



LCBB5014 Data Handling & Business Intelligence at Volkswagen Group



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1. Introduction

The direction of this statement is to examine the conceptual foundations of Business Intelligence (BI), Data Warehousing (DW), and Data Marts (DM) within the background of contemporary business environments. It further explores how these components contribute to enhancing operational efficiency and strategic decision-making within the Volkswagen Group, thereby supporting the achievement of its organizational objectives.

1.2 Introduction of Volkswagen Group

The selected company for this analysis is Volkswagen Group (VW AG), a prominent entity within the global automotive sector. The name "Volkswagen" derives from the German words *Volks* (people) and *Wagen* (car), reflecting its original mission to produce affordable vehicles for the general population. Founded in Germany by the German Labour Front under the Nazi regime, Volkswagen's most iconic model was the Beetle, which was promoted by Adolf Hitler for its affordability and mass appeal. In 1972, the Beetle became the best-selling car in automotive history, marking the brand's entry into a globally expanding market.

Following this success, VW AG diversified its product line with models such as the Golf, Polo, and Passat. Between 1986 and 2012, the Group strategically acquired several renowned automotive brands, including SEAT, Škoda, Lamborghini, Porsche, and Bugatti, thereby strengthening its market position and portfolio. In 2000, Volkswagen committed to vehicle electrification, positioning itself as a leading force in the global electric mobility market, currently ranking second worldwide.

(Volkswagen Group. 2025).

2 Trends in BI, DW, and DM and current trends Real-Time BI and Cloud Warehousing

Business Intelligence (BI) encompasses a set of processes including data collection, transformation, and analysis as well as enabling technologies such as data storage, artificial intelligence (AI), and data visualization. These elements work together to convert raw data into essential knowledge that supports critical decision-making in organizations (Majid et al., 2024).

Data Warehouse (DW) is a data management system created to store and centralize large volumes of information from multiple sources, encompassing a company's historical and current data. Its primary function is to support organizational decision-making by providing a reliable and integrated data environment (Gath, 2024).

Data Mart (DM) is a specialized subgroup of a Data Warehouse planned to support analytical processes within specific business departments, such as Marketing or Finance. It facilitates targeted data analysis by providing tailored datasets that meet the informational needs of particular user groups within the organization (GeeksforGeeks, 2023).

Real-Time Business Intelligence (RTBI), as described by Natali (2025), refers to the use of advanced mechanism and automation that enable organizations to collect, process and visualize data with minimal latency. This capability allows decision-makers to act immediately and formulate strategies based on current, dynamically changing information.

Cloud Warehousing, as defined by Golec et al. (2021), refers to a modern data storage model in which cloud platform services facilitates to store, operation, and interpret large volumes of data without the need for physical infrastructure. This approach empowers adaptive capacity, resilience, and economic efficiency, making it a strategic asset for data-driven enterprises.

2.1 Impact of the data warehouse on decision making

On relation to Maswanganyi et al. (2024), the impact of Data Warehousing on decision-making is substantial, as it enables the transformation of large volumes of raw data into actionable knowledge for strategic, tactical, and operational decisions. This influence is evident in key areas such as data centralization, access to historical records, and enhanced decision-making quality.

For instance, Netflix has leveraged its data warehouse to generate billions of dollars in revenue by personalizing user experiences through algorithmic recommendations and guiding content investment decisions based on audience analytics (Mixon, 2025). Similarly, Goyal (2025) highlights that Amazon's financial growth has been significantly driven by its data warehouse infrastructure, which supports rapid and accurate decision-making. Furthermore, it has optimized operational processes such as inventory management, supply chain efficiency, and personalized customer offerings.

2.2 Process Model

CRISP-DM model, which stands for Cross-Industry Standard procedure for Data Mining, is an extensively adopted technique used by organizations to structure data-driven solution development. It provides a systematic framework that guides businesses in implementing analytical solutions aligned with strategic objectives. The model is composed of six iterative stages:

- **Business Understanding:** Define the perspective of the business project and identify main problems.
- **Data Understanding:** Recollect data and evaluate it, to detect potential problems.
- **Data Preparation:** Clean and transform the raw data in relevant information.
- **Modelling:** Use data mining models as classification, regression, clustering.
- **Evaluation:** Verify if the model meets the business objectives, moreover, Identify opportunities and limitations to improve.
- **Deployment:** Implement the model in real case, including reports, dashboards or operational system integration. (Shimaoka, et al. 2024).

3. Data Warehousing in Volkswagen group

Data Warehousing: According to Volkswagen Group (2025), data warehousing serves as a cornerstone of the company's strategic operations, enabling the analysis, integration, and global sharing of operational data. The Group employs a data mesh architecture, adopting a decentralized model in which each brand within the organization manages its own data domain. This structure fosters agile connectivity and collaboration across brands within the Volkswagen Group. Additionally, the company leverages Amazon Web Services (AWS) to store data and support real-time analytics. Its digital logistics operations are also integrated with the data warehouse, enhancing visibility, enabling the application of artificial intelligence, and generating accurate forecasts throughout the supply chain.

Efficiency: According to Volkswagen Group (2025), the company distinguishes itself from competitors such as Toyota—which relies on a single centralized data warehouse—and Mercedes-Benz, which operates with segmented data structures that, while efficient, limit internal collaboration between sub-brands like Smart and Maybach. In contrast, Volkswagen

Group has implemented a federated data access model that enhances analytical efficiency and enables agile decision-making across its internal brands. By decentralizing data management, each brand—such as Audi, SEAT, and Škoda—maintains autonomy over its own data, thereby eliminating intermediaries and fostering seamless collaboration. This approach improves customer service responsiveness and commercial planning, ultimately resulting in higher data quality and reduced operational costs.

Strategic Decision-Making: In line with Kopczewski et al. (2025), the Data Warehouse (DW) at Volkswagen Group plays a pivotal role in supporting strategic decision-making by integrating and providing real-time access to data. This capability enables management to act with precision, speed, and interdepartmental alignment. Furthermore, the DW fosters a unified, global, and coherent view of the business. By leveraging cloud warehousing, Volkswagen AG empowers its teams to respond swiftly to shifts in customer demand and behavior. Additionally, the integration of artificial intelligence facilitates predictive maintenance, supply chain optimization, and sustainability analysis, further enhancing the Group's strategic agility.

Financial Department: According to Velinov, (2023), the implementation of a data warehouse has significantly enhanced Volkswagen Group's financial performance by optimizing strategic decision-making, reducing operational costs, and fostering technological innovation. This impact stems from the Group's adoption of a centralized architecture that integrates financial, customer, and supplier data, enabling precise forecasting and informed decision-making. As part of its broader digital transformation, Volkswagen has automated financial reporting and inventory management processes, thereby minimized delays and improved operational efficiency. In conclusion, the data warehouse is not merely a technological tool but a strategic pillar that boosts both efficiency and profitability, allowing the company to swiftly adapt to evolving dynamics within the automotive industry.

4.Data Mining Techniques

Classification in Data Mining refers to a predictive, supervised learning model that assigns data into predefined categories based on historical patterns. Techniques such as K-Nearest Neighbours (K-NN) are commonly applied to classify new data by comparing it with existing datasets that share similar characteristics (Bhuyan & Ravi, 2021).

According to Volkswagen Group (2025), classification plays a critical role in the company's strategic operations by enhancing operational efficiency. VW AG employs classification

models in predictive maintenance to categorize components as functional, at risk, or failing—allowing the company to anticipate mechanical issues and minimize downtime. Additionally, classification algorithms are used to automate quality control through image analysis of vehicle components and to segment customers based on patent data and behavioural patterns.

As Bhuyan and Ravi (2021) further explain, Volkswagen Group centralizes its data in the cloud to apply K-NN models effectively. This approach enables the organization to classify production quality by identifying defects and tolerances, thereby supporting continuous improvement and precision in manufacturing.

Clustering is an unsupervised data mining technique used to group similar data points into distinct sets. Unlike supervised models, it does not require pre-classified data, making it particularly effective for uncovering hidden patterns. Moreover, clustering algorithms are adaptable to various data types—both numerical and categorical—which makes them well-suited for exploratory data analysis (Oyewole & Thopil, 2022).

According to Volkswagen Group (2025), clustering has a significant impact on strategic decision-making across multiple domains. It enhances customer segmentation and production efficiency by enabling the interpretation of large-scale data and facilitating decisions based on real behavioural and operational patterns. As part of its predictive analytics framework, Volkswagen employs the K-Means algorithm to segment customer data based on location and preferences (Ay et al., 2023). This allows the business to implement personalized marketing plan that improve customer engagement. Additionally, clustering supports predictive maintenance by identifying and labeling failure patterns, thereby reducing operational costs and increasing product reliability.

5. Predictive Analysis

Power BI: According to Shoaib (2022), the primary objective of Power BI is to enable statistical and predictive analyses through data-driven insights. Within the Volkswagen Group, this software supports a wide range of applications, including the anticipation of customer behaviour and vehicle performance, informed decision-making, and the optimization of operational processes. For example, Power BI is used in predictive maintenance by analysing historical failure data to anticipate engine malfunctions, thereby reducing costs and preserving brand quality. Moreover, Power BI facilitates inventory and distribution adjustments based on demand patterns, enabling customer segmentation and the delivery of personalized advertising

aligned with user habits. When compared to SPSS (Statistical Package for the Social Sciences), Power BI stands out for its user-friendly interface and advanced data visualization capabilities. While SPSS offers robust statistical tools, it typically requires users to have specialized knowledge and is more limited in terms of automated reporting and interactive graphics. In contrast, Power BI supports high-quality, dynamic visualizations and allows for automated report generation through scheduled updates and integration with multiple data sources.

As a result, Volkswagen leverages Power BI to automate reporting across production, logistics, and quality control, significantly reducing manual tasks and enhancing operational efficiency. Its predictive capabilities enable the development of models based on demand trends and engine performance, while its dashboards support scenario simulations involving fluctuations in production and market demand. In conclusion, Power BI delivers substantial benefits to Volkswagen by increasing operational agility, improving planning processes, and fostering continuous innovation. (Specht, 2021).

6. Ethical and Data Security Considerations

GDPR, which stands for General Data Protection Regulation, is a legal framework settled by the European Union that sets strict requirements for how organizations must collect, use, store, and protect the personal data of EU citizens (Herrle, 2019). Its primary objective is to safeguard individuals' privacy rights and ensure transparency and accountability in data processing activities.

According to Volkswagen UK (2025), the company ensures that personal data is collected, processed, and protected in a lawful, transparent, and protected aspect. In consent with the General Data Protection Regulation (GDPR), Volkswagen UK informs clients about how their personal information is collected, stored, and shared. The company provides mechanisms for obtaining explicit consent, such as for non-essential cookies on its websites and services like "We Connect." Importantly, this consent can be revoked at any time at the client's request.

Volkswagen Group also promotes transparency by publishing clear and accessible privacy statements that explain data usage, user rights, and third-party data sharing practices. Despite these measures, the organization acknowledges the persistent nature of digital threats both internal and external and continues to invest in robust data protection strategies to mitigate risks and uphold regulatory compliance.

In work of Baran (2024), a major data breach at Volkswagen Group occurred due to poor cloud configuration management, including incorrect permissions and inadequate security settings. This led to the exposure of sensitive information belonging to approximately 800,000 clients, including GPS location histories, vehicle identification numbers (VINs), and movement patterns. In response, Volkswagen AG implemented immediate corrective actions such as blocking public access to the affected servers and conducting internal audits to trace the origin of the breach.

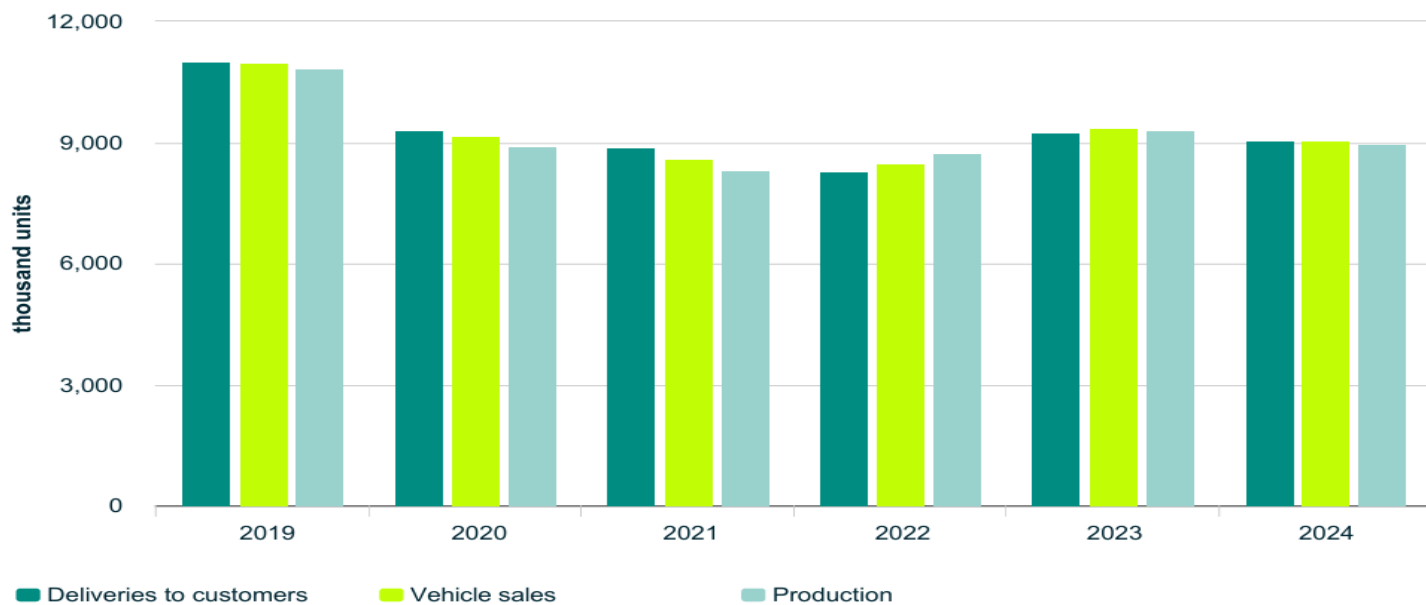
External Environment: According to Ciphersafety (2024), Volkswagen Group experienced a significant cyberattack that resulted in the exposure of approximately 19,000 confidential documents related to research and development of vehicle technologies. This incident led to increased consumer distrust regarding the company's data protection practices. In response, Volkswagen AG reinforced its cybersecurity infrastructure and collaborated with external specialists to contain the breach and prevent future incidents. These measures reflect the Group's commitment to restoring stakeholder confidence and strengthening its digital resilience in an increasingly vulnerable technological landscape.

7. Dashboard

Tableau is a specialized Business Intelligence (BI) tool used by organizations to transform complex data into visual representations through Key Performance Indicators (KPIs), enabling the measurement of organizational performance. It facilitates decision-making by identifying patterns, integrating multiple data sources, and allowing the internal sharing of insights across departments (Patel, 2021).

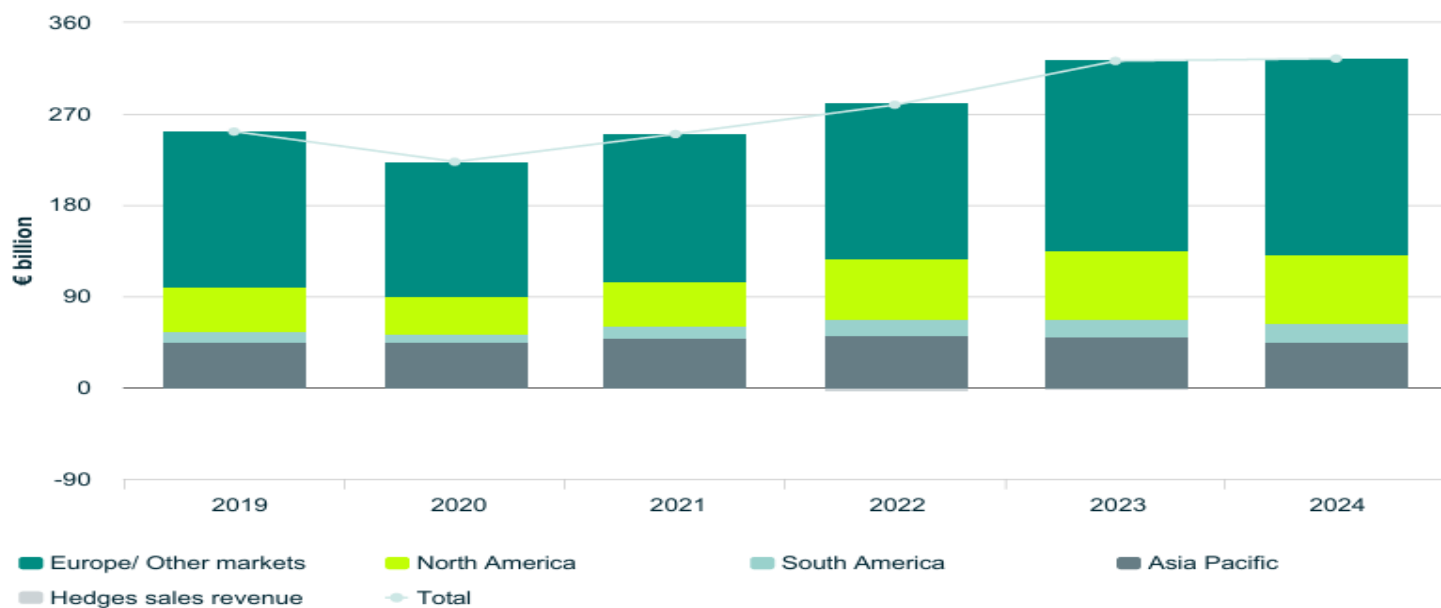
Volkswagen Group, Tableau supports strategic planning by visualizing operational data through dynamic reports, aiding in opportunity detection and initiatives like SUV expansion. It optimizes production by tracking energy use per unit and enhances marketing via customer segmentation and targeting. Tableau integrates behavioural data to personalize campaigns and improve decision-making. A graphic illustrates production, sales, and delivery trends from 2019 to 2024. (Tableau, 2015).

Volume Data



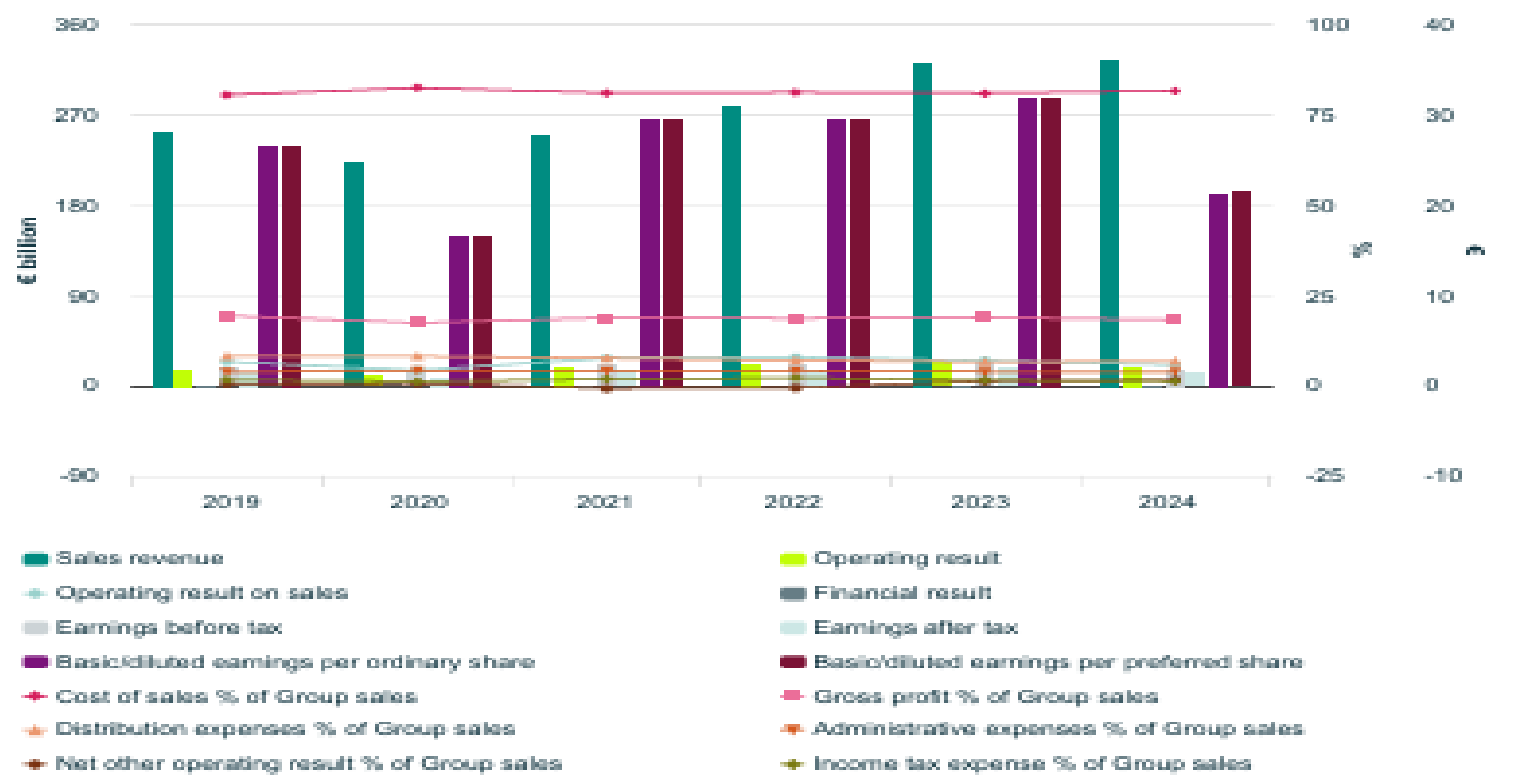
		2019	2020	2021	2022	2023	2024
Deliveries to customers	thousand units	10,975	9,305	8,882	8,263	9,240	9,027
Vehicle sales	thousand units	10,956	9,157	8,576	8,481	9,362	9,037
Production	thousand units	10,823	8,900	8,283	8,717	9,309	8,954

Sales revenue by region



		2019	2020	2021	2022	2023	2024
Europe/ Other markets	€ billion	154.0	133.5	145.6	154.5	187.9	194.1
North America	€ billion	43.4	36.8	45.3	59.9	67.9	67.7
South America	€ billion	11.3	8.6	11.0	15.5	17.1	19.0
Asia Pacific	€ billion	44.0	44.3	48.7	51.4	50.1	44.1
Hedges sales revenue	€ billion	0.0	-0.3	-0.4	-2.3	-0.8	-0.2
Total	€ billion	252.6	222.9	250.2	279.1	322.3	324.7

Income Statement



		2019	2020	2021	2022	2023	2024
Sales revenue	€ billion	252.6	222.9	250.2	279.1	322.3	324.7
Operating result	€ billion	17.0	9.7	19.3	22.1	22.5	19.1
Operating result on sales	%	6.7	4.3	7.7	7.9	7.0	5.9
Financial result	€ billion	1.4	2.0	0.9	-0.0	0.6	-2.3
Earnings before tax	€ billion	18.4	11.7	20.1	22.1	23.1	16.8
Earnings after tax	€ billion	14.0	8.8	15.4	15.9	17.9	12.4
Basic/diluted earnings per ordinary share	€	26.60	16.60	29.59	29.66	31.79	21.36
Basic/diluted earnings per preferred share	€	26.66	16.66	29.65	29.72	31.85	21.42
Cost of sales % of Group sales	%	80.5	82.5	81.1	81.3	81.1	81.7
Gross profit % of Group sales	%	19.5	17.5	18.9	18.7	18.9	18.3
Distribution expenses % of Group sales	%	8.3	8.3	7.7	7.1	6.6	6.9
Administrative expenses % of Group sales	%	3.9	4.2	4.2	4.2	3.9	3.9
Net other operating result % of Group sales	%	0.6	0.7	-0.7	-0.5	1.4	1.6
Income tax expense % of Group sales	%	1.7	1.3	1.9	2.2	1.6	1.4

Notes
1. The year 2022 was adjusted due to the adjustments within the new IFRS 17 framework.

(Volkswagen Group. 2025).

According to Volkswagen Group (2025), KPIs focus on manufacturing efficiency—such as production time, losses, and delays—alongside supply chain metrics like stock control and delivery times. Additionally, the Group monitors country-level sales and sustainability indicators to ensure compliance with environmental regulations and corporate responsibility standards. These KPIs support operational performance and strategic accountability across the organization.

8. Conclusion

In summary, the key findings at Volkswagen Group suggest that BI, DW, and DM is essential for optimal business management. BI and Data Mining play a crucial role in transforming complex data from external sources such as public statistics, social media, and market data as well as internal sources, including customer information, sales, and logistics, into actionable insights for effective decision-making. This process is supported by dashboards, reports, and predictive analytics. Meanwhile, DW and DM provide centralized storage that integrates large volumes of historical and current data from multiple sources. In particular, Data Marts are tailored to specific departments, enhancing the relevance and efficiency of data analysis. Therefore, these components have a significant impact on Volkswagen's strategic and operational performance.

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