How AUDI AG Established Big Data Analytics in Its Digital Transformation

Digital transformation, which often includes establishing big data analytics capabilities, poses considerable challenges for traditional manufacturing organizations, such as car companies. Successfully introducing big data analytics requires substantial organizational transformation and new organizational structures and business processes. Based on the three-stage evolution of big data analytics capabilities at AUDI, we provide recommendations for how traditional manufacturing organizations can successfully introduce big data analytics and master the related organizational transformations.[1,2]

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Digital Transformation Often Requires Big Data Analytics Capabilities

Digital technology plays an increasing role in everyone's daily lives. In particular, in the context of personal mobility, digital technology changes the nature of product value propositions. In response to these trends, many businesses are embarking on digital transformations, and as they do so they will often need to acquire and build big data analytics capabilities. However, to develop the necessary capabilities requires more than lots of data. Companies need to fundamentally transform their decision-making processes.

The focus of this article is on product manufacturers that need to create big data analytics capabilities so they can leverage digital technology to change the nature of their offerings and

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value propositions.[3] Existing efforts focus on the business value of data and are providing insights on leveraging vast amounts of data.[4] For example, insights gained from analyzing huge amounts of data derived from customer interactions over digital channels are transforming the effectiveness of sales processes.[5] In particular, the adoption of evidence-based decision making, not only in sales but in most organizational functions, is improving organizational performance.[6]

Establishing Big Data Analytics Capabilities is a Challenge for Car Manufacturers

One industry that is strongly impacted by digital technologies is automotive manufacturing. Digitization is leading to disruptive product innovations (e.g., autonomous driving), new business models (e.g., mobility-as-a-service and pay-as-you-go services within the car) and digital services (e.g., product recommendations and predictive maintenance). Apart from car assistance and autonomous driving systems, personalized digital services such as remote checks, maintenance reminders, local interest guidance, digital security services and personal entertainment are increasingly valued by drivers.[7] By embedding electronic systems in their cars, automobile manufacturers are providing digital services that increasingly complement the car.

Unlike innovative car manufacturers, such as Tesla or Faraday Future, traditional car manufacturers are finding it challenging to adapt to this "new normal." The necessary digital transformation requires new roles, such as a chief digital officer (CDO)[8], and organizational structures to be established. Despite their historic focus on traditional product engineering and car manufacturing, they have begun to understand that digital services embedded in their physical products are an additional channel for delivering value to the customer. Moreover, they are striving to restrict access by third parties to the data that is produced during a driver's interaction with the car (including the multimedia interface to in-car entertainment systems). And as over-the-air car software updates become possible, product engineering is no longer constrained by long product development cycles and model series. As a consequence, the ability to manage and exploit data about cars and customers is becoming a key competitive competency. This data includes, for instance, telemetry, location and environment data, and the ability to analyze and exploit it requires big data analytics capabilities.

Traditional car manufacturers excel in designing, manufacturing and selling products with long development life cycles of up to seven years and that require high upfront investment. Hence, they face tremendous challenges when aligning their business processes and organizational structures to the dynamics of digital services markets and formulating a digital business strategy.[9] In particular, adopting and assimilating big data analytics requires structural, capability, cultural and procedural transformations across the entire organization. First, issues concerned with data access, data ownership and joint analytics projects become important, and their resolution often requires organizational transformations (e.g., establishing

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3   For an article explaining the transformations needed to harness smart and connected products, see Porter, M. E. and Heppelmann, J. E. "How Smart, Connected Products are Transforming Companies," *Harvard Business Review* (93:10), October 2015, pp. 96-114.

4   For a practical example of how data can be monetized in the retail industry, see Najjar, M. S. and Kettinger, W. J. "Data Monetization: Lessons from a Retailer's Journey," *MIS Quarterly Executive* (12:4), December 2013, pp. 213-225.

5   A survey among German and British car dealers found that digitization has its strongest impact when the new vehicle sales processes include data-supported marketing and lead management as well as digital customer interaction. For details, see Krings, J., Bakker, J. and Koster, A. "Unlocking the value of digitization in automotive sales and distribution," PwC, 2013, available at http://www.strategyand. pwc.com/media/file/Strategyand_Digitization-Automotive-Sales-Distribution.pdf.

6   For anecdotal evidence of the successful use of big data see Davenport, T. H., Big Data at Work: Dispelling the Myths, Uncovering the Opportunities, *Harvard Business Review Press*, 2014.

7   A survey among 10,000 consumers in eight countries found that digital experiences and expectations have a substantial impact on the auto buying decision. For details, see Gissler, A., Oertel, C., Knackfuß, C. and Kupferschmidt, F. *Are you ready for pole position?*, Accenture, 2016, available at https://www.accenture.com/us-en/insight-pole-position-driving-digitization-auto-industry.

8   For a detailed description on the role of the CDO in the era of big data, see Yang, L., Madnick, S., Wang, R., Wang, F. and Hongyun, Z. "A Cubic Framework for the Chief Data Officer: Succeeding in a World of Big Data," *MIS Quarterly Executive* (13:1), March 2014, pp. 1-13.

9   For an article on design options for a digital strategy see Hess, T., Matt, C., Benlian, A. and Wiesböck, F. "Options for Formulating a Digital Transformation Strategy," *MIS Quarterly Executive* (15:2), June 2016, pp. 123-139. For the successful implementation of a digital strategy in the banking industry, see Sia, S. K., Soh, C. and Weill, P. "How DBS Bank Pursued a Digital Business Strategy," *MIS Quarterly Executive* (15:2), June 2016, pp. 105-121.

new analytics and IT units, and a digital innovation hub, and new modes of collaboration between IT and the business). Second, companies need to develop sufficient capabilities (e.g., business acumen, analytics and technical capabilities) and to adopt a shared mindset about the role of data as a critical success factor (i.e., a data-driven culture).[10] Third, insights drawn from big data analytics may significantly improve the information available to managers and thus improve their ability to make evidence-based decisions.[11]

This article describes the journey of AUDI AG, a German car manufacturer, as it established big data analytics and discusses the changing role of AUDI's IT department. This case illustrates the advantages of the organizational design adopted by AUDI and identifies how to overcome the organizational obstacles encountered on the journey toward establishing big data analytics.

A Brief Introduction to AUDI AG

AUDI AG, together with its subsidiary Lamborghini S.p.A., is among the most successful automobile companies in the premium and super sports car segments. The company shipped more than two million luxury cars worldwide in 2015. Originally established in 1909 by August Horch, the company was acquired by Volkswagen (VW) in 1966. Headquartered in Ingolstadt, Germany, it has been operating under the AUDI name since 1985. AUDI's slogan is "Vorsprung durch Technik,"[12] which is well established in the corporate culture and brand image. Consistent with this slogan, the company aims at further extending its market leadership by leveraging digital technology to provide superior products and services to its customers.

"Vorsprung durch Technik is AUDI's brand DNA. It first and foremost describes our

technological ambition but also goes much further: it is the attitude that characterizes the entire AUDI team and pervades everything we do, across every area of our company. Because we want to be the most progressive premium brand in the automotive industry." Luca de Meo, Former Chief of Sales and Marketing[13, 14]

To address the structural and operational requirements of the digital transformation needed to deploy big data analytics, in 2013, AUDI created AUDI Business Innovation GmbH (ABI). This subsidiary is based in Munich, Germany, and its role is to extend the capabilities of existing departments (e.g., IT department and the sales and marketing organization) to develop and implement digital business innovations.

"Interdisciplinary teams are very crucial for success in the future, especially to create technology as well on the business innovations. We decided to create a company located in Munich together with our colleagues from sales and marketing, and we [tasked] IT with bringing teams together that are really focused on creating new solutions for our customers based on new [digitization] technologies." Mattias Ulbrich, Chief Information Officer[15]

ABI is an interdisciplinary digital innovation hub that focuses on the design, development and operation of innovative business concepts, products and services. Its main areas of activity are smart premium mobility, digital retail and analytics services. ABI's agile development teams embrace various disciplines, including software development, big data architecture, data science and user experience. It also has visualization experts who work closely with the respective departments at AUDI. The collaboration of the digital innovation hub with the *data analytics and strategy* unit established within the sales and marketing department, and with the IT

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10   For an explanation of a data-driven culture and its implications for business value in the organizational context, see Kiron, D. and Shockley, R. "Creating business value with analytics," *MIT Sloan Management Review* (53:1), September 15, 2011, pp. 57-63.

11   For an article on evidence-based decision making, see Ross, J. W., Beath, C. M. and Quaadgras, A. "You May Not Need Big Data After All," *Harvard Business Review* (91:12), December 2013, pp. 90-98.

12   The English translation of AUDI's slogan is "Advancement [or progress] through Technology." Since 2007, however, in the U.S. the company has used the slogan "Truth in Engineering."

13   "An interview with Luca de Meo," *Automotive Insights* (1:14), Roland Berger Strategy Consultants, January 2014, available at https://www.rolandberger.com/publications/publication_pdf/roland_berger_tam_automotive_insights_01_2014_20140115.pdf.

14   All quotations in this article are from AUDI personnel.

15   Ibaraki S. *"CIPS INTERVIEWS: Mattias Ulbrich Top International Leader and Innovator, CIO Audi, Winner 2015 EU CIO of the Year,"* CIPS, available at http://www.cips.ca/node/2995.

department, forms the core of AUDI's analytics-as-a-service initiative for leveraging big data analytics.

The Evolution of AUDI toward Big Data Analytics

AUDI's capabilities have evolved through three stages on its journey toward effectively establishing big data analytics. We have labeled these stages as *Advancing*, *Enabling* and *Leveraging* to indicate how big data analytics capabilities advance through the stages (see Figure 1).

In the *Advancing* stage, which began in 2013, the first step was for the digital innovation hub and the data analytics and strategy unit within the sales and marketing department to develop required competencies and capabilities in the field of data analytics. The analytics demands of business units were met one at a time through pilot cases. A mixture of reporting services and

descriptive[16] analytics services was developed using marketing data as the main data source. At this stage, however, decision-making processes were not yet supported by data-based insights.

In the next, *Enabling,* stage, the IT department started to provide technology support for data analytics and thus enabled the digital innovation hub and the sales and marketing department to begin to exploit big data. These three partners met demands for analytics services according to the priorities of business units. Advanced descriptive analytics services were developed by the digital innovation hub in collaboration with the data analytics and strategy unit within the sales and marketing departments and supported by the IT department using more advanced analytics methods (e.g., neural networks) and marketing data. Decision makers gained a better understanding of the value of data analytics, and they began to supplement intuitive and experience-based decision making with data-based insights.

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16 *Descriptive analytics services* explain what happens or is happening and why it is most probably happening. They examine patterns or causalities within data using an explanatory analytics model.

Figure 1: The Three-Stage Evolution of AUDI toward Big Data Analytics
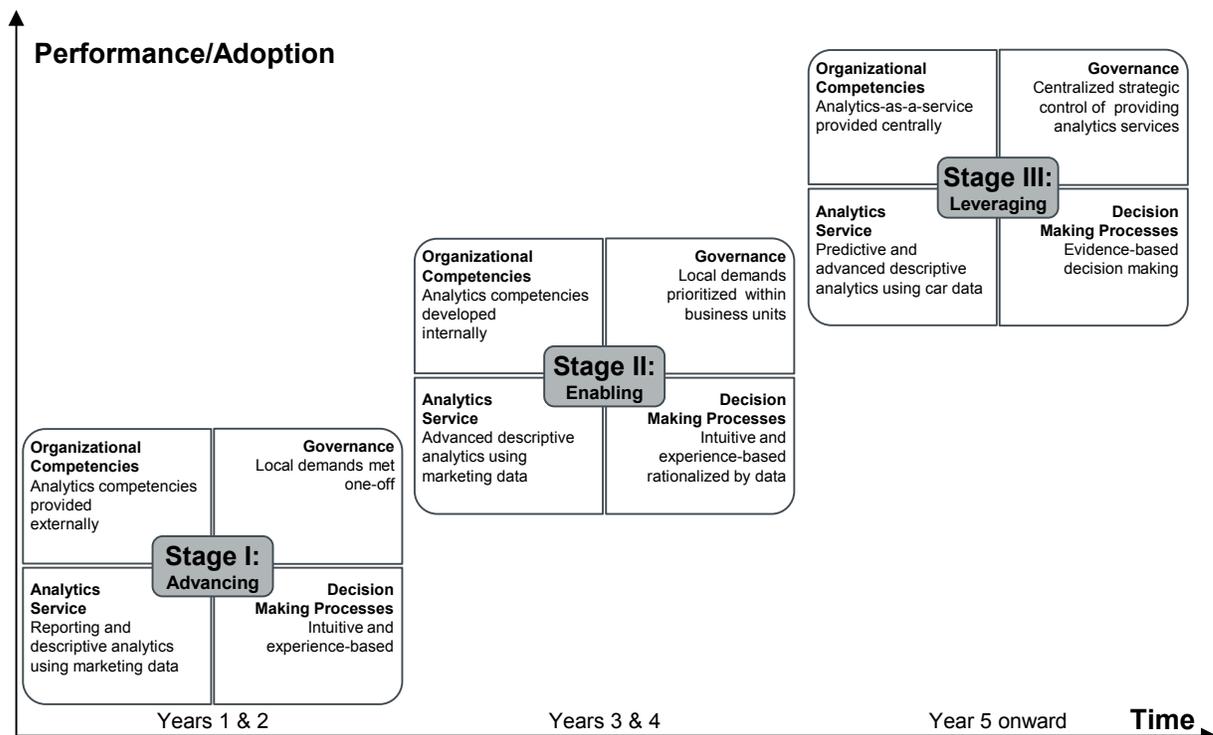
AUDI is currently at the start of the final, *Leveraging,* stage of its journey. The IT department now has the ability to provide data analytics solutions and, in consultation with the sales and marketing department and digital innovation hub, to identify possible further use cases. The current and main focus is on providing "analytics-as-a-service" with advanced analytics methods (i.e., predictive[17] and advanced descriptive analytics) and leveraging operational car data in the design of digital services for drivers of AUDI cars. Big data analytics is thus enabling evidence-based decisions for digital business opportunities.

Stage I: Advancing

In the first, Advancing, stage of the journey, AUDI's sales and marketing department initiated data analytics projects and was held accountable for their success. At this stage, AUDI acquired analytics competencies by using external partners. Commitment for data analytics within the organization grew slowly, and the strategic importance of the area was increasingly recognized. During this first stage, the IT department played a passive role, responding to those who initiated data analytics projects. The digital innovation hub, however, laid the technology foundation for big data analytics during the Advancing stage. Figure 2 summarizes Stage I of the journey toward establishing big data analytics, and the characteristics of the stage are described below.

> *"[The engagement of the digital innovation hub and external consultancies] led to a bad atmosphere at the IT department as [the hub and consultancies] took over their job, and they felt somewhat run over. After-effects are still noticeable [three years later]."* Head of Data Analytics and Strategy

Analytics Competencies Provided by an External Partner. Initially, in 2013, AUDI engaged an external IT consulting firm to gain access to external knowledge and methodological input for data analytics. In cooperation with this consulting firm, the newly created data analytics and strategy unit (within the sales and marketing department) was responsible for analyzing
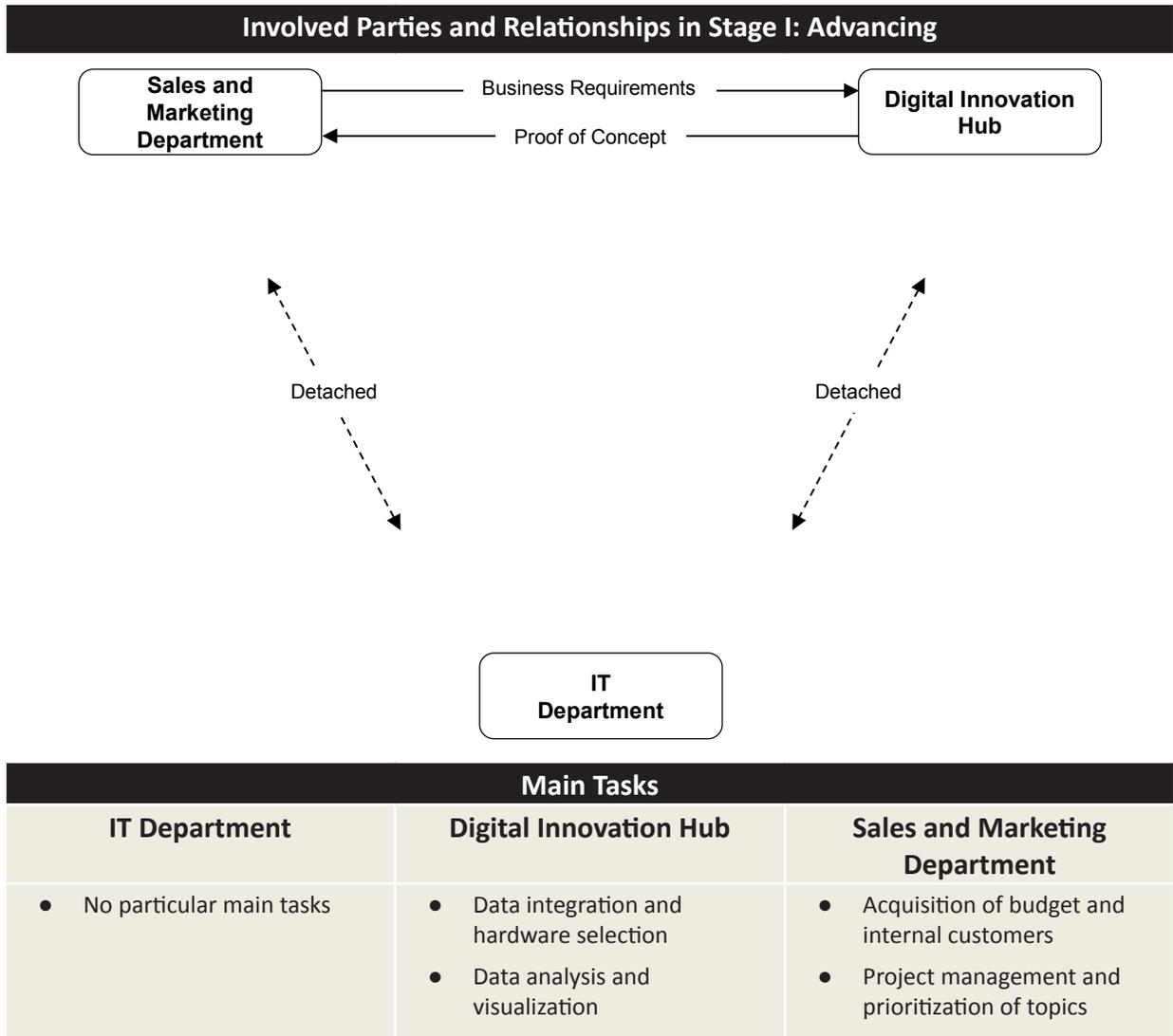
the data flowing through AUDI's web portals. Later, in 2013, the company established the digital innovation hub (ABI) with the objective of replacing the external consultancy and developing internal big data analytics expertise. The IT department had traditionally acted as a coordinator in the field of data analytics by commissioning consultancies and had therefore not established substantial internal expertise. Thus, the consulting firm engaged during Stage I performed the IT department's traditional technology tasks (e.g., data integration, conceptualization and selection of technology infrastructure). The newly established digital innovation hub then took on the responsibilities for these tasks, in cooperation with the sales and marketing department. Without the involvement of the IT department at an operational level, the digital innovation hub designed the big data analytics technology stack and took the first initial steps toward integrating this stack with the current IT landscape (see Figure 2).

As a consequence, the sales and marketing department carried out the first projects based on pilot use cases in cooperation initially with the external consultancy and later with the digital innovation hub. By and large, these activities were detached from the IT department. When the digital innovation hub replaced the external consultancy it assumed the responsibility (e.g., for analysis and visualization tasks) of the use cases and transferred them to a new IT infrastructure. The sales and marketing department communicated its business requirements to the digital innovation hub, and the lab delivered proof-of-concept of pilot use cases.

Meeting Local Demands One at a Time. In 2013, a digitization project team at AUDI's sales and marketing department demonstrated the potential of big data analytics through illustrative pilot cases presented at a steering committee for strategic sales initiatives. This resulted in the sales and marketing department establishing a data analytics unit with a specific focus on "connected retail" (supporting the digitization of AUDI's dealers through data analytics). This unit was established at the end of 2013 and was initially positioned at a low level in the sales and marketing hierarchy. However, it soon rose up the organizational hierarchy and, in 2014, became responsible for data analytics and strategy at

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17   *Predictive analytics services* are based on historical and current data and use analytics models to extrapolate into the future.

Figure 2: Summary of Stage I: Advancing

Main Tasks		
IT Department	**Digital Innovation Hub**	**Sales and Marketing Department**
● No particular main tasks	● Data integration and hardware selection ● Data analysis and visualization	● Acquisition of budget and internal customers ● Project management and prioritization of topics

sales and marketing. The establishment of this data analytics and strategy unit was the first step in creating the analytics capabilities that AUDI needed.

The sales and marketing department's data analytics and strategy unit managed and prioritized all data analytics projects, meeting one local demand at a time by providing proof-of-concept. Based on these proof-of-concepts, the unit was granted a strategic marketing budget. The unit acted as a cost center; it did not pass on the costs of its investments to its customer (i.e., internal units, importers and dealers). This represented a major success factor in establishing

data analytics in the sales and marketing department.

During this phase of Stage I, AUDI had not yet established specific committees to focus on digitization or data. Topics regarding data analytics were discussed only infrequently in existing committees. Although this led to a basic commitment to big data at an executive level, as well as at an operational level within the sales and marketing department, it proved to be inefficient in managing cross-functional data analytics projects.

"We had to prove that data analytics makes sense for AUDI. The problem was where

Table 1: Main Characteristics of Analytics Services at Stage I: Advancing

- Data Source: Marketing data
- Approach: Data-based workaround
- Service Type: Proof-of-concept
- Analytical Type: Reporting and descriptive analytics
- Service Orientation: Improvement of specific marketing topics

to start. Should we start with cleaning up, linking data sources, processes, building structures and then deliver our services, or should we work with short-term pilot use cases to acquire a strong commitment for our topic at AUDI? Traditionally, car manufacturing is just about selling cars, and data is not the focus of our business."
Head of Data Analytics and Strategy

Reporting and Descriptive Analytics Using Marketing Data. Initial proof-of-concept of analytics services for specific marketing topics (e.g., refining the marketing approach for the launch of the AUDI A3 e-tron) were piloted without explicitly co-creating the services with the final internal customers. (Table 1 lists the main characteristics of the analytics services in the Advancing stage of the journey.)

The aim of the proof-of-concept projects was to inform business units of the potential business value of big data analytics in an ad-hoc fashion and to gain their commitment. The sales and marketing department recruited internal pilot customers for the initial design and delivery of analytics services, and the services and their potential were presented at events run by the sales and marketing department for the managing directors of each sales market. Discussions were also held with business units to identify additional data-related use cases.
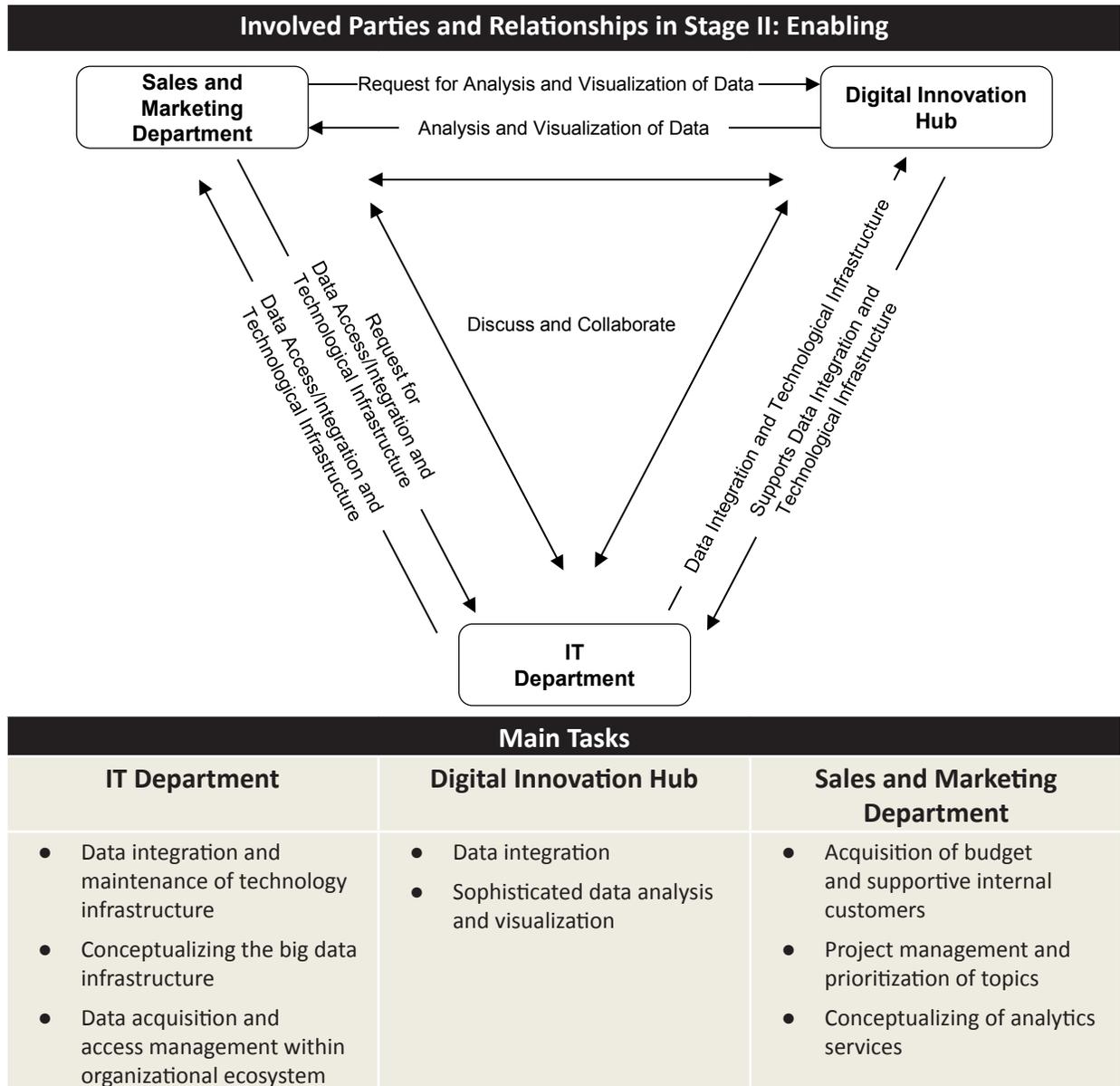
Because of the lack of a proper technology infrastructure provided by the IT department, and thus a low readiness for integrated data sources, analytics services were developed using a workaround approach. For instance, the digital innovation hub developed management dashboards by using the functionality of the visualization software to embed data in the dashboards and send them to internal customers as offline dashboards.

Intuitive and Experience-Based Decision Making. Initially, the positioning of the data analytics unit at a low level within the sales and marketing department, together with the lack of an IT department-supported infrastructure, made it difficult to gain commitment for big data analytics early on. However, the unit's subsequent rise up the hierarchy and the widening of its remit to include data analytics strategy, together with leadership support, paved the way both for greater commitment to big data analytics and for evidence-based decision making. Insights generated from analytics services were used in daily decision-making processes in the sales and marketing department only as on-top information. For example, the department analyzed the demographic distribution of customers for specific car models. This analysis was used to refine the marketing approach so it better addressed the target group and thus made marketing activities more effective and efficient.

Stage II: Enabling

In the second, Enabling, stage of AUDI's journey toward establishing big data analytics, analytics competencies were built up not only in the digital innovation hub, but also in the IT department. During this stage, the IT department enabled big data analytics through isolated technology activities, sometimes taking on or insourcing tasks previously carried out by external consultancies or the digital innovation hub. Analytics services were developed through a more advanced technology infrastructure (e.g., a Hadoop cluster for storing and processing the large volumes of data generated by cars) as well as analytics methods (e.g., descriptive analytics). Figure 3 summarizes the Enabling stage, and the characteristics of the stage are described below.

Figure 3: Summary of Stage II: Enabling

IT Department	Digital Innovation Hub	Sales and Marketing Department
• Data integration and maintenance of technology infrastructure • Conceptualizing the big data infrastructure • Data acquisition and access management within organizational ecosystem	• Data integration • Sophisticated data analysis and visualization	• Acquisition of budget and supportive internal customers • Project management and prioritization of topics • Conceptualizing of analytics services

"The role of IT had changed in a dramatic way. It was the first time we had a unit directly in charge of our topics at the IT department that facilitated our day-to-day work." Head of Data Analytics and Strategy

Analytics Competencies Developed Internally. Through close collaboration between the IT department with the digital innovation hub and with the sales and marketing department, AUDI built up its internal big data analytics competencies to a great extent during the Enabling stage. In 2015, the IT department created a unit responsible for the technology needed to support the analytics-as-a-service initiative. This unit removed the previous irritations concerning the IT department's big data analytics responsibilities. The IT department also created a unit specifically responsible for the general technology infrastructure for big data use cases. This unit was established as an internal IT competence center for synchronizing all existing AUDI big data projects.

"When doing analytics, the requirements are not clear from day one, and you have to collaborate and find a solution together. … The IT unit has to be agile and quick. … It demands a totally new knowledge from the IT department." Head of Big Data IT Competence Center

As well as establishing the competence center structure, the IT department provided technical support for the entire analytics and data warehouse infrastructure (see Figure 3). It took care of data access and integration (whether provided internally by AUDI or externally by VW group systems). The IT department implemented a data warehouse system and an analytics sandbox system, and specified the requirements for a big data infrastructure (a Hadoop cluster). The data access, data integration and technology infrastructure tasks carried out by the IT department were in response to requests from the sales and marketing department. In addition, the sales and marketing department requested from the digital innovation hub the analysis and visualization of data in a digestible manner.

Local Demands Prioritized within Business Units. Increasingly, ideas for analytics services were formulated collaboratively rather than being defined by the sales and marketing department's data analytics and strategy unit. Based on business units' priorities, local demands were met through the development of analytics services. Everyone in the three parties (the digital innovation hub, the sales and marketing department and the IT department) involved in AUDI's analytics-as-a-service initiative knew their responsibilities and was willing to push big data analytics forward. To ensure the work of all three parties was aligned to create holistic analytics capabilities, AUDI established the "program steering board." This board includes the respective managers from all three parties and the product managers from the sales and marketing department and the IT department. Bi-weekly, the board considers the collaboration model, prioritizes topics and reviews the overall strategy, current status of projects and challenges, future goals and open issues.

During the Enabling stage, the services of those providing analytics services still operated largely on a cost-center basis. However, the amount of budget granted centrally for analytics activities by executive management was reduced, with the shortfall being filled by service-oriented payments from internal customers. In developing the business cases for several analytics services, the sales and marketing department's data analytics and strategy unit calculated the payments with a view to establishing itself as a profit center within AUDI.

Advanced Descriptive Analytics Using Marketing Data. The sales and marketing department, the IT department and the digital innovation hub collaboratively developed business-driven analytics services that leveraged advanced analysis methods (e.g., machine learning and neural networks) and marketing data. These services were designed to support the entire "marketing funnel"[18] and mainly used advanced descriptive analytics and occasionally predictive analytics approaches (Table 2 lists the main characteristics of the analytics services in the Enabling stage of the journey.)

For the initial development of Stage II analytics services AUDI used the analytics sandbox system, which imposed little functional limitations but had no integration with operational production systems, and adopted an exploratory approach that was independent of other IT management processes. On the other hand, the production

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18   The marketing funnel describes the various stages of a prospect's journey, from the first interaction with the brand to the ultimate goal: conversion to a customer.

Table 2: Main Characteristics of Analytics Services at Stage II: Enabling

- Data Source: Marketing data
- Approach: Data-based and business-driven
- Service Type: Proof-of-concept and production analytics services
- Analytical Type: Advanced descriptive analytics
- Service Orientation: Improvement of marketing funnel

versions of analytics services required strong involvement by the IT department. The digital innovation hub regularly integrated data from different sources into the sandbox system. Later, these sources were connected to the production systems by the IT department. Furthermore, the IT department implemented the developed analytics model as production systems.

Intuitive and Experience-Based Decision Making Informed by Data-Driven Insights. The second, Enabling, stage of the journey was the first point where all three parties participating in the analytics-as-a-service initiative were actively involved. Moreover, the growing availability of analytics methods and the growing maturity of the technology infrastructure, together with a better understanding of the value of data analytics, led decision makers in the business departments to gradually accept the insights of analytics services. As a consequence, decision-making processes in Stage II were characterized by recurrent patterns based on business experience and intuition, enriched by data-driven insights. For instance, the entire marketing funnel was improved by the results of analytics services. Data-driven insights were used to forecast orders with a three-month time horizon and to optimize media spending.

Stage III: Leveraging

In the third, Leveraging, stage of the journey toward establishing big data analytics, AUDI is leveraging the analytics competencies of the digital innovation hub and the IT department to centrally provide analytics-as-a-service. The IT department is now fully responsible for all technology tasks and is evolving to become a consulting partner for the other big data analytics stakeholders (the sales and marketing department and the digital innovation hub). In particular, digital services are enabled by leveraging the most valuable data source (i.e., operational car data). Figure 4 summarizes the Leveraging stage, and the characteristics of the stage are described below.

> "The traditional IT organization has worked well in the past. But that is no longer the case. ... That is actually the whole transformation that has to take place ... we have to think in delivery units

and services and combine all our capacity and competencies." Head of Data Analytics IT at Sales

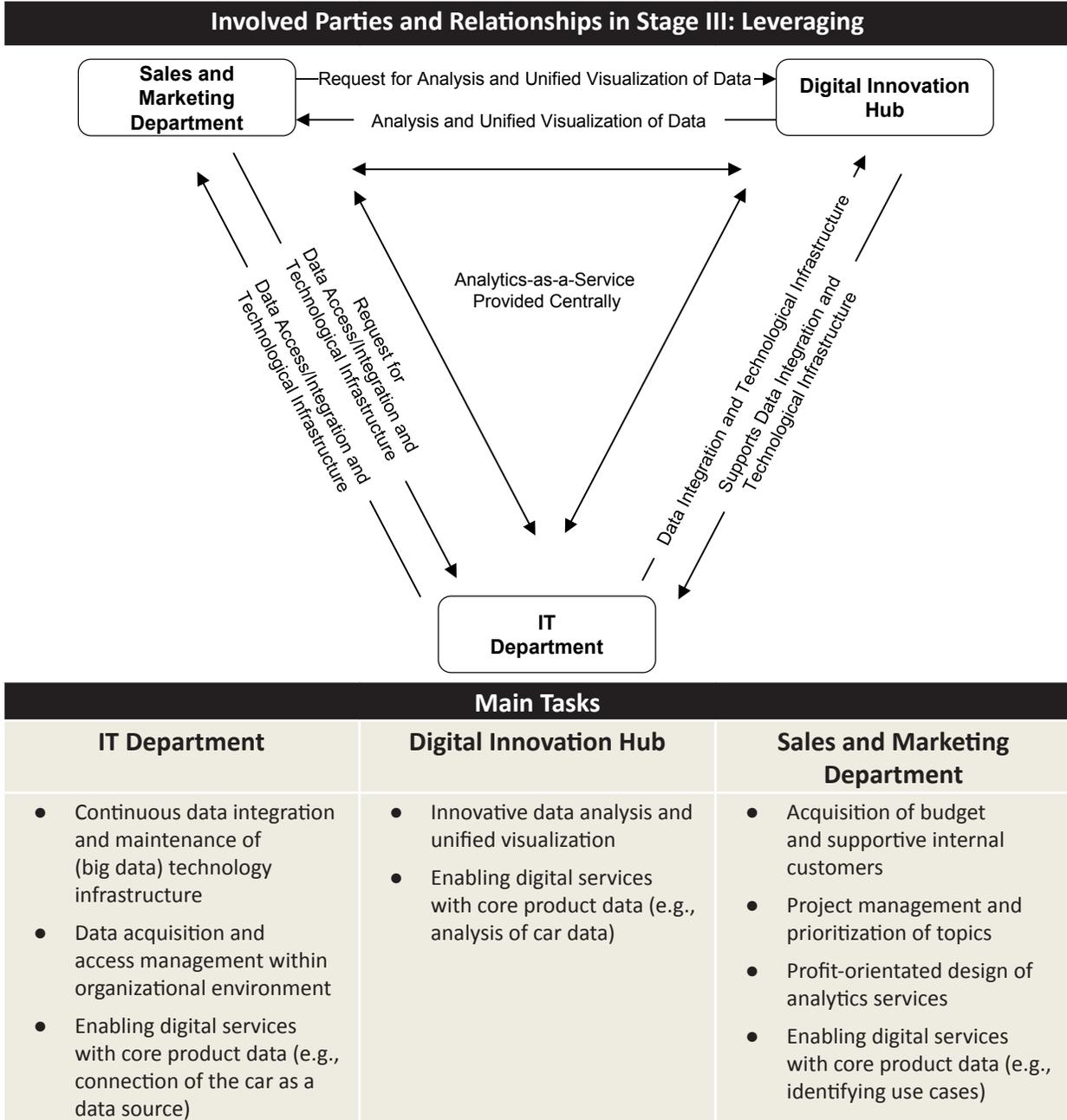**Analytics-as-a-Service Provided Centrally.** By leveraging the digital innovation hub's analytics know-how and the technology expertise of the IT department to iteratively develop sophisticated services on the more advanced technology infrastructure provided by the IT department, AUDI is able to provide analytics-as-a-service centrally (see Figure 4). In practice, the sales and marketing department requests the unified delivery of analytics services across all production systems from the development team, which comprises people from the IT department and the digital innovation hub. The development team provides a unified analytics services platform with standardized look and feel as the single point of contact for each customer of the analytics services.

Initially, a main focus, in particular for the sales and marketing department's data analytics and strategy unit in collaboration with the IT department, was how to connect to the car infrastructure through an appropriate data stream. Focusing strategically on harnessing car data as a continuous data stream presented three major problems. First, multiple units within the IT unit had to participate in technology discussions. Second, given the long development cycle for a new car model, it is difficult to demand further requirements in the middle of a development cycle. Third, in the context of car data, it is necessary to include car production line stakeholders who have a rather conservative manufacturing background. Thus, the sales and marketing department's data analytics and strategy unit had to create visibility as well as understanding of the strategic importance of data generated from cars. To address these problems, the data analytics and strategy unit established collaboration with another unit in the IT department that is responsible for IT infrastructure in AUDI's cars.

Before even beginning the process of integrating the car as a data source, AUDI took the necessary steps to ensure data generated from cars belongs to the customer.

> "[Your] car is a private space, much like a second living room. The movements of

Figure 4: Summary of Stage III: Leveraging

Involved Parties and Relationships in Stage III: Leveraging

Sales and Marketing Department → Request for Analysis and Unified Visualization of Data → **Digital Innovation Hub**

← Analysis and Unified Visualization of Data

Data Access/Integration and Technological Infrastructure

Request for Data Access/Integration and Technological Infrastructure

Analytics-as-a-Service Provided Centrally

Data Integration and Technological Infrastructure

Supports Data Integration and Technological Infrastructure

IT Department

Main Tasks

IT Department	Digital Innovation Hub	Sales and Marketing Department
• Continuous data integration and maintenance of (big data) technology infrastructure • Data acquisition and access management within organizational environment • Enabling digital services with core product data (e.g., connection of the car as a data source)	• Innovative data analysis and unified visualization • Enabling digital services with core product data (e.g., analysis of car data)	• Acquisition of budget and supportive internal customers • Project management and prioritization of topics • Profit-orientated design of analytics services • Enabling digital services with core product data (e.g., identifying use cases)

[your] car are nothing less than a movement profile of [your] day. We therefore have a very clear position at AUDI—the data from the car belongs to the customer. [Customers] alone decide what happens to

it ... without any loopholes." Rupert Stadler, Chief Executive Officer[19]

To satisfy customers' desire to stay in control of their data, and because of data protection rules and legislation, AUDI follows a privacy-by-design

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19   Public Statement by Rupert Stadler, available at http://www.audi.com/en/innovation/piloteddriving/Audi_piloted_driving.html.

approach that includes a customizable privacy setting for all car-related digital touchpoints (e.g., multimedia interface to the car's entertainment and information system, online portal for myAudi and AUDI smartphone apps).

> *"At AUDI, the IT group works closely with business departments ... to support transformation initiatives. We are less request driven and more collaboration driven."* Mattias Ulbrich, Chief Information Officer[20]

Overall, AUDI's IT department is evolving and transforming into a modern IT organization with a strong profile in the development and routine operations of analytics services (e.g., excellence in architecture, DevOps[21] culture and software development). However, the sales and marketing department remains the project lead for analytics services and prioritizes pending projects. Furthermore, as the collaboration between the three parties of the analytics-as-a-service initiative strengthens across departmental boundaries, traditional work processes are being altered. The sales and marketing department itself is increasing its analytics competencies. This enables it to challenge existing analytics models, resulting in more sophisticated analytics services. The digital innovation hub is providing its analytics competencies, the user-interface experience and resources to support the design of analytics models as well as the visualization of analytics insights.

> *"Organizationally, we may have to merge even more. As far as I am concerned, we do not need the separation of IT and the business [data analytics and strategy unit]."* Head of Data Analytics IT at Sales

Centralized Strategic Control of Developing and Providing Analytics Services. The limited resources available for developing analytics services, particularly in the IT department, had

resulted in project delays, which meant that development processes had to be altered. The development team chose to adopt the agile software development method Scrum as the organizing principle for their day-to-day work. Scrum was chosen because it enables AUDI to:

- Strategically prioritize resources more effectively across the multitude of parallel projects

- Ensure transparency across the different business departments

- Orchestrate domain knowledge, analytics skills and IT competencies across departmental boundaries.

Additionally, the IT department designed and implemented a specific process to assure the department's integration in the early phase of each analytics project.

As of 2016, the sales and marketing department is fostering its prominent and leading role for digitally transforming AUDI (e.g., in the areas of connected retail, connected car and connected mobility). To further progress the digital transformation, a *digital business* department was formed within the sales and marketing department. This newly created department includes the data analytics and strategy unit, which is now responsible for enabling digital topics and initiatives through the analysis of different data sources, above all sales data and data generated by cars.

To ramp up a digital mindset in the new department, in late 2016, it ran a workshop about agile work, digital culture, the importance of leadership and new processes. In addition, the department created a "digital factbook," which includes guidelines and rules for the department, specifically for the new way of staffing digital projects depending on the skillsets required for the successful delivery of a project.

In the final, Leveraging, stage of its journey to establish big data analytics, AUDI has now established the roles and responsibilities for the centralized analytics competence team responsible for the analytics-as-a-service initiative. This team is staffed by people from the sales and marketing department, the digital innovation hub and the IT department. The data strategy and analytics unit of the sales and marketing department is now operating

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20   Richter, G. and Wee, D. "Interview with Mattias Ulbrich," *Steering IT into the digital manufacturing era*, McKinsey & Company, October 2016, available at http://www.mckinsey.com/business-functions/business-technology/our-insights/steering-it-into-the-digital-manufacturing-era.

21   The term "DevOps" refers to a set of practices that emphasize the collaboration and communication of both software developers and IT professionals while automating the process of software delivery and infrastructure changes.

as a profit center and aims for a 10% return-on-investment on designing and delivering analytics services to internal customers. AUDI has established a committee comprised of senior executives from different departments (e.g., sales, strategy and IT) to oversee the work of the analytics-as-a-service initiative. Specifically, the committee discusses, aligns and accelerates digital projects and initiatives (e.g., car-data-driven services within the car).

Moreover, in late 2016, AUDI established a CDO role reporting directly to the CEO. The newly appointed CDO is tasked with ensuring the strategic relevance of digitization continues for AUDI.

> *"The projects are always strong when a strong business unit is on board, and that is something we learned little by little in the projects."* Head of Data Analytics and Strategy

Descriptive and Predictive Analytics Using Car Data. AUDI is developing business-driven predictive and advanced descriptive analytics services by leveraging data generated by cars to support digital services. (Table 3 lists the main characteristics of the analytics services in the Leveraging stage of the journey.)

Internal customers are actively involved in the development of analytics services and co-create the value of a service. By using the Scrum method, each analytics service evolves iteratively toward a production version with a standardized look and feel. The analytics competence team from sales and marketing, IT and the digital innovation hub used the input from a one-year pilot project to prepare the business cases for digital services based on data generated by cars. The pilot involved collecting data from the cars driven by 70 AUDI managers to identify initial use cases.

These cars had been equipped with data loggers, which collected usage data continuously (500 signals processed per second) and transferred the data to an AUDI server.

The pilot project made it possible to analyze several behaviors of the drivers (e.g., driving behavior depending on car type, usage time, mileage and favorite radio station). The analyses provided the foundation for developing car-data-driven services based on sophisticated analytics methods (e.g., predictive maintenance using machine learning).

> *"We use machine learning and data analytics to prevent any failures. That means looking at preventive maintenance."* Mattias Ulbrich, CIO[22]

Evidence-Based Decision Making. By using the advanced Scrum method, AUDI was able to strategically prioritize the use of the IT department and the digital innovation hub's limited resources. Moreover, the establishment of the digital business department within the sales and marketing department and the creation of the CDO role further underlined the strategic relevance of big data analytics and digital transformation. As AUDI progresses through the Leveraging stage of its journey, it is increasingly benefitting from the full potential of big data analytics, which is supporting evidence-based decision making and enabling new digital services. Decision makers are starting to appreciate and rely on data-based insights. Insights from analytics services are being used in day-to-day decision making in the sales and marketing department. Additionally, the digital services enabled by big data analytics are increasingly producing operational data that

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22   Ibaraki, S., op. cit., 2015.

Table 3: Main Characteristics of Analytics Services at Stage III: Leveraging

- Data source: Car data
- Approach: Business-driven
- Service Type: Production analytics services
- Analytical Type: Predictive and advanced descriptive analytics
- Service Orientation: Leveraging car data

decision makers can use to continuously optimize the design of digital services.

Ongoing Transformation of AUDI's IT Department

"We as a whole are faced with the greatest upheaval in the industry, including development modes, as well as business cases and business models. … As a car manufacturer, we have to face the challenges of the Internet of Things, including security, privacy and the connection of every car. The car with its design, look and feel will be the carrier of our digital services and the surrounding ecosystem." Head of Car-Related Services

In the past, AUDI's IT department acted primarily as a support unit responsible for engaging external service providers to support the business units. However, digitization and the increasing emergence of cross-functional IT initiatives require the IT department to address its lack of internal know-how and the limitations imposed by AUDI's vertical organization structure. Traditionally, the IT department was not involved in the process of designing a new car model or in the start of a car's production. A consequence of digitization, however, is that AUDI's business units now have to actively involve the IT department. Moreover, AUDI recognized that the IT competencies related to digitization are highly interwoven and have to be integrated rather than being in separate organizational silos. As a consequence, at the beginning of 2015, C-level management at AUDI launched a transformation project called "Move IT," with the aim of coordinating cross-departmental technology-driven areas, such as big data analytics.

As part of the Move IT transformation project, changes to the organizational framework of the IT department and the work methods required to address the challenges of digitization and digital business models were gradually introduced. The transformation project is positioned as a top-down initiative with AUDI's CIO at the helm. The overall goal is to develop and consolidate digitization competencies in decentralized competence structures, called competence networks. These networks complement the traditional organizational structure and are available to interested parties from anywhere within AUDI.

From an organizational perspective, the emerging competence networks cut across individual IT units and other organizational entities, although each network is managed by an IT representative. Thus, the networks are tightly connected to AUDI's IT department, which ensures the department is involved in digital cross-departmental initiatives, such as cyber-physical systems,[23] big data analytics and augmented reality.

In addition, the most important competence networks, such as big data analytics, are embedded as internal competence center structures within the IT department. In this way, the head of each IT competence center is not only in contact with all involved actors doing related work in the particular competence area, but also with the key players in the different business departments. For instance, the "big data" competence center hosts monthly "TechSyncs," which synchronize current projects, tasks and the development of projects related to big data.

"We've emphasized agile software development and the use of Scrum teams. Under agile, you fail fast—make the mistake as soon as possible and then learn from it." Mattias Ulbrich, CIO[24]

AUDI's IT department distinguishes between two types of competence network—technology networks and method networks. The former are concerned with technology-driven areas, while the latter address procedural aspects, such as process and change management, agile software development, modern work methods and social collaboration. In sum, the method networks set the stage for using the appropriate work methods in IT projects. For example, AUDI recognized that it needed the core ability of being able to use agile development to build software-driven services for its cars. This ability is needed so AUDI can fully exploit big data analytics and digitize its core processes. Hence, the IT department established

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23   Cyber-physical systems are the interconnection of mechanical, electronical and software components that communicate through a communication infrastructure.

24   Richter, G. and Wee, D., op. cit., 2016.

a competence network for agile software development.

Applying the Three Stages of AUDI's Journey to Other Manufacturing Organizations

Other product manufacturers face similar challenges to those AUDI faced on its journey to establish big data analytics. The findings from AUDI's journey can thus be applied to other product manufacturing businesses.

In the first, Advancing, stage, manufacturing organizations can analyze large volumes of already available customer data to generate new insights. However, deriving insights in this way is a new organizational capability that requires new ways of intra-organizational collaboration between existing departments and the integration of new departments. A good way of fostering agile collaboration methodologies is to establish an innovation hub within the organization. Such a hub will also stimulate product and service innovations. During the Advancing stage, manufacturers will also have to acquire or develop big data analytics capabilities and knowledge, for example by recruiting skilled employees or engaging with specialized consultancies or through internal training. They will also need to integrate domain knowledge and IT competencies.

During the second, Enabling, stage, manufacturers will need to adjust their established organizational structures and technology infrastructures, and re-allocate departmental responsibilities. They will also need to establish units within their IT departments to further support data analytics. For instance, aerospace companies now have IT units charged with establishing big data architectures to overcome the limitations of "small" data systems.[25] These architectures enable them to analyze unstructured data in addition to traditional "small" data, such as internal, structured and transactional data.

In the Enabling stage, manufacturers' business departments must willingly make their domain-

specific expertise available to digitization initiatives. They must also ensure that there is effective partnering among subdivisions and units that provide key digital capabilities (e.g., agile software development, big data analytics, data-driven product development).[26] A key characteristic of the Enabling stage is that decision makers begin to use data-driven insights to complement their business experience and intuition.

In the third and final, Leveraging, stage, big data analytics is centrally and strategically exploited in a scalable and professional way that significantly transforms the business and industry characteristics—e.g., through the provision of analytics-as-a-service. In industrial manufacturing, for instance, the Leveraging stage is characterized by digital data streams and big data analytics that result in new market offerings.[27] For example, manufacturers can offer customers services for operating and maintaining their products, with charges based on actual usage. This type of business model requires far-reaching transformations of the business, together with robust IT capabilities and big data analytics operations.

Recommendations for Establishing Big Data Analytics

Traditional product manufacturing organizations face a steep learning curve as they embark on digital transformations, which often involve mastering big data analytics. Below, we provide five recommendations for establishing big data analytics derived from AUDI's evolutionary approach described above.

1. Develop Analytics Capabilities to Leverage Analytics-as-a-Service and Evidence-Based Decision Making

The availability of big data changes the way decisions are made in traditional organizations. Instead of relying on the experience of senior managers and large amounts of uncertainty,

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25 For a detailed description of how Lufthansa leveraged big data for business model renovation, see Chen, H.-M., Schütz, R., Kazman, R. and Matthes, F. "How Lufthansa Capitalized on Big Data for Business Model Renovation," *MIS Quarterly Executive* (16:1), March 2017, pp. 19-34.

26 See Chen, H.-M., Schütz, R., Kazman, R., and Matthes, F., op. cit., 2017. For an article detailing the evolution toward harnessing digital data streams in industrial manufacturing, see Herterich, M. M., Uebernickel, F., and Brenner, W. "Stepwise Evolution of Capabilities for Harnessing Digital Data Streams in Data-Driven Industrial Services," *MIS Quarterly Executive* (15:4), December 2016, pp. 297-318.

27 Ibid.

analytics capabilities are leveraged for evidence-based decisions that enhance an organization's competitive advantage. In the early stages of their digital transformation journeys, organizations should create federated competencies supported by a core team of experts who provide support and guidance. These capabilities should be established within an analytics competence team that serves as the central contact for big data analytics. This team gradually acquires the competencies based on the learnings from individual projects. This approach allows business units to be highly flexible in terms of technology usage and analytics competencies. Initially at AUDI, data analytics was mainly driven by the sales and marketing department. Over time, however, additional departments saw the need to also establish their own data analytics capabilities.

Typically, after an initial phase of individual departments "doing their own thing," companies set about centralizing the data analytics efforts and competencies, which enables them to provide analytics-as-a-service and thus target strategic opportunities with strategic capabilities. In later stages, centralization helps to transfer knowledge and speeds up future projects. In parallel, the IT department must shift from simply "following the business" to collaborating with business departments and specialist digital units (such as a digital innovation hub) to develop core competencies for the digital age. Thus, AUDI's analytics capabilities included skilled data scientists and big data architects who were located in the digital innovation hub.

The growing maturity of analytics capabilities enables organizations to adopt evidence-based decision making, although achieving this requires a cultural shift. To effectively leverage big data analytics, evidence-based decision making must be rooted in the organizational culture. This implies that the organization needs employees with well-developed quantitative skills who recognize the importance of data and its analysis. Thus, organizations need to hire employees who have analytical skills, and senior executives need to encourage evidence-based decision making. At AUDI, sales and marketing activities are now rooted in actual operational data. Decision-making processes are geared toward operational data thanks to the big data analytics capabilities

AUDI has been developing since 2013. The insights provided by analytics services enable customer needs to be addressed more accurately in coordinated sales and marketing activities.

2. Adapt Traditional Organizational Structures for the Digital Age

Traditional organizational structures and hierarchies impede interdisciplinary collaboration across organizational boundaries, which is a prerequisite for establishing big data analytics. Organizations therefore need to identify core strategic areas relating to data analytics and build up the necessary expertise in interdisciplinary teams. A key challenge is to get employees to break free from the constraints of existing structures, roles and processes. To help break down the current rigid areas of responsibility, the resulting project structures and centers of excellence should be cross-functional and complement the existing structures. In addition, developing analytics services requires a company to include several stakeholders and to orchestrate competencies from the technology domain (e.g. data integration and technology infrastructure), the business domain (e.g., business acumen) and the analytics domain (e.g., development of analytics models and visualization).

At AUDI, the CIO and the IT department took a proactive role in setting up the organizational framework. Senior business executives recognized the need for cross-departmental collaboration and drove organizational changes within their areas of responsibility. AUDI's analytics capabilities—i.e., the collection of organizational governance instruments needed to implement big data analytics—derived from integrating traditional organizational entities (the IT department for the technology domain and business departments such as sales and marketing) with a new entity (the digital innovation hub).

AUDI established the digital innovation hub early in its journey so it could build up expertise and competencies in an organized way. The company also set up several competence centers located in the IT department, together with associated competence networks. These networks cross departmental boundaries but with an IT manager responsible for each network. The

resulting additional organizational structures ensure that digitization activities are closely aligned with business departments, such as sales and marketing or R&D.

Successful digital transformation also requires clearly defined roles and responsibilities as well as top-management support. At AUDI, the digital transformation effort was further supported by CEO Rupert Stadler, who established a new CDO role reporting directly to him.

Ultimately, the newly established organizational structures are an effective device for cascading digital transformation throughout the entire organization. However, management must ensure that power is balanced between the business departments, the traditional IT department and any newly created digital innovation hubs. If management doesn't do this, restraining forces will emerge based on a fear of loss of power. These forces will slow down, or even stop, initial initiatives before innovative concepts are bearing their first fruits.

3. Establish a Data-Sharing Culture, and Encourage Business Functions to Leverage Operational Data

Business departments often find it challenging to recognize value in operational data and to leverage that data for decision making. The increasing complexity of business makes it difficult to gain insights from the large amounts of operational data generated. Correlations between business actions and actual market effects are often not obvious from an initial look at operational business data. And in many cases, intended effects cannot be verified in retrospect by looking at the data. Thus, when big data analytics is first deployed, business departments can be intimidated by the operational transparency and facts that come to light from the operational data of their business.

Against this background, a key to successfully leveraging big data analytics is for a company to establish a data-sharing and data-driven culture. Data must be perceived as a valuable resource that can help the organization to become a digital company and, thus, sustain or achieve a competitive advantage. Business managers and employees at all levels should therefore welcome the operational transparency of the day-to-day business provided by big data analytics without fearing any negative consequences. Senior executives have to encourage and reward their employees to leave their comfort zone of daily work routines and adopt a data-sharing mindset.

In the early stages of AUDI's journey, access to diverse internal data sources was opposed by restraining forces that were not willing to share their data either because of a perceived loss of power or a lack of understanding of the data analytics and strategy unit's data-driven initiatives. Moreover, AUDI had to resolve data-ownership issues (who is responsible for the data sources and who has the authorization to give access) and data-transparency issues (which data exist already in the IT landscape). AUDI therefore had to convert those who were the restraining forces to become supporters of big data analytics and thus embrace operational transparency and grant access to their data.

In the early stages of the journey toward establishing big data analytics, business functions often operate disconnected from the reality that can be found in data. To counter this, and to avoid cultural objections to digitization initiatives, business functions need to be involved early in plans to leverage operational business data in digital business offerings. They also need to be included when interpreting operational business data and leveraging resulting insights for decision making. Lighthouse projects and proof-of-concept are valid devices for familiarizing the business with the opportunities arising from digitization and operational business data.

At AUDI, the sales and marketing department was the driving force behind leveraging large amounts of operational data. In the first, Advancing, stage of AUDI's big data analytics journey, data from the online car configurator provided an early opportunity to leverage existing operational sales data to investigate potential customer needs. Because the project was initiated by the sales and marketing department, business people were on board from day one, resulting in the success of the project.

4. Leverage Agile Application Development Methodologies

To build digital business models enabled by insights gained from analytics services, organizations will need to collaborate across departmental boundaries, and this will require

them to leverage new development approaches. AUDI, therefore, decided to centralize the big data analytics methodological skills and competencies in a central digital innovation hub. This unit is building competencies in agile approaches for developing analytics services and car features that are based on digital technology. Because of the wide diversity of digitization projects, the methodologies used should be determined by management and the individual project teams, according to the resources available, the characteristic way of working and the project type.

Nonetheless, all agile methodologies have a common characteristic: they encourage failure in the early stages of a project and leverage the learnings in later stages. Senior executives should therefore foster a culture of learning-from-failure and encourage employees to innovate. The rapid iterations and cross-functional teams intrinsic to using agile methodologies for developing new applications enable companies to test what they think they are learning from their data. In turn, the experiments they run create new data.

5. Ensure the IT Department Provides Centralized Operational and Digital Expertise

With the advent of the digital age, the role of the IT department is shifting toward becoming an orchestrator and facilitator of digitization efforts. As a consequence, the IT department plays a critical role in developing the foundational architecture and tools that are necessary to harness operational product data in an efficient and scalable way. Organizations will therefore need to make strategic investments after the initial explorative ramp-up phase that we observed in Stage I (Advancing). The IT organization will also need to build up digital capabilities (e.g., expertise in big data analytics and cyber-physical systems). Although this type of innovative digital capability is not a core competency of the traditional IT department, the department should build up fast-paced digital expertise, even though this will result in a two-speed IT organization. On the one hand, core IT systems are harmonized and centralized in traditional IT projects; on the other hand, digitization initiatives are pushed forward in an accelerated and more agile way.

At an early stage of its big data analytics journey, AUDI's IT department made considerable use of external consultancies and the capabilities of the digital innovation hub. This approach enabled the IT department to quickly build up data analytics expertise and thus led to additional learnings. However, to successfully leverage such resources, in addition to conventional external offerings such as SaaS (software-as-a-service) and cloud-based services, CIOs must ensure that internal technical skills and competencies are on a par with those of external consultancies.

Additionally, the IT department should reach out to business departments by showing interest in their current pain points. It has to satisfy the actual needs of its customers using a collaboration-driven approach instead of just offering commoditized service offerings. Greater orientation toward the business can be achieved by broadening the skill requirements of positions in the IT department.

Concluding Comments

Digitization and digital technology are having a tremendous impact on traditional product manufacturing organizations. In particular, the role of information technology is increasing, causing senior executives to rethink well-established business models. By describing the three-stage journey toward establishing big data analytics undertaken by AUDI, this article illustrates how this traditional German car manufacturer is harnessing digital opportunities in digital business models through data-driven services.

Successfully deploying big data analytics requires not only substantial technology support, but also collaboration between, and alignment of, the IT and business departments. Such collaboration requires diverse mechanisms of organizational governance, such as an analytics competence team (or possibly an analytics competence center) and an analytics-as-a-service initiative. These mechanisms will:

- Provide the organizational framework for fostering analytics capabilities

- Nurture a data-driven culture

- Promote evidence-based decision making within the company.

Moreover, cross-departmental competence networks and cross-discipline competence centers are a means of ensuring the needed collaboration between the IT and business departments. When aiming to overcome the traditional digital divide, organizations must adapt their organizational culture to embrace evidence-based decision making, constant change and a willingness to learn from failure.

Appendix: Research Method

The research for this article was an in-depth case study of the evolution of AUDI's analytics competence capabilities.[28] Starting in 2013, the authors have accompanied AUDI on its journey, with two of them continuously involved in projects at the sales and marketing department's data analytics and strategy unit. Our aim was to obtain rich insights into the changing role of the IT department as the company developed its big data analytics capabilities.

We conducted 18 in-depth interviews with people in charge of units and departments involved in AUDI's digital transformation (e.g., IT, sales and engineering managers, product owner and product manager). There were two rounds of interviews with different objectives for each round. In the first round, we asked interviewees to describe the overall big data analytics journey. Interviews in the second round were designed to gain a deeper understanding of the ongoing transformation of AUDI's IT department. We also reviewed interviews published on websites and presentation slides used at workshops and meetings, and accessed other secondary data sources (e.g., internal presentations and documentation of analytics services).

The interviews we conducted were transcribed and analyzed using a computer-supported qualitative data analysis tool. The data analysis followed a three-stage process of open, axial and selective coding to get a comprehensive view of AUDI's digitization journey.[29] In the open coding stage, we identified key themes and recurring concepts in the interviews. These themes and concepts were ordered chronologically to obtain an initial overview on the milestones and activities along the journey. In the axial coding stage, we focused on topics that were recurring regardless of the point in time. In the selective coding stage, we further developed and refined the previously identified concepts and topics to arrive at the overall digitization journey. The identified concepts and topics were further specified and refined by the two on-site researchers, one of whom took the role of program manager for the analytics-as-a-service initiative, while the other acted as a half-time resource supporting the task of conceptualizing the management processes and governance needed for big data analytics.

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