An In-Depth Case Study of Volkswagen's AI Integration

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Abstract

As Artificial Intelligence (AI) technologies have become increasingly integral to business operations and many firms aspire to generate business value with that, understanding the factors that facilitate or hinder successful implementation is crucial for organizations across industries. Using Volkswagen Group (VW) as a case study, the goal of this study is to comprehensively examine the AI implementations in a holistic manner, including enablers and inhibitors, utilization in terms of automation and augmentation, process-level impacts, and broader firm-level outcomes. This work not only contributes to the understanding of AI adoption within a major automotive player, but also serves as a resource for organizations by navigating through the complexities of AI implementation, offering practical insights and lessons learned from the case.

Keywords

Artificial intelligence, automotive industry, business value

1. Introduction

The rapid advancement of artificial intelligence (AI) has generated new potential value across various sectors. It is regarded as one of the most promising opportunities for global trade today, with the potential to boost the world economy by $13 trillion to $15 trillion by 2030 [1]. However, despite these optimistic estimates, the integration of AI-driven projects and initiatives into various organizational processes has made it challenging for all organizations to explore and implement valuable applications [2]. This difficulty in accessibility and usability poses a significant barrier to the widespread adoption and successful integration of AI technologies within organizations, ultimately affecting their ability to fully harness their potential for value creation [3].

One of the industries that has been exploiting AI potential is the automotive industry. The automotive sector has been undergoing a fundamental transformation primarily fueled by technological innovations in vehicles, manufacturing, and supply chain, as well as various other areas where AI is being utilized [4]. Its integration in the vehicle industry is a good example of how AI technology can take the automotive sector to a new level and completely change the mobility services [5]. AI-driven automotive innovation process is

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not only for increasing efficiency but also is a precedent for other sectors to take advantage of AI for the similar progress. The heterogeneous use of AI in automotive contexts can lead to a complex environment in which the effects of AI can be studied, ranging from design processes to production efficiency [6]. Additionally, the automotive sector's direction towards the Industry 4.0 principles, including the application of AI to production processes, creates a strong argument for the study of AI and manufacturing practices [7]. The automotive industry may be seen as an example of leading the way in adopting Industry 4.0 technologies to improve productivity and operational efficiency with the lessons learnt from which, other industries may follow the same path.

Prior research has underlined the need to skillfully manage domain and AI expertise when introducing AI systems, because of the interdependencies of technology (data, algorithms etc.) and organization (culture, managerial support, domain knowledge etc.) infrastructure [8]. Though research on managing AI is still nascent, studying fully exploit of its value in business will help to advance the productivity of AI in organizations [9]. Such that, the dimensions of the frameworks we examine in this study (Section 2) have been established through the synthesis of various studies in the literature. Examples provided for dimensions are either addressed in different domains or in a generic set of activities, such as marketing, human resource management, and public management. However, it is important to examine the frameworks through the lens of a single business and its operations in order to understand AI integration and the value it provides. It's crucial to note that supporting these frameworks with case studies is imperative for their validation. Therefore, the aim of this study lies in bridging the gap in the literature by providing evidence through a case study, thereby enhancing the validity and applicability of existing frameworks in real-world contexts.

In this study, we utilize the AI business value framework presented by Enholm et al. [10]. This framework possesses a more comprehensive structure compared to similar frameworks, allowing us to understand and assess the value that AI can bring to a business. We use this approach to define its implementation in organizational domain, and to identify and realize the use cases by involving AI enablers and inhibitors, exploring whether AI is predominantly employed for automation or augmenting human capabilities, and extending to the impacts of implementation.

As aforementioned, AI has emerged as a foundational element within the automotive sector, permeating various processes and revolutionizing the industry's landscape. In this regard, we identified the sector for the case that will be studied. In our observations, it was noted that VW possesses contemporary and diverse news sources (VW Media, VW Newsroom, VW Press, etc.), thereby presenting itself as a viable subject for a case study. To understand how businesses can gain AI value (i.e., develop the capability to broadly engage AI systems), we conducted an in-depth case study of VW. Our research was guided by the research question: How does the integration of AI technologies influence business value within diverse organizational contexts? Our findings are based on the analysis of VW’s AI journey. We describe the specific activities that helped VW drive business processes using AI. We then provide a management perspective of how it can strengthen the value and cost drivers of a business and conclude with recommended actions for executives who want to engage their organizations in harnessing the value potential of AI.

The study is organized into four main sections to explore the adoption of AI within organizational contexts. Section 2 reviews existing frameworks addressing AI usage in businesses, providing theoretical background. Section 3 outlines our methodology for conducting an in-depth case study. Section 4 presents findings from our case study analysis, highlighting insights into VW's AI journey and its impact on business processes. Finally, Section 5 offers the conclusion and discussion of our research, synthesizing implications and recommendations.

2. Frameworks for AI in Business

A multitude of frameworks have emerged to facilitate the integration of AI within various business sectors, encompassing domains like marketing, human resource management, and public administration. This comprehensive body of literature provides a nuanced understanding of AI adoption and implementation, highlighting several overarching themes and dimensions.

Within the realm of AI adoption frameworks and models, scholars have proposed diverse conceptual frameworks to delineate the factors influencing successful AI adoption. For instance, Chen et al. [11] introduced a multifaceted framework that considers technological, organizational, and environmental factors shaping AI adoption in business-to-business marketing. Nortje & Grobbelaar [12] offered a comprehensive readiness model framework, encompassing dimensions such as infrastructure, employee culture, technology management, organizational governance, and strategy, to assess an enterprise's preparedness for AI implementation. Additionally, Mikalef et al. [13] contributed a theoretical framework emphasizing the development of AI capabilities and their subsequent impact on organizational performance, emphasizing aspects like data infrastructure, AI culture, and organizational learning.

Exploring the intersection of AI capabilities and business value, scholars have also delved into the mechanisms through which AI generates value across different organizational contexts. Enholm et al. [10] conducted a literature review examining the enablers and inhibitors of AI adoption and delineating its various uses and effects, including process efficiency, insight generation, and operational performance improvements. Similarly, Huang & Rust [14] proposed a strategic framework tailored to the marketing domain, elucidating the roles of AI in decision automation, augmentation, and support systems. Furthermore, Chowdhury et al. [15] presented an AI capability framework specifically tailored to human resource management, addressing resources needed for AI development, contextual factors influencing its use, impacts on the workforce, and organizational outcomes.

In the realm of AI governance and public management, Wirtz & Müller [16] offered an integrated AI framework designed to guide public sector organizations in harnessing AI's potential to enhance service delivery, decision-making processes, and governance structures. This framework delineates technology infrastructure requirements, functional layers for data processing and interpretation, and the applications and services layer encompassing AI-enabled public services and governance mechanisms.

Table 1.
Comparison of Frameworks for AI in Business

Reference	Focus&Sector	Dimensions
[11] Chen et al. (2021)	Marketing	**1. Information Processing Requirements:** Digitalization of the external business environment, Task characteristics, task interdependence **2. Capabilities:** IT investment, Information processing capabilities - AI adoption **3. Learning Capacity:** Adaptive learning, Generative learning **4. Outcomes:** Financial performance, Relationship quality, Marketing innovation
[15] Chowdhury et al. (2022)	Human Resource Management	**1. Resources to Develop AI Capability** ***1.a. Technical Resources:*** Data resources, Technology infrastructure, AI transparency ***1.b. Non-technical Resources:*** Financial, Time requirements, Technical skills, Business skills, Leadership, Culture, Teams coordinations, Organization change, Knowledge management, AI-employee integration, Governance and regulation **2. Context of Use:** Automation, Augmentation **3. Impacts of AI Capabilities and Use on Human Workforce:** Job design, Job characteristics, Autonomy, Trust and confidence, Job satisfaction and motivation, Career development, Team structure, Creative skills, Innovation mindset **4. Organizational Outcomes:** Process efficiency, Data driven decision making, Product/service innovation, Customer satisfaction, Employee productivity, Sustainable business performance, Brand image
[10] Enholm et al. (2021)	Business (General)	**1. Enablers and Inhibitors:** Technological, Organizational, Environmental **2. Use:** Automation, Augmentation **3. First-order Effects:** Process efficiency, Insight generation, Business process transformation **4. Second-order Effects:** Operational performance, Financial performance, Market-based performance, Sustainability performance, Unintended consequences and negative impacts
[14] Huang and Rust (2020)	Marketing	**1. Mechanical AI:** Data collection, Segmentation, Standardization. **2. Thinking AI:** Market Analysis, Targeting, Personalization **3. Feeling AI:** Customer understanding, Positioning, Relationalization
[13] Mikalef et al. (2019)	Business (General)	**1. AI Capability:** Data, AI Culture, Infrastructure, Organizational learning, Technical & Managerial skills **2. Use:** Automation, Decision support, marketing, innovation **3. Outcome:** Competitive Performance
[12] Nortje and Grobbelaar (2020)	Business (General)	**1. Infrastructure:** Infrastructure Platform, Services, Information Networks, Communication Networks, Technological Sustainability and Position Map **2. Employee and Culture** **3. Technology Management**: Technological Categorization and Planning, Technology Requirement Handling, Technology Investment and Capital Management, Cost Management, Technological Competitors' Analysis, Cloud Resources, Network Connectivity, Technology Risk Management, Quality Management, Human Resource Planning **4. Organizational Governance and Leadership:** Executive Support, Budget, Business Opportunity, Strategic Leadership, Business Cases **5. Security** **6. Strategy**: Trial-Ability, Business Clarity, Observable Results, Technology Roadmaps and Scenarios, Technology Forecasting, Technology Forecasting **7. Knowledge and Information Management:** Management Information System and Data Processing, Agent Based Applications, Return on Investment, ERP in Terms of Databases and Software, Technology Knowledge Management, Technology Identification and Selection
[16] Wirtz and Müller (2018)	Public Management	**1. Technology Infrastructure Layer:** Data Acquisition, Data Processing, Data Embedding **2. Functional Layer:** Sense, Comprehend, Act **3. Applications & Services Layer**

Overall, these articles provide valuable insights into the adoption and implementation of AI in business contexts. They offer frameworks, models, and strategies for organizations to leverage AI capabilities effectively, while considering organizational readiness, complementary assets, and potential business value creation. Additionally, the articles address the implications of AI in specific domains like marketing, human resources, and public management.

Upon comparing all frameworks, the following differences and similarities become apparent. It is observed that [11] and [15] categorize the business impacts and outcomes of AI specifically within the domains of marketing and human resource management. Additionally, reference [11] takes a more technical approach to AI classification by discussing two types of learning capabilities in AI algorithms, which sets it apart from other studies. In [14], a framework is developed solely based on the capabilities of AI, with no emphasis on the resources for AI technologies or its impacts and outcomes for businesses. In [13], the AI use dimension has been examined under four subcategories: augmentation, decision support, marketing, and innovation. However, rather than being treated as separate subcategories, decision support and innovation are more accurately considered under the umbrella of augmentation. Meanwhile, marketing applications can either be evaluated as automation or augmentation, depending on how they are applied.

On the other hand, reference [12] focuses on the infrastructure, resources, and enablers that are crucial for an enterprise's AI implementation, but it does not delve into the use of AI or the outcomes for a business. In [16], a unique dimension is presented that focuses on the functional layers of an AI system, which outlines the fundamental workflow from sensing the environment, understanding the data, and taking appropriate actions. However, in the study, the developed framework only addresses the technology infrastructure aspect in terms of resources and does not delve into outcomes. In [10], a comprehensive framework is developed covering enablers and outcomes, encompassing other studies. The AI use dimension in this study includes subcategories of automation and augmentation, similar to [15]. This dimension in both studies provides a more generic and inclusive perspective on the implementation of AI, differing from other works. Upon reviewing all these studies, it has been observed that the framework presented in [10] encompasses aspects of other studies and provides a more suitable categorization for the purpose of this case study.

3. Methodology

We followed a case study approach employing content analysis to investigate VW's utilization of AI, spanning the last five years. Primary data sources that are used include news articles from VW's official media pages, external news channels, organizational websites interacting with VW, annual reports, and official project documents. The data collection spans the last five years, ensuring comprehensive coverage of VW's AI initiatives.

To facilitate data analysis, 12 news shared on news channels related to VW were examined, along with VW's annual reports from the last five years. The websites of companies providing AI services or AI infrastructure to Volkswagen were reviewed.

Additionally, Google searches were conducted with keywords such as "Volkswagen AI," "VW AI projects," "VW machine learning initiatives," "Volkswagen autonomous driving technology," "VW AI applications," "Volkswagen AI research," "VW smart technologies," "Volkswagen AI in production," "Volkswagen smart manufacturing," and "Volkswagen AI investment" to find relevant news from other sources. In total, 18 news found through searches, the websites of 3 companies providing services to Volkswagen (Amazon, Argmax, and Actico), and 1 annual report were selected for examination within the scope of this case. These sources were examined by each author, considering the framework. Topics related to VW's use of AI were categorized separately within the framework by the authors. The similarities and differences between the authors observations were discussed. As a result of the discussion, 30 findings deemed suitable for the framework from the examined sources were placed on a common schema.

Finally, the findings derived from the content analysis are presented in a tabular format (Table 2), allowing for a clear and concise representation of key insights. This presentation facilitates stakeholders' access to and comprehension of the implications of VW's AI endeavors, supporting informed decision-making and strategic planning. The insights provided enable researchers to gain a deeper understanding of the academic and practical impacts of the initiatives, encouraging further exploration and investigation in the field.

4. Volkswagens' AI Use Cases

In this comprehensive case study, we delved into VW's strategic integration of AI across various facets of its operations. The exploration of use cases is meticulously categorized, encompassing AI enablers, automation and augmentation applications, process-level impacts, and the far-reaching implications at the firm level. Drawing insights from research findings, news sources, and organizational reports, this section provides a nuanced understanding of how VW leverages AI technologies to enhance efficiency, automation, and sustainability within its diverse range of processes and functions.

4.1. Enablers

At the core of VW's supply chain transformation lies the VW Industrial Cloud, a sophisticated platform built on Amazon Web Services (AWS). With 124 factory sites worldwide and a vast network of over 1,500 suppliers, VW sought to consolidate its operations into a single architecture to enhance efficiency and collaboration [17]. Leveraging AWS technologies in IoT, machine learning, data analytics, and computing services, VW established a scalable and agile infrastructure tailored to the automotive industry's unique requirements. Utilizing AWS machine learning services, VW harnesses data from sensors on the shop floor to drive predictive maintenance and optimize production processes [18].

Additionally, AWS Outposts extend the capabilities of the Industrial Cloud to factory sites, ensuring seamless integration and real-time data exchange. By creating an open platform, VW empowers partners to contribute innovative solutions, fostering a collaborative ecosystem geared towards mutual benefits and continuous improvement.

Table 2.
VW AI Use Case Categorization Based on AI Business Value Framework

ENABLERS	AI USE	PROCESS-LEVEL IMPACTS	FIRM-LEVEL IMPACTS
a. Technological Infrastructure ***Amazon Web Services:*** **Machine** learning services — running algorithms using information gathered from sensors on the shop floor — and AWS Outposts [17], [18]. ***Industrial Cloud:*** Cloud computing solutions tailored for industrial applications and manufacturing processes (IoT Integration, Analytics and Insight, SCM, Manufacturing Process Optimization) [19], [20]. ***VW Automotive Cloud:*** Expedite the realization of connected vehicle services, encompassing intelligent driver-assist systems and personalized communication and navigation solutions [21]. **b. Organizational Enablers** **Strategy:** Utilizing collaborative approaches and investing to pioneer software, hardware, mapping, and cloud infrastructure for self-driving vehicles [22], [23]. ***Culture:*** Establishment a proactive embrace of AI technology, aimed at driving innovation in digital products and fostering a collaborative culture across global tech sectors to swiftly develop and implement advanced digital prototypes [24], [25]. ***Managerial & Financial Support:*** Spearheading initiatives to integrate AI technologies across brands and business units, manage IT projects, drive cultural change, spur innovation [26]. Funding initiative underscores its commitment to advancing responsible AI development by providing substantial financial support, spanning social and technical sciences [27].	**a. Automation** ***Intelligent Robots (Cobots):*** Intelligent collaborative robots (cobots) powered by AI in its manufacturing processes, contributing to increased automation and efficiency in the automotive domain [20]. ***Mobile Charging Robots:*** Fully autonomous charging of electric vehicles in confined spaces, such as underground garages, aiming to contribute to the expansion of the electric vehicle charging infrastructure [28]. ***Chatbots:*** The integration of Cerence Chat Pro, powered by ChatGPT, into VW's voice assistant enhances in-car interactions, providing advanced capabilities such as controlling infotainment, navigation, and air conditioning through intuitive language [29]. ***NLP:*** Identifying similarities and patterns in reports and claims. This systematic analysis facilitates the rapid detection of potential quality issues, allowing for timely feedback into the early stages of product development, thereby augmenting overall product quality efforts. [30] **b. Augmentation** ***Prewave:*** Utilizing AI, specifically an algorithm developed by the Austrian start-up Prewave, to proactively identify sustainability risks across their supply chain. This AI-driven monitoring system scans publicly available media and social networks in over 50 languages and 150 countries, providing early warnings for potential breaches related to environmental pollution, human rights abuses, and corruption [31]. ***Actico:*** Development of an ML-enabled statistical forecast model, which evaluates the probability of fraud in credit applications and thus, enables the targeted management of questionable applications [32]. ***Blackwood Seven:*** Employing an AI-driven media agency, to enhance its media buying decisions in Germany, leveraging predictive analytics and transactional data for optimal media investment strategies [33].	**a. Process efficiency** ***Improved productivity:*** Enhancing productivity by integrating collaborative robots that work alongside humans, leveraging AI to streamline and optimize manufacturing processes [20]. ***Reduce/eliminate human errors:*** Accurate application of country-specific labels on vehicles, quality testing by detecting the finest defects in components using computer vision [34] [30]. **b. Insight generation** ***Decision quality:*** Identifying patterns and optimize strategies, emphasizing augmentation rather than replacement of human decision-makers, ensuring that algorithms serve to support and empower employees rather than supplanting their expertise in strategic decision-making [30]. **c. Business process transformation** Transforming core business operations for digitalization by integrating AI technologies to enhance efficiency and innovation [35].	**a. Operational performance (New products and services)** ***AI-Optimized material structures:*** Utilizing AI to develop a modular repeating structure of tiny pyramids, significantly reducing the weight of the steel frame housing electric vehicle batteries, enhancing range, and providing a durable, lightweight alternative [36]. **b. Financial performance** ***Amazon Web Services:*** Implementation of the VW Industrial Cloud on Amazon Web Services is expected to yield substantial financial impacts for the VW, including a targeted 30 percent increase in productivity, a 30 percent decrease in factory costs, and potential savings of €1 billion in supply chain costs [17]. **c. Sustainability performance** ***Smart management of energy:*** To generate sustainable savings, for example in compressed air control systems [26]. ***Inclusive Mobility:*** Addresses mobility challenges faced by people with disabilities through the development of autonomous vehicles and related technologies [37]. **d. Unintended consequences and negative impacts** Challenges and financial risks faced highlighting the struggle to develop profitable business models amidst the high costs and uncertain market demand for autonomous mobility services [38].

The adoption of the Industrial Cloud positions VW to achieve global efficiencies in its manufacturing operations [19]. By facilitating data interchange between systems and plants VW aims to enhance visibility and decision-making across its supply chain, paving the way for enhanced agility and responsiveness to market demands.

In a business, enablers for AI aren't solely comprised of the technological infrastructure itself. The company's managerial approach, strategy, and investment decisions in this area also contribute as organizational enablers influencing AI value. Under the banner of the NEW AUTO strategy [26], VW has redefined its vision, aiming to become a software-oriented provider of sustainable mobility. Central to this strategy is the recognition of technology and data competence as the key drivers of transformation. VW established the IT Board position and formulated the NEW IT functional area strategy, focusing on delivering highly automated enterprise processes, agile development of IT products, and systematic utilization of data across the organization. This strategy is bolstered by strategic investments, including a $2.6 billion investment in Argo AI aimed at pioneering software, hardware, mapping, and cloud infrastructure for self-driving vehicles. After this investment, despite Argo AI's failure [38], continuing investments in similar areas for partnerships with Horizon Robotics and CARIAD demonstrate the company's commitment to this direction of strategy [23]. Additionally, VW has proactively embraced AI technology, fostering a culture of innovation and collaboration. The establishment of the AI Lab signifies VW's commitment to leveraging AI for the development of digital products and services [25]. By acting as a globally networked competence center and incubator, the AI Lab facilitates collaboration with the tech sector to rapidly develop digital prototypes and transfer them to VW brands for implementation.

4.2. AI Use

Our findings suggest that, at the heart of VW's automation strategy lies the integration of intelligent collaborative robots (cobots) powered by AI. These cobots collaborate with human operators, augmenting their capabilities and driving efficiency in manufacturing processes [20]. By automating repetitive tasks and streamlining assembly line operations, VW achieves higher productivity, reduced cycle times, and enhanced product quality.

Another automation use, VW's commitment to electric mobility is exemplified by its development of fully autonomous charging robots. These robots enable charging of electric vehicles in confined spaces, such as underground garages, contributing to the expansion of the electric vehicle charging infrastructure. Through AI-driven automation, VW ensures convenient and accessible charging solutions for EV owners, driving the adoption of electric vehicles [28].

In the realm of customer interaction, VW has leveraged AI to enhance in-car experiences through chatbots and NLP algorithms [29]. By integrating Cerence Chat Pro, powered by ChatGPT, VW's voice assistant systems enable intuitive language-based control of various vehicle functionalities. Another usage where NLP is utilized for automation is analyzing reports and claims systematically, facilitating the rapid detection of potential quality issues [30]. This automation streamlines customer service processes, improves user experiences, and ensures timely resolution of quality concerns, ultimately enhancing customer satisfaction and brand loyalty.

To bolster its sustainability efforts, VW collaborates with Prewave, an Austrian start-up, leveraging AI to proactively identify sustainability risks across its supply chain. Prewave's AI-driven monitoring systems scan publicly available media and social networks, providing early warnings for potential breaches related to environmental pollution, human rights abuses, and corruption. By augmenting its supply chain management with AI-driven insights, VW mitigates risks, upholds ethical standards, and fosters sustainable business practices [31].

In the realm of financial management, VW harnesses AI-enabled statistical forecast models developed by Actico to evaluate the probability of fraud in credit applications. By augmenting traditional risk assessment processes with AI, VW can identify and manage questionable applications more effectively, minimizing financial risks and optimizing credit approval processes [32]. This augmentation enhances financial security, ensures compliance, and strengthens VW's position in the market.

In optimizing its marketing strategies, VW partners with Blackwood Seven, an AI-driven media agency. By leveraging predictive analytics and transactional data, Blackwood Seven's AI algorithms enhance VW's media buying decisions, ensuring optimal allocation of resources and maximizing advertising impact [33]. Through AI-driven augmentation, VW enhances its marketing effectiveness, reaches target audiences more efficiently, and drives brand awareness and sales.

4.3. Process-Level Impacts

In terms of process efficiency, Volkswagen has witnessed significant improvements through the integration of AI technologies. Firstly, the introduction of collaborative robots, or cobots, alongside human workers has remarkably enhanced productivity within manufacturing processes [20]. These cobots, powered by AI, streamline operations and optimize workflows, ultimately leading to reduced cycle times and increased output in Volkswagen's production facilities. Moreover, Volkswagen has effectively tackled the issue of human errors through AI implementation. For instance, in the application of country-specific labels on vehicles, AI algorithms ensure precise placement and adherence to regulatory standards [30]. Similarly, quality testing procedures leverage computer vision technology to detect even the minutest defects in components, thereby enhancing overall product quality and reliability [34].

Moving to insight generation, VW emphasizes augmenting human decision-makers rather than replacing them entirely with AI. By leveraging AI to identify patterns and optimize strategies, VW empowers employees to make informed decisions swiftly and effectively. This approach ensures that AI serves as a supportive tool, enhancing human expertise in strategic decision-making and ultimately improving decision quality across the organization [30]. Furthermore, VW is undergoing a profound business process transformation through the integration of AI technologies. By embracing digitalization, VW enhances efficiency and innovation across its entire value chain. AI-driven solutions optimize processes, automate tasks, and unlock new opportunities for growth and competitiveness [35]. As VW continues to evolve, AI plays a central role in driving business process transformation, ensuring its position as a leader in the automotive industry.

4.4. Firm-Level Impacts

VW's adoption of AI intelligence brings about operational advancements, particularly in the realm of product innovation. By leveraging AI-optimized material structures, VW engineers develop a modular repeating structure of tiny pyramids, significantly reducing the weight of steel frames housing electric vehicle batteries [36]. This innovation not only enhances the range of electric vehicles but also provides a durable, lightweight alternative, showcasing VW's commitment to pushing the boundaries of automotive engineering.

Furthermore, the integration of AI in vehicles enables VW to offer smart features that transform traditional automotive offerings into innovative products. These smart features enhance safety, connectivity, and overall user experience, setting VW apart in a competitive market landscape [39]. By embracing AI-driven advancements, VW enhances its operational performance by delivering cutting-edge products that meet evolving consumer demands.

The implementation of the VW Industrial Cloud on Amazon Web Services (AWS) promises significant financial impacts for the VW Group. By leveraging AWS's cloud infrastructure, VW targets a 30 percent increase in productivity and a corresponding 30 percent decrease in factory costs. Additionally, VW anticipates potential savings of €1 billion in supply chain costs, underscoring the financial benefits of AI integration for operational efficiency and cost optimization [17].

In pursuit of sustainability, VW employs AI-driven solutions to optimize energy management, particularly in compressed air control systems. By smartly managing energy usage, VW not only reduces operational costs but also minimizes environmental impact, aligning with its commitment to sustainable practices [26]. Furthermore, VW addresses mobility challenges faced by people with disabilities through the development of autonomous vehicles and related technologies, promoting inclusive mobility and social sustainability [37].

However, alongside these positive impacts, VW faces challenges and financial risks associated with the development of autonomous mobility services [38]. The high costs and uncertain market demand for autonomous mobility services pose significant hurdles, highlighting the complexities of developing profitable business models in this emerging field. VW must navigate these challenges while maintaining its commitment to innovation and sustainability, ensuring that its AI-driven initiatives deliver long-term value for both the company and its stakeholders.

5. Conclusion and Discussion

The in-depth case study of the AI integration efforts of VW has thrown up several intriguing points and implications for the organizations that want to tap into the power of AI efficiently.

The first thing the case study brings to attention is the key role of having a well-built technological infrastructure to enable AI integrations. Such as VW's Industrial Cloud and strategic alliance with major tech providers (AWS), a perfect fit for the kind of scalable and flexible computing solutions that suit the peculiar nature of an organization's operating industry or operations. In addition to improving efficiency and collaboration between

members, VW implements an integrated architecture that allows partners to respond to changing requirements with new solutions, thus forming a purposeful environment for mutual benefit and progress in the long term.

In a nutshell, the case study also points out the role of organizational supporters in AI implementation. The strategic vision of VW, embodied in the words of its NEW AUTO strategy and the setting up of its AI Lab, clearly shows the critical part leadership, culture, and cross-functional collaboration plays in the use of AI. With its proactive approach to embracing AI technology, and by promoting an innovative environment, the carmaker has become the setting for the quick growth and implementation of top-notch digital prototypes, ultimately leading the process of turning AI-driven value into reality.

The last part of the study also shows that AI has various implications from automation, augmentation, and business process transformation among others. The utilization of AI in the form of intelligent collaborative robots (cobots) by VW manifests the ability of AI to automate redundancy, as well as improve system efficiencies and productivity in general. Among all these cases, another notable value that stands out is the adoption of AI in vehicles. Enhanced in-car assistants utilizing large language models represent a very current example. On the other hand, taking the concept of autonomous vehicles to a different perspective through making mobility solutions more accessible and inclusive for everyone, including individuals with disabilities or special mobility needs is another noteworthy topic.

Alongside concrete case studies that have tangible outcomes examined within the framework, there are also potential applications and implications. In addition to the Automotive Cloud's promises for future automobiles, such as enhancing emergency assistance and remote vehicle access, it also has the potential to significantly impact battery optimization and development. By leveraging the driving and battery data generated by vehicles, the cloud can contribute to the refinement of batteries, leading to longer ranges and improved performance. This data-driven approach holds immense potential to drive innovation within the automotive industry, paving the way for more efficient and sustainable vehicles.

As stated in the introduction, one aim of this study is to test the external validity of the framework. We are aware that focusing on a single example and a single sector for validation purposes is a weakness of the study. However, we are able to provide recommendations for the framework we used and the process of AI integration in business. Beginning with a suggestion for the framework we use, we can emphasize the importance of determining whether AI use pertains to products or business processes. In the cases we examined, we couldn't precisely align business value with either products or processes within the framework. As a suggestion, similar to how AI use is categorized into two headings, automation and augmentation, the distinction between whether business value is related to products/services or the business's processes could be made, thereby expanding and updating the framework.

During the study, another issue that caught our attention was the geographical bias in AI integration. The cases we examined cover very diverse destinations. In such a situation, it's crucial to consider geographical variations and potential biases when applying the framework across different countries and regions. Local context, cultural norms,

regulatory environments, and market dynamics all play significant roles in shaping the adoption and impact of AI technologies on businesses worldwide. Our humble suggestion is to consider these aspects for future research to develop a more robust framework design or to ensure successful AI integration efforts.

Beyond the knowledge about the challenges and opportunities of AI implementation in the automotive giant, we hope that this study also offers benefits for other industries that are looking for solutions on the same path. Through providing lessons from the AI travel experience of VW, the study provides a base of knowledge, for strategic planning and implementation, and for responding to the risks and unintended consequences that might appear.

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