it was identified what were the problems with the current approaches that were being used. Once those were defined, a goal was set (develop a new e-commerce architecture where businesses can easily reach customers in a more flexible and effective way, using the newest technologies available).

As this was a complex and broad goal, a set of objectives was defined to archive it, (Framework the e-commerce problematic; Study the current available technologies; Propose a new e-commerce architecture; Build a use case; Validate the architecture by conducting expert interviews).

To establish a knowledge basis on the status of e-commerce and its heading, a literature review was conducted. This literature review is composed of four main sections, concepts, an overview of e-commerce, the technologies that are being used and the technologies that are emerging into the field.

Apon extracting the main literature findings, these were used to create and propose a new architecture. This architecture was then used to create a use case for a fictitious company.

To validate qualitatively the architecture and its applicability in the use case, interviews were conducted with experts that work closely with the field of e-commerce. The criticism and the recommendations that were given were very important and were taken into account to improve the architecture, making it more robust.

By completing the objectives that were defined on the start of the research, the goal of developing a new e-commerce architecture where businesses can easily reach customers in a more flexible and effective way, using the newest technologies available was reached.

5.2. LIMITATIONS

One limitation that this paper faces is that only companies that have high investment available can make this kind of architecture. These limitations are partially true, although the architecture can also be seen as a road map, as said before, businesses are extraordinarily complex and each one has its uniqueness, as such, businesses can implement different parts of the architecture depending on their needs.

Two other limitations are the reduced focus on detail in the architecture and the lack of connections to other parts of a business. This high-level approach is intended to capture a holistic vision. Only by using this approach is it possible to create an architecture that can be pondered by any e-commerce business, if it were in more detail, it would limit the architecture to only a few businesses.

Finally, as the architecture was not implemented due to lack of time and resources, another limitation arises as it is not fully validated. Although, to address this problem, we have interviews that were conducted with experts that work closely with the field. The criticism and recommendations made by the experts allowed the update of architecture, making it a more reliable solution.

5.3. FUTURE WORK

Based on the limitations identified in this study, there is some work that still needs to be done.

Firstly, regarding the implementation itself, it should be tested and reevaluated again to see its viability. This test would define it the use architecture is in fact useful and better than a monolithic one,

If high investment is a problem, the business in question must make cost-benefit analysis, and strategic plan. Using the resources that are available based that analysis and on how much they are willing to spend, this can be by removing features or changing tools.

When doing the implementation there could be a demand to connect to other parts/solutions of the business. This should be done to test if the data flow of the architecture has no issues when integrating the business. Before this connection to other parts of the business, the architecture must gain more detail on how each component of the architecture works and is adapted to each business.

The field of e-commerce is in constant change, as such, the literature review must always be in a state of the art to respond quickly to these changes.

By addressing the issues presented in this section, the proposed e-commerce architecture can become more robust, practicable, providing businesses with a flexible and effective architecture for reaching customers and optimizing operations.

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APPENDIXES

APPENDIX A

Note: Due to all the experts being Portuguese, the interviews were fully conducted in Portuguese. This transacript was used as the start of all interviews.

Interview transcript for all interviews

Interviewer: A minha tese é sobre E-commerce e tem como objetivo transformar uma arquitetura com as tecnologias disponíveis na atualidade.

Esta tese de mestrado surgiu como uma forma de combater problemas e-commerce atuais, sendo estes: Arquiteturas monolíticas (rígidas e sem capacidade de flexibilidade), o rápido avanço tecnológico, a necessidade de personalização por parte do consumidor e a necessidade de tomada de decisão com base dados em todos os momentos.

Apos uma análise ao estado atual do e-commerce, às tecnologias atuais e emergentes, cheguei a uma arquitetura, esta foi montada com o objetivo de criar valor ao consumidor e automatizar processos.

Para começar, a arquitetura definida é API e Cloud Based de forma a permitir grande flexibilidade, escalabilidade e fácil conexão por parte de todos os seus elementos.

Esta arquitetura é uma arquitetura geral, como cada negócio é bastante complexo e cada um tem a sua realidade, esta terá de ser adaptada posteriormente a estes.

A arquitetura começa com a necessidade de ter tanto a parte de supply chain (armazenamento) como touchpoints físicos e digitais ligados por uma "single source of truth".

Esta "single source of truth" seria um headless commerce que teria dados de produto, cliente, encomendas e conteúdo, permitindo assim um flow de informação, mais rápido e a fácil adaptação em todos os ambientes tecnológicos.

De seguida seria necessário criar um data warehouse onde seriam enviados todos os dados tanto de cliente como de armazém. Estes dados seriam tratados e posteriormente enviados para uma base de dados, CDP ou então para um repositório de dados real-time.

Existe esta divisão de repositórios surge pela necessidade de fazer analises diferentes com scopes diferentes.

Base de dados, para fazer analises que requerem maior processamento.

CDP para analises relacionadas como o cliente, real-time como forma de atuação imediata. Estes dois repositórios serviram para impactar tanto o cliente, como no negócio em real-time ou numa fase posterior.

Para finalizar a arquitetura geral, acabamos com o tracking do status da encomenda, que faz feed em headless commerce.

Passando agora para um caso de uso fictício, “The Coffee Company” é uma empresa de café nacionalmente reconhecida pela sua qualidade, esta opera tanto fisicamente (armazéns, lojas) como digitalmente (site,app, blogs, redes sociais)

Com a arquitetura definida anteriormente em mente, chega a fase da aplicação ferramentas e estratégias ao negocio.

Uma arquitetura de e-commerce cloud based garante uma maior facilidade de implementação de tecnologias como Big Data, Artificial Intelligence, Generative AI, Metaverse (artificial reality e virtual reality) e mesmo Bockchain, criando assim como limite de soluções a imaginação, a capacidade de investimento da empresa e a sua maturidade digital.

Em armazem estas tecnologias podem ser utilizadas para:

- Supply Management System quando combinado com Big Data: otimização do inventário, previsão de procura e garantia de entrega a tempo e da forma mais eficiente.
- Artificial Intelligence: monitorizar o armazenamento através de reconhecimento de imagem. Criar um modelo de process mining onde a AI avalia os processos atuais e mostrar como estes se podem tornar mais eficientes
- Generative Artificial Intelligence: teria acesso a todas as informações sobre operações de armazém, para que se possa gerar informações em múltiplos touchpoints do armazém (operações ou gestão). Alguns desses touchpoints teriam permissões para executar ações no negócio dependendo do nível de acesso do utilizador.
- Blockchain: Como forma de acompanhar o produto nas suas diferentes fases, quais processos sofreu, onde, por quem e como chegou à fase atual.
- Artificial Reality: quando juntada com o supply management system, os trabalhadores podem ter informações relevantes em tempo real sobre entradas/saídas do armazém ou até mesmo obter informações detalhadas sobre determinado pacote.

Nos diferentes touchpoints estas tecnologias podem ter aplicabilidades mútuas ou completamente distintas. Para 1º interação considero crucial a aplicação das seguintes tecnologias tendo em conta que estas teriam como base um conceito lookalike a outros utilizadores.

Mutuas:

Big Data: analise do comportamento do utilizador, comparando-o com outros clientes para descobrir quais são as necessidades e preferências destes. Esta abordagem ajudaria depois na conversão sendo conversão tanto notoriedade como um follow up ou até uma compra.

No site: Aparecimento de um pop-up com produtos parecidos aos vistos ou da categoria vista ou produtos similares

Na loja: Através da analise de processamento de vídeo do comportamento conseguíamos informações do tipo, este tipo de pessoas geralmente prefere este tipo de produto e compra bastante com este produto. Com apoio dos funcionarios da loja que teriam um ecrã com esta informação sobre cada utilizador, estes abordariam o cliente com bastante mais informação.

Inteligência Artificial Generativa: Forneceria ao cliente todos os detalhes sobre produtos, a sua disponibilidade e também poderia recomendar produtos semelhantes ou vender produtos cruzados que acompanhem o produto que está a ser mostrado.

Lojas:

Já nas lojas seria aplicado Big Data como forma de otimização de inventário, previsão de procura.

Pontos digitais:

Nos pontos de contato digitais já existira maiores possibilidade de aplicação de tecnologias.

A criação de um ambiente de Virtual Reality permitiria ao utilizador interagir com a marca nas diferentes fases de produção e venda.

Generative AI: supervisionaria chatbots e pesquisas sugeridas. Pode também ser implementada a utilização de um site "prompt" ou seja um site totalmente vazio onde este se modificaria com base as pesquisas que o utilizador fosse fazendo.

Quando existisse segunda interação com a marca, esta já seria capaz de implementar outras tecnologias, tais como:

Mutuas:

Big Data podem ajudar a identificar tanto o segmento quanto o público-alvo através da análise de dados de comportamento do cliente.

Tal como no armazém nos touchpoints também se criaria um modelo de process mining onde a Artificial Inteligence avaliaria a jornada do cliente e tentaria descobrir qual é o próximo passo a ser dado para melhorar a sua probabilidade de conversão.

Pontos de Contato Digitais:

Com a utilização do CDP, Artificial Inteligence e headless commerce seria possível desenhar o site de acordo com as preferências dos utilizadores assim que eles entrarem nestes. Com cada interação este seria cada vez mais personalizado. Permitiria também a recomendação de produtos, cross seling e upselling.

Através de Artificial Intelingence Marketing pode facilmente criar e otimizar campanhas nos mais variados formatos e personalizá-las para cada cliente, gerando mais engagement e maior conversão. A personalização pode ser a vários níveis, sendo um destes por exemplo a localização, que caso o utilizador está perto de uma loja, seria remetido para esta.

Generative Artificial Inteligence: Geraria conteúdo dinâmico com base nos dados dos clientes, sendo este conteúdo desde descrições até criação de recomendações com base as preferências do consumidor (ex: eu gosto de um café com corpo denso e com sabor intenso, este poderia sugerir apenas um café ou então um mix de cafés que traria esse resultado.)

APPENDIX B

Notes: Due to the expert being Portuguese, the interview was fully conducted in Portuguese.

As it was a structured interview and the experts would only answer to questions on the end of the presentation, the presentation is on appendix A and referenced in this appendix

Interview 1 Transcript, Interview Date: July 04, 2024

Interviewer: Concorda com a gravação e a utilização desta gravação para o desenvolvimento da minha tese de mestrado?

Expert 1: Sim, sim

Interviewer: APPENDIX A

Interviewer: Considera a arquitetura proposta útil, sim/não, porque sim/não?

Expert 1: Sim, é útil, toda a informação que advém de vários touchspoints, suply chain e lojas físicas é centralizada num único data warehouse que depois disponibiliza informação para um CDP ou para algoritmos do machine learning, estes depois podem ser utilizados para ativar determinados casos de uso e que podem servir também para análises e tomada de decisões. Por mim está OK, é o caminho normal, digamos assim, de uma arquitetura generalizada para cada empresa. Não identificando aqui que tipo de cloud, que tipo de algoritmo, que tipo de CDP, que tipo de casos de uso aplicar.

Interviewer: Tem alguma crítica em relação à arquitetura proposta? Pode ser crítica positiva ou negativa.

Expert 1: O real time pode estar embutido no CDP, ou seja, a tua seta poderia não só, ou seja, da parte do real time, poderia não só ir para baixo, mas também para o lado. Muitas vezes o que fazes é , determinados dados ou determinados eventos do site estão a cair em real time dentro do CDP, há dados que não precisa de real time para ir segmentando os clientes, mas há outros que sim, porque depois, dependendo do CDP, que escolhas tu queres ativar a segmentação de clientes em algum sítio. Se tu quiseres ativar a segmentação de clientes dentro do teu site enquanto a pessoa está a navegar, tu podes fazê-lo em real time dentro do próprio CDP. Portanto, é um requisito ter informação em real time dentro do CDP ligando este diretamente ao touchpoint.

Existem também questões de balanceamento entre custo e a necessidade. Não vou por exemplo, investir numa arquitetura de metaverse que tenha que gastar 50000 EUR se eu no meu site vende 1000 EUR por mês, tudo o que tem que ser balanceado. Portanto, à medida que as empresas vão crescendo o seu nível de vendas e ao nível de clientes, quando começa a ter um crescimento bastante elevado, um volume de clientes muito grande e um volume de vendas muito grande aqui já começa a fazer sentido investir nestas tecnologias emergentes.

Implementar um modelo de ou algoritmos generativos custa bastante dinheiro, treinar o modelo custa mesmo muito dinheiro e não é qualquer empresa que o consegue fazer, que retorno é que eu vou ter sobre este processo? Ou seja, eu faturei 1000, mas isto custou me 500. Vale a pena? Qual é a minha margem? Se calhar não.

Interviewer: Aconselharia implementar a arquitetura proposta? Sim ou não? Porquê?

Expert 1: Sim, Aliás, a arquitetura proposta para a empresa onde estou é muito semelhante. Nós estamos a fazer a migração do data warehouse para cloud. Também consideramos que temos de ter ligação com o CDP que temos que ter sistemas em real time para produzir determinadas respostas a necessidades de negócio, portanto, isso tudo está a ser considerado mais ou menos nessa arquitetura que mostraste, ou seja, em termos de arquitetura a posição da arquitetura, é muito semelhante àquilo que estás a propor em termos generalizados.

Interviewer: Tem alguma recomendação ou sugestão para futuras melhorias da arquitetura ou proposta?

Expert 1: Sim, quando tens diferentes plataformas, diferentes sítios onde buscar os dados, muitas vezes essas plataformas ou esses locais ou essas empresas nem sempre têm informação disponibilizada via APIs. Então tens que ter flexibilidade suficiente de conseguir integrar a informação da forma como ela vem. OK, não quer dizer que essas empresas não têm que evoluir, mas nós temos que nos sujeitar em determinados monumentos à forma com que a informação vem desde origem, ou seja, se a origem não tiver API's temos que integrar de outras formas, seja pelos ficheiros, seja pelo que for.

APPENDIX C

Notes: Due to the expert being Portuguese, the interview was fully conducted in Portuguese.

As it was a structured interview and the experts would only answer to questions on the end of the presentation, the presentation is on appendix A and referenced in this appendix

Interview 2 Transcript, Interview Date: July 04, 2024

Interviewer: Concorda com a gravação e a utilização desta gravação para o desenvolvimento da minha tese de mestrado?

Expert 1: Claro que sim

Interviewer: APPENDIX A

Interviewer: Considera a arquitetura proposta útil, sim/não, porque sim/não?

Expert 2: Extremamente útil. Porquê? Porque hoje no retalho tens 3 grandes problemas, a ligação da parte logística à parte de vendas, a atualização de stocks e a parte logística ou de compras saber o que é que está a vender mais ao momento. Às vezes essa informação tem um atraso e não é dada com a velocidade necessária, e mesmo para a parte de compras que depois alimenta a parte de logística não sabes quais são as trends do mercado ou mesmo as trends da tua marca.

Depois tens essa ligação da parte digital com a parte de dados, a atualização de stocks na parte digital mais todos os insights que a parte digital fornece em termos de e user behaviour e tendências de mercado. Isto depois dá para fazeres forcast tanto a nível digital como físico quando também integrado com a cadeia logística em real time, como tu tens aí, eu acho que isso é o sonho de qualquer de qualquer retalhista. À parte disso, muito facilmente consegues ter uma visão holística de tudo o que se passa no teu negócio, do ponto a ao ponto ao ponto z. Consegues ver o que é que está a ser comprado, porque está a ser comprado, consegues através da blockchain, ter uma encriptação total de dados transacionais e dados de negócio que podem ir de A a Z sem qualquer data Loss, sem comprometer dados sensíveis, tanto pessoais dos teus utilizadores, como dados de faturação da empresa, que acabam por ser também sensíveis. Exemplificaste muitas possibilidades que isso tem, temos personalização de flows, marketing.

Interviewer: Tem alguma crítica em relação à arquitetura proposta? Pode ser crítica positiva ou negativa.

Expert 2: Eu acho que a arquitetura, a não ser que me esteja também a faltar alguma coisa, acho que a arquitetura correta estás a ligar todos os touchpoints, a cadência de informação é correta, a ligação de informação quem recebe e que dá também é correta. O que tu estás aqui a apresentar, abre te aqui 1000000 de possibilidades em tudo porque tu, a partir do momento

em que tenhas uma arquitetura destas, tu já tens as ligações feitas e sabendo que é completamente API based não tens aí qualquer tipo de bloqueio. As possibilidades são tão grandes que os únicos problemas que poderias ter eram relativos as empresas em si, a sua capacidade digital, maturidade e também a capacidade de investimento.

Interviewer: Aconselharia implementar a arquitetura proposta? Sim ou não? Porquê?

Expert 2: Completamente que sim, primeiro vais evitar o erro humano e a falta de comunicação e isso num negócio por muito digital que tu tenhas tudo o que tem parte humana está mais sujeito a erro, ao delay e depois um ser humano pode adoecer e não pode passar a informação, a máquina não, desde que tenha uma ligação. Não estou a dizer que ia demitir metade da empresa, obviamente que não, mas lá está para mim dava me uma garantia que conseguia ver mesmo um sábado ou um domingo, não precisava de chatear ninguém para ter acesso à informação ou para saber que as coisas estão a correr, Implementaria 100%.

Interviewer: Tem alguma recomendação ou sugestão para futuras melhorias da arquitetura ou proposta?

Expert 2: Eu não posso recomendar nada e todas as melhorias que eu posso sugerir não são melhorias, são Add-ons porque, como a tua arquitetura já parte da base sólida e completamente maleável, todo são add-ons ai, a partir do momento em que tenhas essa base de dados, basicamente só tens é que tratar e injetar dados. Todos os teus, os teus pontos de entrada, como end points de dados, tu consegues a partir dessa arquitetura base. Por isso não. Se fosse add-ons esta conversa ia ser diferente, íamos almoçar e jantar e ainda estávamos a falar de possibilidades.

APPENDIX D

Notes: Due to the expert being Portuguese, the interview was fully conducted in Portuguese.

As it was a structured interview and the experts would only answer to questions on the end of the presentation, the presentation is on appendix A and referenced in this appendix

Interview 3 Transcript, Interview Date: July 04, 2024

Interviewer: Concorda com a gravação e a utilização desta gravação para o desenvolvimento da minha tese de mestrado?

Expert 1: Sim, claro

Interviewer: APPENDIX A

Interviewer: Considera a arquitetura proposta útil, sim/não, porque sim/não?

Expert 3: Não há como não. Obviamente que sim. Útil, de forma genérica, bem pensada, pensada bem nos touchpoints, em todos os pontos de toda a jornada do produto e do cliente. Portanto, sem dúvida alguma, parece me muito útil.

Permite ter informação toda interligada, desde a origem até à entrega, mas também guarda e utiliza toda a jornada ao longo da vida útil do cliente. Através disso consegues otimizar a jornada, ligando toda a informação e tornando todo o processo produtivo o mais eficiente possível depois toda a interação com o cliente. É uma experiência tal como se quer, portanto, consegues ter informação personalizada

Interviewer: Tem alguma crítica em relação à arquitetura proposta? Pode ser crítica positiva ou negativa.

Expert 3: A única coisa que eu acho é que toda a parte de Stock e de Armazém tem que ser um bocadinho mais elaborada ou mais bem pensada. Acho que pode faltar uma parte de visualização física de como é que funciona o procedimento de um Armazém.

A gestão de stock em real time interligado em todas as todas os partes do mundo, em todas as localizações. É um tema difícil, ou seja, tu podes fazer com stock de segurança e prioridades, mas mesmo assim é muito difícil teres o Stock sempre 100% real. Com tantos touchpoints em real time, se esta informação falhar num deles é um problema muito grande. Mas acho que está acho que a arquitetura está bem pensada.

Interviewer: Aconselharia implementar a arquitetura proposta? Sim ou não? Porquê?

Expert 3: Como não? Permite-nos ter informação para todos os intervenientes da equação, seja de produto, seja de cliente 100% atualizada e que o impacto seja o melhor possível na cadeia de valor da empresa.

Interviewer: Tem alguma recomendação ou sugestão para futuras melhorias da arquitetura ou proposta?

Expert 3: Use cases, exemplos práticos, mais exemplos práticos que ajudem a demonstrar a casuística. Já me foste falando de vários, no entanto tenta desenhar a journey dos use cases que falaste e pensar na parte visual de ligação com o Armazém. Acho que na parte de online e de cliente tem essa coisa muito, muito melhor oleado, na parte de armazém nem tanto. E acho que aquilo que te iria ajudar a olear melhor era visualmente veres como é que funciona o processo do armazém.

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