How Lufthansa Capitalized on Big Data for Business Model Renovation

Enterprises have begun to derive value from big data, but many challenges remain. This article reports how Lufthansa successfully discovered big data value, addressed the technical complexities, and used big data as the basis for renovating its traditional business model to one that embraces customers as value co-creators. From Lufthansa’s experience, we identify the challenges and critical success factors for innovating with big data and navigating through uncharted waters. The key is to shift the focus from technology to business values.¹ ²

Hong-Mei Chen
University of Hawai‘i at Manoa
(U.S.)

Roland Schütz
Deutsche Lufthansa AG
(Germany)

Rick Kazman
University of Hawai‘i at Manoa
(U.S.)

Florian Matthes
Technische Universität München
(Germany)

Big Data Deployment Gap

“Big data” is the term for data sets that are so large or complex that traditional data processing applications are inadequate to deal with them. Big data offers unprecedented opportunities for enterprises to use analytics for achieving new levels of competitive advantage, including optimizing operations, customer intelligence and innovation in products and services. It is one of the most significant technology disruptions for businesses since the meteoric rise of the Internet and the digital economy.³

Proponents of big data expect organizations to derive much value from high velocity,⁴ massive volumes of data originating from “everywhere,” including the Internet of Things (IoT).⁵

¹ Dorothy Leidner is the accepting senior editor for this article
⁴ In the context of big data, velocity refers to the ability to analyze streamed data.
⁵ How to derive value from digital data streams flowing from the IoT is discussed in Herterich, M., Uebnerickel, F. and Brenner, W. “Stepwise Evolution of Capabilities for Harnessing Digital Data Streams in Data-Driven Industrial Services,” MIS Quarterly Executive (15:4), 2016, pp. 299-320.
smart watches, mobile phones,6 weblogs, social media, embedded devices and much more.7 This highly variable data may be structured, semi-structured or unstructured.8 But, despite all the hype,9 extracting value from big data remains a daunting task. The challenges and risks10 are greater in big data system development than in traditional “small” data system development because of:

- The technical complexity arising from the 4V (volume, variety, velocity, veracity)11 characteristics of big data
- The paradigm shift needed in design thinking
- The rapid proliferation and evolution of big data technology
- The organizational agility required to deliver value from big data.

Exploiting big data and gaining value from it requires large amounts of up-front investment and involves high risks. Because of this, enterprises have typically embarked on a prolonged process for discovering the potential value of big data before deploying big data systems. As of the end of 2014, even though many enterprises had indicated their intention to adopt big data, actual deployments were still scarce.12 We call this new phenomenon in big data adoption the “Deployment Gap.” In a previous study,13 we identified one key reason for this Deployment Gap: an enterprise’s inability to discover innovative uses—that is, value—of big data.14

In that previous study, we identified Lufthansa as the exemplary enterprise that has managed to successfully discover value from big data and moved to deployment. It signed a $1.25 billion contract in November 2014 with IBM to enhance its infrastructure for big data deployment. Furthermore, Lufthansa has transitioned to a “renovated” airline business model enabled by big data, which we call “Amazon In the Air” (AIA)—positioning Lufthansa as the Amazon of the airline industry.15 This article describes how Lufthansa discovered big data value and how its newly renovated business model was enabled by big data, and identifies the critical success factors for closing the Deployment Gap. (The research on which this article is based is described in the Appendix.)

Lufthansa’s Competitive Environment and Business Model

Lufthansa, formally Deutsche Lufthansa AG, headquartered in Cologne, Germany, is the largest airline in Europe. It operates services to 220 destinations in 78 countries across Africa, the Americas, Asia and Europe, using a fleet of more than 660 aircraft. In 2014, the Lufthansa Group, which comprises several airlines, carried about

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8 An example of value derived from unstructured data is can be found in Muller, O, Junglas, I., Debortoli, S. and Brocke, J. V. “Using Text Analytics to Derive Customer Service Management Benefits from Unstructured Data,” MIS Quarterly Executive (12:4), 2016, pp. 243-258.
11 For an explanation of the 4Vs of big data, see http://www.ibm-bigdatahub.com/infographic/four-vs-big-data.
15 Amazon, established in 1994, evolved from an online book retailer to today’s global e-commerce leader. The success of Amazon’s business model evolution is largely attributable to the fostering of its IT capabilities and its commitment to analytics to provide differentiating quality products and services that, in turn, build customer loyalty.
106 million passengers, had an average number of 118,973 employees and revenues of €30.01 billion.\textsuperscript{16,17}

The airline industry is characterized by low profit margins, mergers, entry of new budget carriers, disruptive competition, fierce airfare wars, strict legal and safety requirements and great economic uncertainty. The low profit margins underscore the need for business innovation. For example, in 2012, the International Air Transport Association (IATA)\textsuperscript{18} expected airlines to achieve a collective global profit of $18 billion. That sounds impressive, but on revenues of $746 billion, the average net margin was just 2.4%. That’s less than $6 per passenger. In 2013, net margin was 2.6%; the average airline earned 8.9 U.S. cents per available seat km (ASK) and spent 8.7 U.S. cents per ASK. Needless to say, reducing costs and increasing revenue is a strategic imperative for Lufthansa and, indeed, all airlines.

Market upheavals, consumer trends and global travel patterns have brought about substantial changes in the airline industry. Trends impacting the aviation sector include:

- Economic power shifting to Asia
- Global demographic trends creating new customers and mobility patterns in long-haul flights and in purchasing power
- Global digitization creating permanent changes in all areas of life.

As a consequence, customer centricity, ancillary revenues and mobility solutions are on all airline CIOs’ agendas. According to SITA,\textsuperscript{19} almost all airlines (92%) plan to address these challenges by generating higher ancillary revenues. Focusing on ancillary revenues makes sense because of the disproportionately high cost burden at other stages of the airline customer engagement cycle, shown in Figure 1. In particular, airlines incur high costs but have low margins in the flight stage of the cycle. There are opportunities for ancillary revenues in the pre-flight stages, e.g., the shopping and ticket purchase stages.

Increasingly, airlines have found new ways of moving away from the traditional business model for selling tickets. For example, they have moved to retail models such as online travel agencies

\begin{figure}
\centering
\includegraphics[width=\textwidth]{Figure1}
\caption{Airline Customer Engagement Cycle and Cost Distribution}
\end{figure}

\textsuperscript{17} As of January 2017, €1 = $1.05.
\textsuperscript{19} SITA, the world’s leading specialist in air transport communications and information technology, provides annual reports on airline IT trends. According to its Airline IT Trend Surveys (2013 to 2016), mobile, IoT and business analytics are top investment priorities.
OTAs) and department stores. Most airline websites already provide services for the entire customer engagement cycle, including pre-travel planning and booking, web check-in, flight status, activities, car rentals, hotels and more. Airlines now see personalization as the key to building customer loyalty.

New players and emerging markets greatly challenge airlines’ existing revenue model. Many new ultra-low-cost carriers and hybrid low-cost carriers have moved rapidly from Europe to Australia, North America and Asia. In response, Lufthansa has been forced to adopt new thinking on how to deliver value. Moreover, worldwide point-to-point air traffic is rapidly expanding. Lufthansa must grow its direct traffic outside its main hubs, which is why it wants to build on the success of its Eurowings subsidiary.

Like all airlines, Lufthansa is subject to the whims of economic, business, political, societal and environmental uncertainty. These include the ups and downs of fuel costs, disasters and other “disruptions.” In 2014, for instance, while fuel costs decreased, airlines faced major challenges arising from the political crises in Ukraine and the Middle East, and the adverse effects on global aviation of the Ebola epidemic in West Africa. In addition, the strike by its own pilots had a significant impact on Lufthansa’s business performance in 2014. Finding ways to manage and control the risks and minimize the damage when disruption occurs are of paramount importance.

Lufthansa is a premium full service carrier (PFSC) that provides excellent travel experiences. It is aiming to become the first “five star” carrier in Europe. To help achieve this aim, it has made investments in upgrading aircraft (installing lie-flat seats in 100 aircraft), purchasing new aircraft and launching the Premier Economy Class.

However, Lufthansa realized that focusing on aircraft services alone was insufficient. Given the highly competitive and volatile nature of the airline industry, it decided to renovate its business model. IT plays a major role in this renovation: IT innovations are needed for reducing operational costs, providing excellent customer experiences, expanding ancillary revenues, delivering mobile and self-service solutions, differentiating from other PFSCs and managing disruptions. In the words of Lufthansa’s CIO, “Aircraft and new [IT] applications are now considered to be of equal priority; we can only move forward by improving IT capabilities. We believe that this is the only opportunity to survive the coming competition.” Big data is at the core of the value derived from Lufthansa’s IT innovations.

Enabling a Service-dominant Business Model through Big Data

Through a formal, top-down innovation process, Lufthansa identified big data as an important enabler of all the desired innovations and more. It identified big data value and innovation in four major areas:

1. Personalizing the customer experience
2. Handling irregular (IRREG) situations
3. Predicting departure delays and being proactive in IRREG recovery
4. Implementing predictive and preventive aircraft maintenance.

Big data capabilities in these areas provide the foundation for renovating Lufthansa’s business model to one that centers on customer experience and service innovation. (The values identified in each of these areas are described below.)

In reframing its customer value proposition, Lufthansa wants to go beyond the current airline OTA and department store business models, which, by including a variety of pre- and post-travel products and services, had already gone beyond the traditional model that focused on selling airline tickets. The strategic imperative for Lufthansa is to leverage IT innovations to provide the best personalized travel experience for its customers.

Big data enables the design of an end-to-end customer experience—it starts before customers arrive at the departure gate and does not end when customers leave the terminal on arrival. Lufthansa’s value proposition is not about “selling” premier and ancillary services but about predicting and meeting customers’ needs beyond their expectations. It wants to provide personalized services when they are least expected—pre-travel, en-route, on arrival and post-travel. Big data is being mined to discover
innovative service offerings and operational efficiencies that were not possible before:

“Big data is obviously beneficial for helping functions such as commercial ticket sales. However, it is also important for improving our predictive analysis of ground operations, load control, aircraft turn-around operations, staff management and aircraft maintenance that are critical parts of providing a great end-to-end customer experience.” Director, IT Service Factory

Ground Ops

As mentioned earlier, we refer to Lufthansa’s renovated business model, which employs big data analytics to achieve “five star” service, as Amazon In the Air (AIA). The AIA business model not only likens the airline industry to Amazon but also highlights that Lufthansa competes with Amazon in many service offerings. As stated by Lufthansa’s CIO: “Travel is a trigger for the opportunity to provide services to the customers. We are competing, in this way, with Google and Amazon.”

In the AIA model, customers are seen as co-creators of value. For example, when an aircraft is delayed, a customer might try to arrange a car share with other customers to a nearby city. The car share could be facilitated by Lufthansa, so Lufthansa and the customer co-create a solution for problems caused by the flight delay. Co-creating value with customers is not the traditional perspective of customer relationship management (CRM), which views customers as "transactions." It is also different from the ineffective social CRM strategies where social media is just another channel to target customers who are viewed as external to the company.²⁰

The AIA model reframes Lufthansa’s relationship with its customers and fully transitions the airline from goods-dominant logic (GDL) to service-dominant logic (SDL).²¹ The sidebar summarizes the distinction between these two logics. Big data can help to enable the shift from goods-dominant to service-dominant logic. It can also offer insights into customers and can be leveraged to manage the entire customer engagement cycle, using the resources of customers, logistic network partners, service partners and others to co-create the best customer experience.

The fundamental shift from goods-dominant to service-dominant logic has subtle but profound implications for how Lufthansa conceptualizes IT-enabled service initiatives and how it approaches service innovation. When shifting from the old model of selling tickets to providing the best “experience,” Lufthansa needed to avoid being trapped in a goods-dominant mindset. For example, it has a unique asset—passengers waiting in its lounges or sitting in its seats for hours, often bored. Lufthansa knows each passenger intimately: big data provides it with great insight about each customer, and it reasoned that it could monetize a passenger’s idle time by doing one of the following:

A. Selling ancillary services or advertising products (and thus competing with Amazon), or

B. Helping customers use the time according to their own preferences, such as conducting their business, doing on-line shopping, booking activities at travel destinations, etc.

With Option B, which is service-dominant, Lufthansa could still “sell” ancillary services, and may ultimately sell more than with Option A, which is goods-dominant. Importantly, Option B is a by-product of genuine, excellent customer services.

The choice of Option A or Option B will result in dramatically different big data requirements, system design and business process implementation, as well as eventual customer experience outcomes. By fully shifting to service-dominant logic principles, big data can be effectively leveraged to enable the AIA business model to achieve Lufthansa’s innovation goals.


²¹ Service-dominant logic (SDL) first appeared in Vargo, S. L. and Lusch, R. F. “Evolving to a New Dominant Logic for Marketing,” Journal of Marketing (68), 2004, pp. 1-17. This paper detailed all the foundational premises of SDL and described in depth the differences between service-dominant and goods-dominant logic.
Discovering Big Data Value

To discover big data value, Lufthansa used Value Discovery, a top-down innovation process. Value Discovery comprises three phases: innovation process, use case development and strategic development planning. Use case development is the core activity in Value Discovery. The use case approach is a scenario-based technique that can be used to solicit innovative uses of big data. This approach is the cornerstone of modern methods for eliciting systems requirements and has been commonly employed in developing “small” data systems. But use cases are even more useful for identifying innovations involving big data because requirements and system boundaries are fluid in the big data context.23

At Lufthansa, the formal, top-down innovation process identified hundreds of big data use cases. Additionally, as stated by Lufthansa’s Director, IT Service Factory Ground Ops, “There are many bottom-up efforts also.” However, not every use case demonstrates big data value, so all of those identified went through a selection, prioritization, cost-benefit analysis and experimentation process, including feasibility studies, to discover business value. This resulted in four primary use cases that prompted the deployment of big data at Lufthansa.

These four primary use cases are described below and clearly show how big data can provide value at both the strategic and operational levels. Operational excellence is of paramount importance in the airline business because much value co-creation with customers results from feedback, comments and interactions with customers in transactions or social media. These primary use cases were then used as input (or the basis for) big data requirements or as the blueprint for strategic development planning and the subsequent system design and

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23 For more information on use case development techniques and the value-engineering methodology, see Chen, H-M., Kazman R., Garbajosa, J. and Gonzalez, E., op. cit., January 2017.
implementation for realizing the business value discovered.\textsuperscript{24}

**Primary Use Case 1: Personalizing Customer Experiences**

Traditional CRM or social CRM systems aim at personalization. However, they can be blunt instruments. The interactions via these systems were designed primarily to sell, not to engage or build relationships and trust between customers and the brand. Although the objectives of personalization do not appear significantly different from traditional CRM programs, big data provides access to new data and tools that enable more effective personalization. For instance, Lufthansa already had a customer loyalty program ("Miles and More") that has customer profile information. This information is now personalized by augmenting it with external data, including social media data, such as customers’ hobbies, where they have been traveling to, how often they travel, which sports team they are loyal to, etc. According to the Vice President, Cluster Domain Commercial and Passenger, Lufthansa now uses big data to:

"Remember all customer interactions; recognize customers (online or in person), especially high-value customers such as first class, frequent flyers, brand influencers, etc.; use what was learned about customers to service all their travel needs; learn to anticipate customer preferences and be proactive; make it convenient and natural to interact with customers using the channels they prefer; and be there when the customers need them, in real time."

Millions of data items are delivered in real time to ensure customer-related content is presented at the right time, in the right channel and in the most digestible and actionable form. The expected outcome is to increase customer loyalty and revenue, improve marketing and sales effectiveness and reduce the cost of customer service delivery. "Our goal is to provide end-to-end personalized service when it is least expected." (Vice President, Cluster Domain Commercial and Passenger)

Lufthansa is currently (2016-2018) running a project with a supplier consortium to roll out broadband satellite-based Internet connectivity on its short-haul fleets, both in premium and economy cabins. Given sufficient bandwidth, this will open up the possibility of selling goods and services while airborne based on passenger-specific content.

Lufthansa also reframed its email marketing approach to take account of individual customer profiles and immediately increased conversion rates by 30% (2016 data). It has also introduced an upgrade option based on passenger behavioral data. Investing in this option has delivered a significant ROI.

**Primary Use Case 2: Handling Irregular (IRREG) Situations**

By definition, IRREG situations occur only occasionally, but the consequences from improper handling of such situations may often be very costly. Big data can be used to rapidly identify and react to activities on Facebook, Twitter and other social media. A strong lesson was the shooting at Los Angeles airport on November 1, 2013. The impact that a 10-minute event like this can cause is shocking:

- One casualty (a Transportation Security Administration agent)
- Over 118 flights en-route to the airport were canceled or rerouted
- 135 flights scheduled departures were canceled
- 127 flights were delayed by at least 15 minutes.

However, information about these impacts propagated slowly. "If social media content had been integrated in the real-time systems and been evaluated, appropriate IRREG handling could have started earlier and, hence, business impact could have been mitigated." (CIO, Lufthansa)

One innovation Lufthansa has introduced is real time redirection of passengers during an IRREG, such as transferring inbound passengers to a different flight and rerouting them through another city. Lufthansa’s Director, IT Service Factory Ground Ops told us that big data is used for "proactive IRREG management, turnaround processes, passenger transfer management (at

\textsuperscript{24} Techniques for translating scenarios to big data system design are described in Chen, H-M., Kazman R. and Haziyev, S., 2016, op. cit.
hubs), using internal and external data to do proactive steering (making a decision on whether to wait for passengers and baggage from a late inbound flight).” Admittedly, he added, “verifying the accuracy of information from social media and external data sources in real time is a difficult task.”

As of 2017, Lufthansa is equipping all ground staff and flight crews with mobile devices. These devices provide staff and crew with comprehensive operational data and access to social networks and thus enable them to support passengers in all kinds of situations at the airport and in the aircraft cabin using state-of-the-art communications. IRREG situations will henceforth be managed using real-time data.

**Primary Use Case 3: Predicting Departure Delays and Proactive IRREG Recovery**

Flight delays are another kind of IRREG situation (although, on average, 73.9% of commercial flights are on time and only a quarter of the many causes of delays to an airline’s schedule are within its direct control). Delays are obviously not just operational issues; they impact passengers and employees. The major impact, however, is to an airline’s bottom line. IRREG recovery has three aspects: aircraft, crew and passenger re-accommodation. The complexity of resolving these three aspects simultaneously and in the most optimal way often calls for a technology-based solution. IRREG recovery is the most challenging form of airline operational management because it requires dynamic assessment of the current situation and real-time decision making. The people, plans, procedures, policies and technologies that facilitate a "typical" airline day become critical during an IRREG. According to Lufthansa’s Director, IT Service Factory Ground Ops, big data can help recovery by knowing where each employee is, especially eligible flight crew, and positioning them optimally in real time for returning to full operations.

Big data analytics systems used to help plan schedules to maximize revenue and minimize customer discontent must be robust enough to allow for recovery from IRREG situations. Based on historical IRREG data, Lufthansa has developed a big data analytics application to support decisions that minimize the number of passengers missing their connections when flights are disrupted. This application has increased customer satisfaction significantly and minimized the collateral damage resulting from an IRREG. Lufthansa also uses a big data application, based on statistical evaluation of historical data, to predict the probability of needing to offload baggage and the related departure delays because of passengers not showing up.

Big data can also be used to monitor customers’ responses to an IRREG event on social media and thus enable Lufthansa to understand customers’ emerging sentiment and plans. For example, IRREG procedures for recovering from a flight delay could include an option for facilitating car sharing organized by a passenger (as described earlier).

There are many ways in which big data predictive analyses can enable proactive handling of IRREG situations. In one instance, a huge storm was predicted, and all flights leaving New York’s JFK airport were cancelled. All affected passengers were notified the day before the storm actually hit. They were offered alternative travel options prior to the storm, which greatly improved their positive view of Lufthansa and thus helped to build loyalty.

Lufthansa’s Director, IT Service Factory Ground Ops summarized that the airline uses big data to minimize delays by:

> “Predicting network behavior and departure delays of aircraft throughout the day, taking into account reactionary delays, rotation oriented, and weather and congestion at airports; learning delays from historical patterns augmented by today’s real-time info, including unstructured social media data; and learning optimized flight routes from past flight data.”

He added that the benefits of big data analytics include:

> “Decreasing financial loss due to delays; pleasing passengers by shortening flight times and minimizing wait times; saving fuel; complying with crew duty times; and protecting the environment.”
Primary Use Case 4: Predictive and Preventive Aircraft Maintenance

Because the safety of passengers and crew members is the top priority for all airlines, predictive and preventive aircraft maintenance is critical. Lufthansa’s Vice President, Cluster Domain Ops and Cross Domain said that, in addition to maintenance records, aircraft-related data should include operator’s notes, technicians’ notes, operational personnel’s observations, external data from other airlines, etc., to allow “many eyes” for the state of an aircraft. Lufthansa’s big data approach in this area includes:

- Collecting and evaluating aircraft status information to predict failures of parts
- Continuous air-to-ground communication (for safety reasons)
- Making data available in real time and searching for patterns indicating failures, especially for engines (which are the most expensive and potentially most life-threatening aircraft component)
- Scheduling predictive maintenance events to avoid an aircraft flying to destinations short of spare parts.

The big data value from predictive and preventive aircraft maintenance includes:

- Prevention of downtime and reduced schedule interruptions
- Safer, longer-lasting planes
- Cost savings from matching maintenance to wear
- Improved spare part handling and logistics
- Fewer unplanned delays for passengers.

In 2016, Lufthansa Technik, the maintenance division of Lufthansa, embarked on a strategic partnership with FLYdocs, an independent U.K.-based software business focusing on the aviation industry. Its product, also known as FLYdocs, is an Enterprise Level application for Operators, Lessors, Asset Managers, Banks, MROs and Manufacturers. FLYdocs’ e-enabled approach (a first in the aviation industry) revolutionizes the way aircraft documentation and data are accessed and managed. The more data that is stored and handled in a standardized manner in FLYdocs, the more the value that can be derived from the related business intelligence (BI) approaches.

The Big Data Paradigm is Enabling Lufthansa’s AIA Business Model

The combination of service-dominant logic principles and the big data paradigm is the driving force behind Lufthansa’s AIA business model. The big data paradigm means collecting data from everywhere (weblogs, social media, mobile apps, etc.), and is an open world system concept that is critical for CRM from the service-dominant logic perspective. This paradigm requires the integration of internal, external, real-time and batch-processed data, whether structured or unstructured, to provide the base for big data analytics. Prior to deploying big data systems, Lufthansa stored only structured, transaction-oriented data (about 30 terabytes in its data warehouse). But now, as stated by Lufthansa’s CIO, “we want to link with unstructured and semi-structured data from social networks, etc. We need to know about customer likes/dislikes, etc. from all possible data sources.” Including all these different types of data, Lufthansa has realized more benefits, as highlighted by the Director, IT Service Factory Ground Ops: “We currently have a DSS [decision support system], but incorporating big data—external data in real time—has improved our predictive analysis results for ground operations, staff management and aircraft maintenance.”

Significantly, according to the Senior Director, Solution Design and Vendor Management, the big data paradigm could speed up the delivery of value by reducing:

“The time it takes to make data available to my business teams for analysis; the time it takes for enhanced data insights; and the time it takes to uncover new insights (implementing new functionality to my solution).”

Figure 2 provides a high-level view of how Lufthansa has adopted the big data paradigm and the associated data flows, which integrate new (NoSQL databases) and old (relational data warehouse) systems. This figure represents a typical big data paradigm. Data-in-motion,
data-at-rest and data in different formats are ingested, cleansed and integrated through an ETL (extract, transform, load) process. Quality data is stored in the MDM (master data management) system. Data-in-motion is analyzed (using stream processing) on the fly without first being stored, to provide real-time analysis. Data at rest is a snapshot of the information that is collected and stored.

Data in many forms (from weblogs, social media, etc.) “lands” as raw data and is archived in a Hadoop system that can handle the large volumes. MapReduce is used to retrieve archived data for analytics. An integrated exploration process then uses data from the real-time stream combined with data from the Hadoop system and data warehouses. The data and results from four modules (real-time analytics, landing, analytics and archive, and integrated exploration) are then displayed in the intelligence analysis, decision management, BI and predictive analytics, and navigation and discovery modules. Managers interact with these modules.

As shown in Figure 2, the potential of big data comes from the variety of data from multiple sources that can be explored to provide insights.

Previous “small” (structured, relational) data systems could not support this wide variety. Before big data deployment, Lufthansa relied on “small” database/data warehouse systems to perform analytics on only internal, structured, mostly transactional data, which was very limiting. In primary use case 1 described above (personalizing customer experiences), business value can be generated by combining customers’ social media data with their transaction history in the data warehouse. This enables Lufthansa to see customers’ shopping preferences and history, their hobbies, their friends, what products they buy and recommend, their product reviews, their political views, where they live and what they like to do. Lufthansa can then predict what a customer is going to need (e.g., travel to Asia to see their parents or for a business trip) or want (e.g., a vacation in Hawaii) or do (e.g., order a movie on the flight) or buy (e.g., an expensive anniversary gift).

Note, however, that not all big data is new data. Lufthansa has a wealth of internal data that was not previously used because it was not captured or not in the structured format needed for “small” data analytics. This information includes, for example, a customer’s queries in various channels, including on the phone with the reservations department or in person with the luggage department to find lost luggage. Another
example is a pilot's handwritten notes about a flight experience.

Applying big data analytics to existing data can also provide insights that can reduce costs and identify innovative services. For example, a flight plan is generated for each flight, and this plan must meet all safety and regulatory requirements. Comparing historical plans with actual performance and mining the data of flight histories can generate insights for minimizing flight times, improving aircraft productivity and minimizing maintenance times, while also reducing operational costs such as fuel. Ideally, optimal flight plans will be automatically generated and updated based on the environment at both departure time and during the flight.

Critical Success Factors for Innovating with Big Data

Lufthansa's success in innovating with big data to renovate its business model is predicated on the seven success factors (CSFs) described below. Some of these factors are not new but are crucial for closing the big data Deployment Gap. We identified the critical success factors after much analysis with no preconceived theories, but realized they are consistent with the service engineering framework shown in Figure 3, called BITAM-SOA (Business-IT Alignment Model—Service Oriented Architecture).26 Significantly, the success of big data adoption at Lufthansa appears to rest on Lufthansa's business-IT alignment capabilities, which encompass three aspects: communications (see CSF 1, CSF 2, CSF 3 and CSF 4 below), architecture (see CSF 5 and CSF 6 below) and governance (see CSF 7 below). Each

Figure 3: The BITAM-SOA Service Engineering Framework

of these aspects has both technical and social dimensions based on BITAM-SOA framework.

**CSF 1: A Formal Top-Down Value Discovery Process**

Lufthansa went through a three-year Value Discovery process before adopting big data. As mentioned above, Value Discovery has three phases: innovation process, use case development and strategic development planning, including cost-benefit analysis, sourcing decisions, talent management, etc.

Well before embarking on its big data journey, Lufthansa’s strategic focus had been on innovation and digitization. An innovation fund had been created to support innovative solutions and technologies, and an innovation hub had been established in Berlin to strengthen links with relevant start-up companies. “Innovator Awards” were given to employees who developed and implemented innovative ideas and projects. In addition to these incentives to innovation, Lufthansa used a formal top-down innovation process to solicit ideas for big data applications. Hundreds of use cases were generated and ranked, and a few “lighthouse projects” were selected, prototyped and later scaled up. This extensive process resulted in well-defined “values” that could be derived from big data, and these values enabled the new AIA business model. Although there have also been many bottom-up innovation efforts at Lufthansa, without a formal top-down process, use case generation and selection would not have been effective.

**CSF 2: Direct Involvement by the CEO**

Top management support has been cited as a critical success factor for virtually every system implementation. In Lufthansa, however, this factor went beyond support. The direct communication between CEO and CIO reflects the strategic role of IT at Lufthansa. IT innovation is now front and center for Lufthansa. In the IS literature, direct communication between the CEO and CIO has been reported as critical for successful IT innovations.27 Referring specifically to big data, Lufthansa’s CIO said: “IT has a more strategic role than in the past. I am now directly working with the CEO, but that wasn’t the case in the past. Even in the early stages of a project the CEO is interested.”

**CSF 3: Service-dominant Guidelines for Deploying Big Data**

The AIA business model requires a full transition from goods-dominant to service-dominant logic. The entire enterprise, business and IT, must embrace service-oriented principles and the associated strategic focus on reaping the business values from big data. To make the full shift, service-dominant system design principles (shown in column 2 of Table 1) must be applied to govern big data requirements and guide big data system design and business process management. These principles will ensure that the resulting systems will help the organization to develop genuine relationships with its customers. In the words of Lufthansa’s Data Governance Manager: “Big data is like other IT functions/platforms; always a means to an end and never an end in themselves.”

Table 1 lists the foundational premises of service-dominant logic28 and the associated system design principles These are contrasted with the traditional goods-dominant system design principles for customer experience applications. In addition, as shown in Figure 3, the components of the business architecture layer need to be aligned with the IT infrastructure layer to support the service-orientation and customer-centric value propositions.

The success of Lufthansa’s AIA business model hinges on the full transition from goods-dominant logic to service-dominant logic to ensure that genuine customer-relationship-building propels innovative end-to-end design of the customer experience enabled by big data. Whether big data has or has not been deployed, any CRM or social CRM initiatives will be ineffective without a true service orientation. However, the AIA business model would not be possible without big data.

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27 This is the communication aspect of business-IT alignment in the service engineering framework. For more detail, see Reich, B. H. and Benbasat, I. “Factors That Influence the Social Dimension of Alignment Between Business and Information Technology Objectives,” *MIS Quarterly* (24:1), 2000, pp.81-114.

CSF 4: Business-Case-Driven Decision Making with Creativity

There is currently much hype about the prospects for big data. Typically, those with vested interests create hype around technology innovations and promote them as must-deploy-or-fail opportunities in an effort to influence the adoption of the technology. Lufthansa, however, is not jumping on the big data bandwagon.

“Yes, most of the major vendors are offering big data to us, but we were not too impressed until we came to our own realization that we needed it. … I have representatives from big data vendors in my office everyday—literally every day. There is a lot of pressure to adopt. However, we want to be with the leading technology but not the ‘bleeding’ technology. We are cautious.”

CIO, Lufthansa

We do careful assessment of the big data technology. We have a steering committee on the big data initiative; we went through our innovation process to discover value from big data and we came up with a few lighthouse projects.”

The CIO also said that adoption of big data was “driven by business cases, not by technology.” And the Data Governance Manager said: “To start big data processing, the right use of business cases is a prerequisite. You should know exactly what business targets you want to achieve with big data.”

Previously, Lufthansa had adopted a service-oriented architecture (SOA) approach to solve the specific problem of interoperability. But the current adoption of big data is aiming at innovation to create competitive advantage. In the words of the Data Governance Manager, “Big data technology enables the utilization of high volumes of external and internal data to create new insight in the current business model and even help to start new or changed business opportunities.”

Table 1: Service-dominant System Design Principles

<table>
<thead>
<tr>
<th>Service-Dominant Logic</th>
<th>Service-Dominant System Design</th>
<th>Traditional System Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Premises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The customer is always a co-creator of value</td>
<td>Include customer competencies and networks for IDIC (Identify, Differentiate, Interact, Customize) CRM design; shared information among customers, firms and networks; dynamic interaction design with customers; focus on both the firm’s and customers’ processes; analysis of the entire customer interaction chain; many-to-many design; customer involvement in design</td>
<td>Customers seen as external entities; static view of users/customers and interaction process; single-view of customer, 1-1 design; focus on firm’s processes</td>
</tr>
<tr>
<td>The enterprise cannot deliver value, but can only offer value propositions</td>
<td>Internal and external process integration; dynamic value configuration with customers’ network and supplier chains</td>
<td>Integration of firm’s internal processes; value configuration from firm’s resources</td>
</tr>
<tr>
<td>A service-centered view is inherently customer-oriented and relational</td>
<td>Longer-term customer value; design for trust and loyalty in a network</td>
<td>Shorter term measurement of benefit, value, profitability</td>
</tr>
<tr>
<td>All social and economic actors are resource integrators</td>
<td>Including both the firm’s and customers’ competencies and resources; dynamic integration for personalization; end-to-end process integration</td>
<td>Include just the firm’s competency and resources</td>
</tr>
<tr>
<td>Value is always uniquely and phenomenologically determined by the beneficiary</td>
<td>Value measurement needs to capture intangible, experiential quality of services (dynamic); customer-focused balanced scorecard</td>
<td>Predetermined value assumed</td>
</tr>
</tbody>
</table>
The lesson from the Lufthansa case is that enterprises must cultivate effective innovation processes and creative system designers for devising innovative big data use cases where business value can be derived. At Lufthansa, use case development was critical to big data value discovery and subsequent deployment. The creativity required for devising big data use cases goes beyond the problem-solving capabilities that are commonly seen as the main qualifications for system designers.

CSF 5: An IT Architectural Foundation for Growth and Integration

Lufthansa runs more than 350 complex applications, and its IT infrastructure is geographically distributed among several data centers. A top priority for improvement is data management. There are several airlines in the Lufthansa group so it is important to be careful about the “scope” of data—to which airline does the data belong? One of Lufthansa's big data efforts is to provide support for personalized experience applications and customer profiling. The focus, according to the CIO, is on consolidating data to create “a single point of truth for all customer info.”

One of Lufthansa's major IT achievements has been to implement SOA technology. Major corporations like Lufthansa see SOA as key to cost-effectively obtaining organizational agility and aligning the business and IT. The underlying principles of SOA are: open standards for interoperability, loose coupling, reuse of shared services, and dynamic “orchestration” of component services. With SOA in place, Lufthansa has a large enterprise service bus (ESB)\(^{30}\) that allows it to connect legacy applications to newer ones. This ESB is important when implementing big data systems because new and old systems need to be integrated continuously. The SOA infrastructure thus provides a good foundation for growth and integration. The CIO says: “We have been good at integrating these old technologies,” referring to how Lufthansa integrated its existing Teradata data warehouse, Oracle 11 and Oracle 12 with Hadoop-based systems and emerging technology.

CSF 6: Effective Outsourcing and Vendor Management

Lufthansa's main strategy for big data deployment has been outsourcing. The CIO told us: “We have no in-house developers. Everything is outsourced. We have more than 200 providers. We are trying to consolidate this to a smaller number next year.” Outsourcing at Lufthansa has a long history. Until April 2009, its inventory and departure control systems were managed by LH Systems. Lufthansa's reservations systems were outsourced to Amadeus in the 1990s, following a decision to outsource all components of the Passenger Service System. The $1.25 billion outsourcing deal with IBM in November 2014 continued the outsourcing strategy.

“I am fully confident about our outsourcing. We always separate infrastructure and applications. We have enough time to prepare, and we are used to working with external providers.” CIO, Lufthansa

Vendor management is therefore critical for successful adoption of big data. Lufthansa's Senior Director, Solution Design and Vendor Management focuses on the critical tasks of:

- Supporting the evaluation of the best-fitting solution and partner to implement and maintain a big data solution
- Setting up the right contractual framework
- Negotiating the best-fitting and flexible contract for a big data solution related to the need and knowledge of the organization (scalability, pricing model, etc.)
- Setting up the right vendor governance model for the chosen vendor (solution)
- Avoiding the creation of a big data vendor “zoo” by working with the architects to define a future-oriented target architecture for big data that avoids creating a heterogeneous landscape.

This senior director added: “The market offering in big data is very broad and moves very rapidly; thus it's critical to support the procurement processes to be compliant with the

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30 An enterprise service bus is a middleware component that provides fundamental communication services enabling flexible distributed computing architectures.
new agile world, from bimodal IT\textsuperscript{31} to a speedboat approach.\textsuperscript{32}*

The outsourcing strategy employed by Lufthansa mitigates some of the development complexity associated with big data but creates new complexities, such as managing 200 providers and ensuring that all system components interoperate.

**CSF 7: Data Governance and Talent Planning Processes**

The fourth V of big data—Veracity—refers to the uncertainty of data: the organization may be getting "dirty" data. Lufthansa's Data Governance Manager stated: "To utilize these volumes of big data, coming from different sources, with different structure or even unstructured, it is critical to have data governance processes and clear responsibilities for the data. We have developed these processes and roles and found a framework to manage the data. …. A major success factor of big data management is the data quality (completeness, accuracy, conformity, timeless, consistency, uniqueness, privacy). For all these quality criteria, you can define performance indicators and measure the degree of achievement."

Lufthansa has many data specialists in command-and-control centers who are continuously working to improve data analytics. But, according to the CIO, "... some resources, such as data scientists, might be in short supply, and recruiting them might be tricky and expensive." Having plans in place to recruit suitably qualified data specialists is a crucial aspect of the strategic deployment of big data.

**Concluding Remarks**

The Lufthansa case demonstrates how business value deriving from big data can enable an innovative business model, which we call "Amazon In the Air" (AIA). This model is helping Lufthansa to survive and thrive in a fiercely competitive business environment. We venture to suggest that the business-IT alignment capabilities of all three aspects of the BITAM-SOA service engineering framework—communication, architecture and governance—are essential for successful big data deployment.

There are two practical implications from the Lufthansa case. First, although it is important to incorporate new semi-structured or unstructured data driven by use cases, integrating existing data is crucial for big data innovation. Blending the old with the new is a challenge in big data and requires a thoughtful IT architectural approach and data governance processes. Second, to use analytics for competitive advantage, it is necessary to build a culture that fosters analysis. Only 0.5% of all data is ever analyzed.\textsuperscript{33} Some of the most useful data isn't being captured or is inaccessible. We also caution against "Hadumping" (Hadoop dumping), where enterprises just collect big data but do not use it for analytics.

**Appendix: Research Method**

The Lufthansa case reported in this article follows on from an earlier study. The first study was an empirical multiple case study of 23 large European enterprises designed to examine the "why" and "how" of firm-level big data adoption. These enterprises were from a wide range of industries, and their average number of employees was over 150,000. Lufthansa was the only company in this first-stage study that could shed light on the "how" of big data value discovery and on closing the Deployment Gap. We believe that Lufthansa is not a "typical" case but rather an exemplar that can help shape best practices for innovating with big data. As a follow on to the initial research, we collaborated with the CIO of Lufthansa, who co-authored this article.

The first-stage research used a case study methodology, and we collected data from multiple sources for each case company (Lufthansa included): public corporate information, management consultant reports, magazine and newspaper articles, informal exchanges with colleagues, formal interviews, and site visits, as well as documents (slides, internal

\textsuperscript{31} According to Gartner, bimodal IT is an organizational model that segments services into two categories based on application requirements, maturity and criticality. Mode 1 is traditional, emphasizing scalability, efficiency, safety and accuracy. Mode 2 is nonsequential, emphasizing agility and speed.

\textsuperscript{32} The "speedboat" approach contrasts with the "oil tanker" approach adopted by many organizations for big projects, with big promises and big investments, but doomed to hit a big iceberg.

technical reports, use cases, etc.). In Stage 1 of the research, we conducted 28 semi-structured interviews, each lasting one to three hours, with 40 people, mostly C-level executives, VPs, chief architects and heads of business intelligence units. Specifically, we interviewed the CIO of Lufthansa, exchanged emails, and obtained Lufthansa's internal documents, annual reports and presentation slides.

The breadth of the initial study prepared us well for the second stage of the research: an in-depth examination of the “how” of big data adoption at Lufthansa. We also learned in the first stage that many companies would benefit from a detailed “how” study. We would like to thank the following individuals at Lufthansa for their contributions to this article, including their time spent in interviews and on responding to emails, and on verifying the correctness of all the facts presented in this article:

- Didier Arnold, Senior Director, Solution Design and Vendor Management
- Mirco Bharpalania, Director, IT Service Factory Ground Ops
- Günter Friedrich, Vice President, Cluster Domain Commercial and Passenger
- Dr. Matthias Hocks, Vice President, Cluster Domain Ops and Cross Domain
- Klaus Hohmaier, Data Governance Manager

**About the Authors**

**Hong-Mei Chen**
Hong-Mei Chen (hmchen@hawaii.edu) is a professor of Information Technology Management at the Shidler College of Business at the University of Hawaii at Manoa. She conducts cross-disciplinary empirical research on information systems design and development. Her current research interests include big data engineering and management, innovation-driven system design methods, cybersecurity, social customer relationship management, business-IT alignment and service engineering. She has obtained large grants and directed several large-scale multi-million-dollar, multi-institution research projects. She serves on the National Science Foundation review panels and large grant management team. She is widely published in prestigious MIS and software engineering journals.

**Roland Schütz**
Roland Schütz (roland.schuetz@dlh.de) is the Executive Vice President and Chief Information Officer, Lufthansa Group. After his education in natural sciences and supercomputing, he worked as scientist. In 1996, he moved to the finance industry and held several management positions in IT service delivery organizations. He joined Lufthansa Group in 2005 as Chief Operating Officer of Lufthansa Systems, and, in 2010, was appointed CIO of Lufthansa Cargo. In 2014, he was appointed CIO of Lufthansa Passage, and in 2016, became CIO of all Lufthansa Group Airlines. He has been CIO of Lufthansa Group since February 2017.

**Rick Kazman**
Rick Kazman (kazman@hawaii.edu) is a professor at the University of Hawaii at Manoa and a research scientist at the Software Engineering Institute of Carnegie Mellon University. His primary research interests are software architecture, design and analysis tools, software visualization and software engineering economics. Kazman has created several highly influential methods and tools for architecture analysis, including SAAM (Software Architecture Analysis Method), ATAM (Architecture Tradeoff Analysis Method), CBAM (Cost-Benefit Analysis Method) and the Dali and Titan tools. He is the author of over 200 publications and has co-authored five books.

**Florian Matthes**
Florian Matthes (matthes@tum.de) holds the chair of Software Engineering for Business Information Systems at Technische Universität München. His current research focus is on methods and technologies driving the digital transformation of enterprises and societies—enterprise architecture management, service platform and ecosystem modeling, collaborative model-based working environments and semantic analysis of legal texts. He is co-founder and chairman of the board of CoreMedia (1996) and infoAsset (1999), and scientific advisor of UnternehmerTUM, the center of innovation and business creation at Technische Universität München.