Leveraging Enterprise Architecture to Address Big Data Analytics Challenges in the Retail Industry

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Abstract

Big Data Analytics (BDA) has become a trend in recent years, and with the fast-changing capabilities of the retail industry, it can unlock great potential for organisations. However, this comes with its challenges. Based on literature review, this paper focuses on challenges related to technological, organisational, and human aspects that traditional retailers encounter when implementing BDA including privacy and security, data processing, data quality, lack of strategy, and lack of skills. To address these challenges, the paper explores the adoption of Enterprise Architecture (EA) Frameworks, particularly The Open Group Architecture Framework (TOGAF) and Zachman Framework (ZF), further enhancing these using the case of Walmart. The result of TOGAF can provide a sense of guideline and minimise technological and organisational challenges, while ZF partially yields a coherent and practical approach to be applied.

1. Introduction

Companies are reported to spend more than 10% of their IT budget on data alone and are undergoing a revolution by leveraging BDA. Diverse data of all types are generated at an unprecedented rate, which is known as big data. BDA refers to a collection of analytic techniques and technologies which have been specifically designed to analyse big data. BDA helps companies with their decision making, process improvements, and business outcomes (Grover et al., 2018).

The retail industry is known for its diversity and includes a wide range of businesses, products, and services. The industry's spectrum can range from large department stores, to supermarkets, to online retailers, and more. In this paper, retail refers to large traditional stores, like Walmart. When companies in this sector have a big network of stores located at different geographic locations, where they do not fully understand customer needs and market potentials, BDA is used to analyse datasets, product insights, and to gain competitive edge. For example, datasets can be used to forecast sales, and companies can deploy appropriate strategies to optimise operations and maximise sales (Singh et al., 2017).

As BDA is becoming a trend, companies are looking to invest in this approach. However, Gartner estimated that around 85% of big data projects fail to generate value (Avidon, 2021). Hence, this paper aims to provide guidance to retailers to improve the success rates of BDA implementations and explore the question "How large traditional retail companies can use EA frameworks to address the challenges in BDA?". EA is a collection of organisational documents describing various aspects of an organisation from an integrated business and IT perspective. EA intends to bridge the communication gap between business and IT stakeholders, and facilitate information systems planning (Kotusev et al., 2020).

This paper will first discuss the key challenges of retailers that were identified and assessed through a literature review. Two EA frameworks, TOGAF and ZF, were explored to assess whether these are suitable to address the

challenges. A case study was also performed to analyse how Walmart, one of the world's largest retail companies, uses BDA to overcome challenges.

2.   Literature Review

Our literature review identified various challenges in retail that were classified in two major categories: technological and organisational & human. These were further divided into subgroups as discussed in the following sections.

2.1.   Technological

2.1.1.   Privacy and Security

Big data poses significant privacy and security risks while analysing enormous volumes of customer data (e.g. fraudulent services and data theft to gain insights into customer behaviour, tastes, and trends (Le & Liaw, 2017). According to PwC, 89% of consumers are concerned about personal data, prioritising data privacy and security in the retail industry (Power & Guinto, 2014). Hence, data privacy must be prioritised to ensure customer information is collected and processed in both a transparent and an ethical manner. As a result, retailers are required to collect and process the data in compliance with industry standards and regulations, which protects customer data from unauthorised access (Aktas & Meng, 2017).

2.1.2.   Data Processing

Data integration refers to the process of combining data from multiple sources in a unified manner. Within the retail industry, data is generated in numerous ways, like point-of-sale systems, customer relationship management systems, and inventory management systems (Aktas & Meng, 2017). This results in the generation of different formats (CSV, JSON, or XML), structure (unstructured or semi-structured), and levels of granularity (store level or product level data), posing a big challenge in the accuracy of insights (Akter & Wamba, 2016).

Data volume is the quantity of data that needs to be stored and analysed. In the retail industry, data is increasing exponentially, ranging from a few dozen terabytes to petabytes in a single dataset (Elgendy & Elragal, 2014). As the volume increases, so does the complexity to store, process, and analyse data efficiently (Ying et al., 2020). This needs to be addressed because working with large data volumes can be time-consuming and resource intensive, thus retailers need to invest in resources and infrastructure to ensure scalability as data grows, which in turn gains relevant and accurate insights in a timely manner (Ridge et al., 2015).

2.1.3.   Data Quality

Data availability is known as having continuous accessibility to necessary and required data, such as proprietary data (e.g. business interactions) and externally obtained data (e.g. social media) (Ramadan et al., 2020). This becomes important in retail to generate insights for research & development, business operations, and proper coordination throughout the supply chain (Silva et al., 2019). For example, in the UK retail industry, product data are inconsistent in 80% of instances, which negatively affects its operations (Aktas & Meng, 2017).

Data veracity implies the accuracy, truthfulness, and reliability of the data from various sources (Ying et al., 2020). It becomes vital in retail because, despite going through data selection and transformation processes, it is still prone to errors, inaccuracies, and redundancies, which affects business decisions (Ridge et al., 2015). Moreover, data may not be integrated easily into specific categories, making it difficult to derive insights and identify patterns (Ying et al., 2020). This hinders BDA's value, as insights generated to set dynamic prices, personalised offers, etc. is only as good as the data it is based on.

2.2. Organisational

2.2.1. Lack of Strategy

Large investments are required by organisations when implementing new technologies to utilise BDA, as they cannot store and analyse big data with legacy systems (Morimura & Sakagawa, 2022). An effective strategy guides an organisation to allocate resources and select appropriate technologies relative to the specific needs in BDA. However, investing alone does not guarantee success. Strategy identifies business opportunities that can be addressed by BDA. Its pre-defined purpose connecting the interests of different stakeholders is needed to realise competitive advantages from BDA. You must define its explicit purposes, and success goals (Morimura & Sakagawa, 2022). In the retail industry, a strategy should include possible insights (e.g. consumer trends and behaviours derived by BDA) to meet business goals.

2.2.2. Lack of Skills

Inadequate skills is becoming an ongoing concern when implementing and investing in BDA technologies, as scarcity of talent that can make use of the data to describe, prescribe, predict, and diagnose situations is increasing. As data becomes more integrated, it's harder to find the right people to analyse results and develop insights (Aktas & Meng, 2017). BDA requires two types of skills: technical and managerial (Morimura & Sakagawa, 2022). Technical skills means to identify problems, understand patterns, assess implications, and then develop and test the hypotheses (Aktas & Meng, 2017). Managerial skills are being able to increase the willingness within the organisation and to communicate in the language of business (Akter & Wamba, 2016). In retail, these skills become significant as they can be used in marketing tactics, decision making processes, process refinement, supply chain management and more (Akter & Wamba, 2016).

3. Addressing Challenges Using TOGAF and Zachman Framework

This section explains how EA addresses the above-mentioned challenges in the retail industry. While there are various EA frameworks, TOGAF and ZF were selected because both are the most widely accepted and applied frameworks in the industry (Kotusev, 2021).

3.1. TOGAF

TOGAF is a methodology for designing, managing, and aligning an organisation's IT infrastructure and operations (Carr & Else, 2018). TOGAF has four architectural domains as follows: business, data, applications, and technologies. Further, it is divided into independent parts, such as the Architecture Development Method (ADM). The ADM provides a tested and iterative process for developing architectures, as shown in Figure 1 (The Open Group, 2022). In the retail industry, it offers customised and comprehensive approaches that will enable retailers to cope with the complexity of BDA while aligning their technology infrastructure with their business goals (The Open Group, 2022).
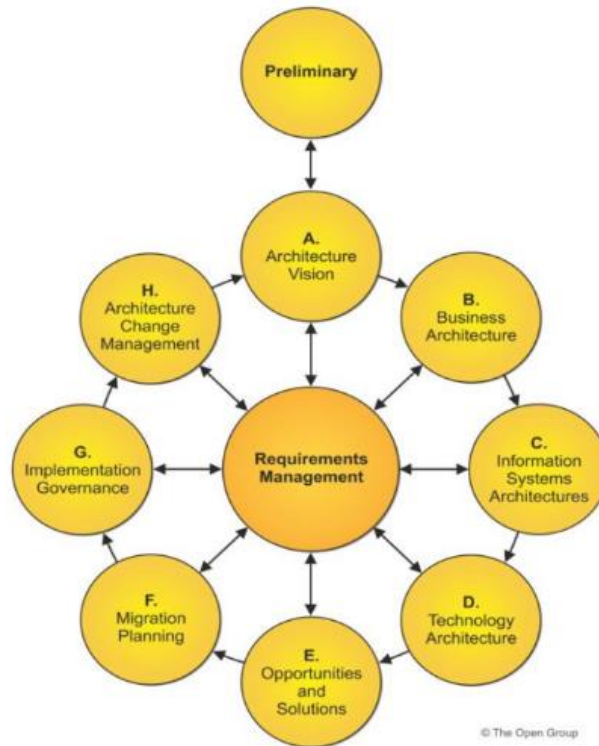
Figure 1: TOGAF Architecture Development Cycle

3.1.1. Privacy and Security

A Risk Management Framework gives organisations a structured way to identify, assess, and manage privacy and security risks. TOGAF also utilises a Security Services Catalogue to establish a common terminology and reference framework for managing security and its objectives, which is integrated across the four domains and the ADM Phases (The Open Group, 2016). ADM Phase C: Information System Architecture, provides guidelines to design security and privacy controls required to protect the organisation's data and information systems and ensure that the architecture is compliant with relevant regulations. ADM Phase D: Technology Architecture, specifies the network security, access control, encryption, and other security measures for the organisation's technology infrastructure.

3.1.2. Data Processing

ADM Phase C: Information Systems Architectures - Data Architecture, provides considerations for designing a data architecture that addresses data integration and growing data volumes. The framework offers guidance on data management including how and where data entities are created, stored, and transported. TOGAF also aids retailers in identifying information sharing needs between applications by assessing the degree and complexity of data transformation needs. This makes it possible for organisations to evaluate the software needs for an efficient integration of internal and external data. As a result, organisations can develop a thorough understanding of the data landscape, leading to creating adequate solutions, and selecting appropriate tools, for data integration and scalability to accommodate expanding data volumes.

3.1.3. Data Quality

ADM Phase C: Information Systems Architectures - Data Architecture, identifies three key considerations when building the target data architecture to ensure data quality (The Open Group, 2022). Data management is the effective use of data to generate accurate and reliable insights such as defining the system of record, understanding how data is used across the organisation, and using data profiling tools to evaluate data quality. Data migration presents data that meets the requirements and constraints of the selected BDA tool, ensures the BDA tool populates quality data, and

establishes an enterprise-wide common data definition. Data governance establishes structure, standards body, management system, and data-related programs to manage the governance aspects of data throughout its lifecycle.

3.1.4. Lack of Strategy

ADM Phase A: Architecture Vision, sets the overall strategic foundation for implementing BDA. In this phase, business goals, strategic drivers, business requirements, and concerns of relevant stakeholders are identified which provide context for the architectural work. Key performance measures are also defined to determine if the goals and objectives of BDA efforts are met. Moreover, the architectural roadmap, which is incrementally developed throughout the ADM phases, contains the list of individual work packages needed to achieve the target BDA architecture. The business value of each work package is highlighted along with other important strategy aspects such as key milestones, timelines, and resources required for BDA implementation (The Open Group, 2022).

3.1.5. Lack of Skills

ADM Phase C: Information Systems Architecture - Data Architecture, acknowledges 'people' in its Data Governance category (The Open Group, 2022). This identifies the roles and skills of people needed to manage data transformation in the organisation, helping it to identify if training is required to meet its needs. However, it can be argued that with the right planning in each ADM phase, each phase is capable of recognising skills required for each stage to hire the right people when handling a change. Moreover, TOGAF also defines an Architecture Skills framework, establishing the architecting skills required in an organisation. This is divided into the various roles, skills, and proficiency levels required. The detail provided can help the hiring process within an organisation, saving costs. Although this framework doesn't relate to data scientists' skills (the most applicable for BDA), enterprise architects are important as they ensure efficient integration is achieved to derive insights. Nonetheless, ADM doesn't tell us how this issue can be tackled, but the Architecture Skills provide a guideline.

3.2. Zachman Framework

ZF is an ontology (structure) that offers a descriptive perspective on EA, while providing valuable insights into organisational structure and operations (Gerber et al., 2020). As shown in Figure 2, the framework is a 6 x 6 matrix that shows the fundamental perspectives of an enterprise (columns) and fundamental aspects (rows) of an enterprise system (Zachman, 2019). Within the retail industry, this can be used to help companies align their data architecture with their business strategy and goals, enabling them to take complete advantage of BDA (Gerber et al., 2020).

	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*
Objective/Scope (contextual) *Role: Planner*	List of things important in the business	List of Business Processes	List of Business Locations	List of important Organizations	List of Events	List of Business Goal & Strategies
Enterprise Model (conceptual) *Role: Owner*	Conceptual Data/ Object Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
System Model (logical) *Role:Designer*	Logical Data Model	System Architecture Model	Distributed Systems Architecture	Human Interface Architecture	Processing Structure	Business Rule Model
Technology Model (physical) *Role:Builder*	Physical Data/Class Model	Technology Design Model	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
Detailed Reprentation (out of context) *Role: Programmer*	Data Definition	Program	Network Architecture	Security Architecture	Timing Definition	Rule Speculation
Functioning Enterprise *Role: User*	Usable Data	Working Function	Usable Network	Functioning Organization	Implemented Schedule	Working Strategy

Figure 2: Zachman Framework Structure

3.2.1. Privacy and Security

ZF provides guidelines on how privacy and security can be addressed using the six aspects (columns) of the matrix (Ertaul & Sudarsanam, 2005):

- What: represents the information and data that an enterprise needs to manage according to the levels of security and confidentiality.
- How: addresses the security process of the enterprise classified according to the level of criticalness, such as data archiving and data audits.
- Where: defines the location of storage data which requires a high level of security when the information is being stored or transferred using encryption methods.
- Who: defines the privacy and security authority and responsibility of human resources within the company.
- When: describes the organisation's time dimensions, based on the security level of the information, enabling the designer to schedule timely system events.
- Why: discusses corporate ethics and threats from external security sources, such as server attacks or storage threats.

3.2.2. Data Processing

The "where" or network column partially addresses data integration and scalability issues by providing insights into the network of data sources and their distribution (Zachman, 2019. By identifying internal and external data sources, organisations can determine how data can be accessed, extracted, and transformed for integration purposes as well as discover specific areas where issues might arise. ZF also provides an understanding of how data is distributed in different locations across various systems and networks which enables organisations to design an architecture that is capable of accommodating growing volumes of data. However, ZF does not provide comprehensive guidelines for handling the complexity involved in data integration and scalability.

3.2.3. Data Quality

The "what" or data column provides a holistic approach to address data quality through different perspectives. The contextual perspective identifies data that is important in a high level of aggregation (e.g. customers, suppliers, and products) (Rezaei & Shams, 2008). The conceptual perspective provides a semantic model which is a high level view of important data entities and their relationships (Rezaei & Shams, 2008). The logical perspective provides a logical data model that defines and adds further information to the semantic model, which is represented by an entity-relationship model (Rezaei & Shams, 2008). While ZF provides an understanding of the data column through different perspectives, it does not provide an explanation on how to ensure data quality.

3.2.4. Lack of Strategy

The "why" or motivation column from the contextual perspective involves the identification of business goals and strategies. This includes a list of factors vital to organisations' strategic initiatives, including the identification of critical success factors relative to BDA efforts across functions. The conceptual perspective includes the development of business and operational plans that incorporate policies, procedures, and standards for implementing BDA. However, ZF only provides a descriptive view of the architectural components related to strategy setting and does not prescribe guidelines on how to develop strategies and business plans.

3.2.5. Lack of Skills

The "who" or people column represents the roles and responsibilities of each person within and outside the organisation through the different perspectives. From the conceptual perspective, it explains the roles and responsibilities of each process. Once fully understood, the organisation is capable of identifying who would be appropriate for a role. The functions perspective shows us the people working within the roles and responsibilities identified, allowing an organisation to decide if certain skills are lacking within a specific process (Zachman, 2019). Although it is realised through ZF the skills that are missing in an organisation, it doesn't provide guidance on how we can solve the issue.

3.3. Comparison of TOGAF and Zachman

This table shows the comparison between the two EA frameworks discussed above to address the BDA challenges in the retail industry:

Challenges	TOGAF	ZF
Technological		
Privacy & Security	Yes	Yes
Data Processing	Yes	Partial
Data Quality	Yes	Partial
Organisational & Human		
Lack of Strategy	Yes	Partial
Lack of Skills	Partial	Partial

4.   Case Study: Walmart

4.1.   How Walmart Uses BDA

From over a million customers, 2.5 petabytes of unstructured data is collected every hour by Walmart, and is used to manage its supply chains, perform research on changing customer trends, and examine social media. The analysed data is used to create actionable insights, increasing its sales by 10-15%. Through data, data-driven strategic decisions are made to understand what customers are buying, what customers outside Walmart are buying, and researching online and offline trends (Liu et al., 2018).

4.2.   How Walmart Addressed Retail Challenges

4.2.1.   Privacy and Security

Walmart has been proactive in addressing security and privacy issues, investing heavily in its cybersecurity program. These issues are tackled and monitored by Walmart's security team (Walmart, 2023). It has implemented a platform which allows highly dynamic modelling of customer data for privacy protection. Furthermore, privacy programs and security measures ensure customer data is collected and protected in a transparent and ethical manner. Artificial Intelligence (AI) and BDA also prevented privacy breaches and threats (Walmart, 2023). Overall, these measures helped it maintain its reputation.

4.2.2.   Data Processing

Walmart possessed over 40 petabytes of data in 2014 and built a robust data architecture that supports continuous data integration, avoiding siloed data to make sense of this (Marr, 2017). This captured and stored data from various sources and supported the use of application programming interfaces to allow data to be used across multiple applications, eliminating incomplete and inconsistent data (Woods, 2017). Moreover, Walmart built a private cloud to process 2.5 petabytes of data every hour to ensure scalability, and set up an analytics hub called Data Café to transform, model, and visualise over 200 streams of internal and external data (Marr, 2017).

4.2.3. Data Quality

The use of high quality and real time data is key to driving Walmart's business performance. Walmart's flexible and fully integrated data architecture, along with its Data Café, can monitor voluminous internal and external data in real time, and produce vast amounts of verified and quantifiable data rapidly. This greatly reduced the amount of time to solve complex business problems from weeks to minutes (Marr, 2016). The implementation of the café allowed Walmart to make accurate information widely available, and disseminate reliable information as fast as possible, in order for business units to take immediate action and reduce turnaround time (Marr, 2017).

4.2.4. Lack of Strategy

Walmart, which operates on a large scale and network, has long seen the value in data analytics. It was able to identify business requirements that can be addressed by BDA and deployed appropriate strategies for each. For example, the company leveraged on big data to improve inventory management using predictive analytics. Also, Walmart used social media big data solutions (i.e. Social Genome, Shopycat) to improve product offerings (Marr, 2016).

4.2.5. Lack of Skills

The biggest roadblock for Walmart is to find the right talent to perform analytics on the large data it collects. Its senior recruiter stated, "The staffing supply and demand gap is always there". Therefore, Walmart is constantly on the lookout for professionals with "working knowledge of data science programming languages like Python and R to build machine learning models". To mitigate this, they used crowdsourcing analytics talent techniques. This meant that they held competitions for people to analyse their historical data and talk about the impact on sales based on that analysis (ProjectPro, 2023).

5. Recommendations

Challenge	Walmart	TOGAF	ZF
Privacy & Security	Implemented platform that allows high dynamic modelling for protecting privacy of customer data. Dedicated a team that monitors and ensures compliance with data privacy regulations.	ADM Phase C: Information Systems Architecture ADM Phase D: Technology Architecture	User technology model and functioning enterprise perspectives
Data Processing	Implemented data architecture and cloud infrastructure to support data integration and increasing data volume.	ADM Phase C: Information Systems Architectures - Data Architecture	x
Data Quality	Implemented data architecture and data café to ensure high quality and readily available data.	ADM Phase C: Information Systems Architectures - Data Architecture	x
Lack of Strategy	Identified business requirements that can be addressed by BDA.	ADM Phase A: Architecture Vision	x

Lack of Skills	Used crowdsourcing analytics talent techniques.	x	x

This table explains how Walmart addressed the challenges in BDA and how its approach aligns with TOGAF and ZF. The solutions that Walmart took are aligned to TOGAF in technological and organisational aspects. However, challenges related to human aspects were not fully tackled. Even though TOGAF provides a strong foundation for BDA, a complete organisational transformation into implementing BDA will require more research, particularly additional frameworks, such as The Skills Framework for the Information Age, which are specifically designed for human resources (The SFIA Foundation, 2000). In the case of Walmart, there is limited evidence supporting alignment with ZF. However, given our analysis of ZF in section 4.2, the framework can be partially applied, and it might benefit organisations in other industries.

6.   Conclusion

To conclude, EA frameworks are not applied entirely, but are used as a guidance to implement certain solutions within the organisation to integrate BDA successfully. Retail industries have faced various challenges in BDA, and TOGAF and ZF have provided a structure, to a degree, by creating a guidance and starting point for organisations. By analysing Walmart, we can confirm parts of a framework can be used according to the business needs, thus it is recommended for organisations to examine the challenges through the lens of multiple frameworks. Hence, future research is recommended in this area.

7.   Limitations and Future Research

This research was limited to the retail industry and the majority of the literature focused on large retail companies in the US, being less applicable to SMEs and other geographical areas. Hence, it is recommended that researchers investigate BDA's application in other industries and expand geographically, while also taking into consideration SMEs to strengthen this study's generalisability. Finally, it is recommended that researchers investigate the application of BDA in countries that are traditional and conservative, where BDA is not widely used.

8.   References

Aktas, E., & Meng, Y. (2017). An Exploration of Big Data Practices in Retail Sector. Logistics, 1(2), 12. mdpi. https://doi.org/10.3390/logistics1020012

Akter, S., & Wamba, S. F. (2016). Big data analytics in E-commerce: a systematic review and agenda for future research. Electronic Markets, 26(2), 173–194. springer. https://doi.org/10.1007/s12525-016-0219-0

Avidon, E. (2021, August 18). How to increase the success rate of data science projects. TechTarget. https://www.techtarget.com/searchbusinessanalytics/feature/How-to-increase-the-success-rate-of-data-science-projects#:~:text=In%202016%2C%20Gartner%20estimated%20that

Carr, D., & Else, S. (2018). State of Enterprise Architecture Survey: Results and Findings State of Enterprise Architecture Survey EA Principals Results and Findings. https://eapj.org/wp-content/uploads/2018/05/EAPJ-Special-Edition-State-of-EA-Survey.pdf

Elgendy, N., & Elragal, A. (2014). Big Data Analytics: a Literature Review Paper. Advances in Data Mining. Applications and Theoretical Aspects, 8557(1), 214–227. https://doi.org/10.1007/978-3-319-08976-8_16

Ertaul, L., & Sudarsanam, R. (2005). Security Planning Using Zachman Framework for Enterprises. http://mgov.cn/lab/Archives/EuromGov2005/PDF/16_S039EL-S13.pdf

Gerber, A., Roux, P. le, Kearney, C., & Merwe, A. van der. (2020). The Zachman Framework for Enterprise Architecture: An Explanatory IS Theory. Lecture Notes in Computer Science, 12066, 383–396. https://doi.org/10.1007/978-3-030-44999-5_32

Grover, V., Chiang, R. H. L., Liang, T.-P., & Zhang, D. (2018). Creating Strategic Business Value from Big Data Analytics: A Research Framework. Journal of Management Information Systems, 35(2), 388–423. https://doi.org/10.1080/07421222.2018.1451951

Kotusev, S. (2021, July 1). A comparison of the top four enterprise architecture frameworks | BCS. Www.bcs.org. https://www.bcs.org/articles-opinion-and-research/a-comparison-of-the-top-four-enterprise-architecture-frameworks/#:~:text=Presently%2C%20TOGAF%20has%20achieved%20the

Kotusev, S., Kurnia, S., Dilnutt, R., & Taylor, P. (2020, January). Can Enterprise Architecture Be Based on the Business Strategy? ResearchGate. https://www.researchgate.net/publication/339028040_Can_Enterprise_Architecture_Be_Based_on_the_Business_Strategy

Le, T. M., & Liaw, S.-Y. (2017). Effects of Pros and Cons of Applying Big Data Analytics to Consumers' Responses in an E-Commerce Context. Sustainability, 9(5), 798. https://doi.org/10.3390/su9050798

Liu, Y., John, S., Han, H., & Debello, J. (2018). The Challenges of Business Analytics: Successes and Failures. https://core.ac.uk/download/pdf/143480944.pdf

Marr, B. (2016). Big data in practice: how 45 successful companies used big data analytics to deliver extraordinary results. J. Wiley.

Marr, B. (2017, January 23). Really Big Data At Walmart: Real-Time Insights From Their 40+ Petabyte Data Cloud. Forbes. https://www.forbes.com/sites/bernardmarr/2017/01/23/really-big-data-at-walmart-real-time-insights-from-their-40-petabyte-data-cloud/?sh=37ecb9cc6c10

Morimura, F., & Sakagawa, Y. (2022). The intermediating role of big data analytics capability between responsive and proactive market orientations and firm performance in the retail industry. Journal of Retailing and Consumer Services, 71, 103193. https://doi.org/10.1016/j.jretconser.2022.103193

Perkins, A. (n.d.). Creating a "High Performance" Enterprise in a Changing Environment. https://f.hubspotusercontent00.net/hubfs/4863804/White%20Papers/Zachman%20-%20Creating%20a%20High%20Performance%20Enterprise%20in%20a%20Changing%20Environment.pdf

Power, C., & Guinto, G. (2014). Build customer trust through data privacy. https://www.pwc.com.au/industry/retail-consumer/assets/data-privacy-jun14.pdf

ProjectPro. (2023, April 24). How Big Data Analysis helped increase Walmart's Sales turnover? ProjectPro. https://www.projectpro.io/article/how-big-data-analysis-helped-increase-walmarts-sales-turnover/109#toc-9

Ramadan, M., Shuqqo, H., Qtaishat, L., Asmar, H., & Salah, B. (2020). Sustainable Competitive Advantage Driven by Big Data Analytics and Innovation. Applied Sciences, 10(19), 6784. https://doi.org/10.3390/app10196784

Rezaei, R., & Shams, F. (2008). A Methodology to Create Data Architecture in Zachman Framework. World Applied Sciences Journal, 3(2), 43–49. https://www.idosi.org/wasj/wasj3(supplement%202)/6.pdf

Ridge, M., Johnston, K. A. J., & Donovan, B. (2015). The use of big data analytics in the retail industries in South Africa. African Journal of Business Management, 9(19), 688–703. https://doi.org/10.5897/ajbm2015.7827

Silva, E. S., Hassani, H., & Madsen, D. Ø. (2019). Big Data in fashion: Transforming the Retail Sector. Journal of Business Strategy, 41(4). https://doi.org/10.1108/jbs-04-2019-0062

Singh, M., Ghutla, B., Lilo Jnr, R., Mohammed, A. F. S., & Rashid, M. A. (2017). Walmart's Sales Data Analysis - A Big Data Analytics Perspective. 2017 4th Asia-Pacific World Congress on Computer Science and Engineering (APWC on CSE). https://doi.org/10.1109/apwconcse.2017.00028

The Open Group. (2016). Open Group Guide Integrating Risk and Security within a TOGAF ® Enterprise Architecture. https://www.delegata.com/wp-content/uploads/2018/02/integrating-risk-and-security-within-a-togaf-enterprise-architecture-g152.pdf.

The Open Group. (2022, April). The TOGAF® Standard — Digital Edition - Introduction. The Open Group. https://pubs.opengroup.org/togaf-standard/

The SFIA Foundation. (2000). SFIA full framework view. SFIA. https://sfia-online.org/en/sfia-8/sfia-views/full-framework-view?path=/glance

Walmart. (2023, January 1). Walmart Privacy Notice. Walmart. https://corporate.walmart.com/privacy-security/walmart-privacy-notice

Woods, D. (2017, March 31). Data Fusion, Data Privacy: What We Can Learn From Walmart's Flexible Data Architecture. Forbes. https://www.forbes.com/sites/danwoods/2017/03/31/data-fusion-data-privacy-what-we-can-learn-from-walmarts-flexible-data-architecture/?sh=4556967a5aa7

Ying, S., Sindakis, S., Aggarwal, S., Chen, C., & Su, J. (2020). Managing big data in the retail industry of Singapore: Examining the impact on customer satisfaction and organizational performance. European Management Journal, 39(3). https://doi.org/10.1016/j.emj.2020.04.001

Zachman, J. A. (2019). About the Zachman Framework. Zachman.com. https://www.zachman.com/about-the-zachman-framework