Amazon in the Air: Innovating with Big Data at Lufthansa

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Abstract

Big data offers great opportunities for innovation. However, at the end of 2014, at the peak of its hype, big data deployment was still scarce and failures abounded. This article presents a case of how Lufthansa, the largest airline in Europe, successfully tackled the task of discovering value from big data, addressing the inherent technical complexities, and transforming their business model of selling airline tickets to customers to one that we call "Amazon in the Air" where service-dominant logic prevails. This case demonstrates that IT innovation is the *business imperative to survive and exemplifies the complex business environment and rapid changes for which big data is being considered. Our case study also sheds light on the challenges and critical success factors for innovating with big data and how to navigate through uncharted waters, employing new thinking and new approaches to seize innovation with big data.*

1. Introduction

The big data tsunami is sweeping over enterprises and changing the business landscape. Big data only recently became a megatrend, in 2011, when IBM created the hashtag #bigdata [31]. Big data is characterized by the 5 Vs: a large **volume** of a **variety** of (structured, semi-structured and unstructured) data can be ingested and collected in real time, at high **velocity**, from everywhere (thus introducing concerns over **veracity** – the accuracy of data) to provide business **value** [8]. "Everywhere" could mean from the IoT (Internet of Things): Apple watches, mobile phones, web logs, social media, embedded devices, and so on. Big data enthusiasts claim that the data "deluge" makes the scientific method obsolete: With enough data, the numbers speak for themselves [3]. In a short few years, big data is now at the peak of the Hype Cycle for Emerging Technologies [14]. Big data is possibly the most significant technology disruption in business and academic ecosystems since the meteoric rise of the Internet and the digital economy [2]. MGI predicts that big data will become a key basis for competition, productivity growth, and innovation [23].

However, Gartner reported "2013 is the year of big data experimentation, 2014 too." As of the end of 2014, actual big data deployments are still scarce [15]: only 13% of respondents said their IT organizations put big data projects into production in 2014, and failures abound. According to a CIO Survey in 2013, 55% of big data projects were not completed [21].

"Why is there such high hype but low adoption rates and scarce deployments?" we wondered. This is a paradox, different from previous enterprise IT adoption trends, such as ERP (Enterprise Resource Planning), SOA (Service Oriented Architecture), etc. Adoption of innovations has been a topic of significant interest for decades. Research on this topic has proliferated as enterprises increasingly depend on IT innovation to grow, compete, or survive. To help practitioners shape effective business strategies and ensure competitive advantage, it is essential to understand why, how, and under what conditions enterprises have succeeded or failed in adopting IT innovations. However, despite the large number of innovation adoption studies, little work has examined emerging IT innovation such as big data [24] [4] [25] [5] and only scant empirical evidence has been provided [25].

To fill this void, we conducted a two-stage study: (1) to demystify big data adoption, and (2) to study and present an exemplary case of *successful* big data adoption. The first-stage research and the resulting new model and theory (the Big Data Adoption Model and the Complexity Tolerance Theory) are detailed elsewhere. Most importantly, our first-stage research results serve as a motivation for selecting, studying and presenting the Lufthansa case in *this* article. In our second-stage research, we collaborated with the CIO of Lufthansa in completing the present study.

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2. Research Method

In the first-stage, we conducted an empirical multiple case study of 25 European enterprises (23 large enterprises, 1 medium, and 1 small). The average number of employees of these enterprises is > 150,000. There are 5 outsourcers and 20 non-outsourcers. 21 were German-based, with another 4 in Europe but based outside Germany. 1 of the 4 non-German companies was headquartered in the U.S. The industries include: telecommunication services; manufacturing: automation & power; manufacturing: airplanes; global financial services; logistics; airline; reinsurance and financial services; manufacturing: smart plants; conglomerate; financial services; insurance and reinsurance; manufacturing: automotive components; manufacturing: automotive; investment banking; utility: energy, telecom, and IT; insurance software provider; tax and legal software provider; general outsourcing; outsourcer: energy technology provider; outsourcer: smart city and energy; outsourcer: telecom IT services.

For this exploratory research, we utilized the grounded theory method [16] [17] which is particularly appropriate for studying emerging phenomena that go beyond previous theories. Applying grounded theory, our process started with broad research questions. We did not have *a priori* identification of variables, preconceived hypotheses or theories, but we did have a solid understanding of literature and theories in many IS subfields. We collected data from multiple sources including public corporate information, management consultant reports, magazine and newspaper articles, informal exchanges with colleagues, formal interviews, site visits, documents (slides, internal technical reports, use cases, etc.) provided by the case companies, and engaged in collaborative practice research (CPR) [8] with 2 outsourcers. One author worked for one of the conglomerates. We conducted 28 semi-structured interviews with 40 people, lasting 1 to 3 hours. We could have contacted more companies but did not because we reached a saturation point where we no longer learned anything new. We concluded that more companies and data would not change the emerging theory. 25 cases is considered a large sample size in studies employing grounded theory.

Our first-stage research findings confirmed Gartner's survey results: big data deployment is scarce. Note that our multiple case study is not intended to be a survey and the statistics here are not significant. However, it is interesting to note that only 12 percent of our case enterprises had moved to deployment. In contrast to previous studies that have treated technology adoption decisions as a binary propositions, our study found that there are four adoption categories in big data adoption: *Not adopting*, *Experimented but Not Adopting*, *Not Yet Deployed,* and *Deployed*. Many companies in the *Not Adopting* categories (experimented or not) are not able to move to deployment for the following reasons: (1) misfit with business model, (2) lack of organizational capability (e.g., Business-IT alignment and strong organizational Innovation Process), (3) the Innovator's Dilemma (e.g., current systems are perceived as being adequate) [12] and risk avoidance, (4) inability to find innovative use cases [28], (5) disappointment due to overselling and unrealistic expectations created by hype [1] and, (6) inability to deal with the complexity associated with system development paradigm shifts [8].

Our first-stage research revealed that big data adoption shifts the focus from the technology to the business model and from problem-solving to innovation, departing from previous IT adoption trends. We identified many new adoption factors, in particular psychological factors that were not reported previously. Moreover, we discovered a "deployment gap": with the best intention to adopt, many of our case enterprises stayed in the "Limbo" stage of *Not Yet Deployed*. They are either unable to move to deployment by not being able to address the complexity and paradigm shifts or they remain in experimentation mode for fear of the "Uber effect" (e.g., a disruptive innovation that changes the entire industry), fear of missing out [26], and a strong desire for innovation. This last point may appear paradoxical: different from previous enterprise IT adoption, most enterprises desire game-changing innovations from big data, not just incremental improvements of their existing business models.

Lufthansa, one of the 4 case enterprises in the *Adopted* category in our multiple study of 25 enterprises, was the ***only*** case that had created a new game-changing business model enabled by big data, which we call "Amazon in the air". Theirs is an exemplary case that helps to understand how to navigate through uncharted waters for seizing opportunities with big data. The analysis of this case and the formation of the critical success factors for big data adoption has benefited from the analysis of the other 24 cases in our first-stage research. The Lufthansa case also aids our first-stage research: forming our new theory, Complexity Tolerance Theory, on firm-level enterprise IT adoption.

3. Transformation Imperatives

Deutsche Lufthansa AG (commonly called Lufthansa), 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 carried about 106 million passengers, had an average number of 118,973 employees and a revenue of 30.01 billion euros [22].

The airline industry is marked by low profit margins, constant mergers, frequent entry of new players, disruptive competition, fierce airfare wars, strict legal and safety requirements and great economic uncertainty. The low profit margins underscore the need for business transformation. For example, in 2012, the International Air Transport Association expected airlines to achieve a collective global profit of $18 billion. That sounds impressive, but on revenues of 746 billion, the airlines earned an average net margin of just 2.4%. That's less than $6 per passenger. In 2013, net margin was similarly low, 2.6%: the average airline earned 8.9 US cents/ASK (Available Seat Km) and expensed 8.7 US cents/ASK [20]. Needless to say, reducing costs and increasing revenue is a transformation imperative for Lufthansa

Market transformations, consumer trends and global travel patterns have imposed substantial changes in the airline industry. Trends affecting the aviation sector include: (1) economic power shifting to Asia, (2) global demographic trends create new customers and mobility patterns in long-haul flights and in purchasing power, and (3) global digitization creates permanent changes in all areas of life. As a result, customer centricity, ancillary revenues and mobility solutions are on the airline CIOs' agenda. According to a 2013 airline survey [30], mobile and business intelligence are top investment priorities. A third area high on the investment agenda is customer relationship solutions with 97% of airlines looking at personalization to build loyalty. Almost all airlines (92%) plan to monetize this investment through higher ancillary revenues. There are opportunities for ancillary revenues in pre-flight stages, e.g., Shopping and Ticket Purchase stages, as the cost burden is disproportionate in other stages of the customer engagement cycle, as shown Figure 1. Airlines bear high costs but low margins in the Flight stage.

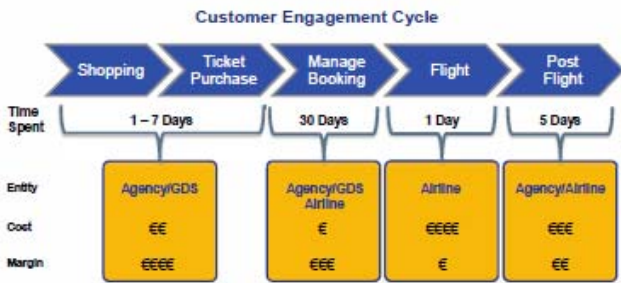

Figure 1. Customer Engagement Cycle and Cost Distribution

Distribution needs to be viewed as more than shopping for and selling tickets. New ways of breaking the traditional airline business models of selling tickets have proliferated. We have already witnessed the airlines moving into retail models of OTAs (Online Travel Agent) and department stores. All the 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.

In addition, new players and emerging markets constantly challenge the airlines' value chains. As the ultra-low-cost carriers and hybrid low cost carriers rapidly moved from Europe to Australia to North America and Asia, Lufthansa was forced to adopt new thinking on how to deliver value. Positioned as a premium full service carrier (PFSC) to provide excellent travel experiences focusing on customers and quality, differentiating Lufthansa from other PFSCs is an imperative. Offering more high-end features such as lie-flat seats is insufficient. In addition, worldwide point-to-point traffic is rapidly expanding. Lufthansa's business must grow in direct traffic outside their hubs and that is why they want to further build on the success of their Wings airlines [22].

Finally, Lufthansa, like all other airlines are subject to the winds of economic, business, political, societal and environmental uncertainty. This includes the ups and downs of fuel costs, disasters, and other "disruptions." For instance, while fuel costs decreased in 2014, among the major challenges for the entire industry were the political crises in Ukraine and the Middle East, as well as the adverse effects on global aviation of the Ebola epidemic in West Africa. In addition, the large strikes by their own pilots had a significant impact on Lufthansa's business performance in 2014 [22]. Ways to manage and control the risks and minimize the damage when disruption occurs is of paramount importance.

As all of an airline's critical business processes rely on IT, IT Innovation is the strategic imperative for Lufthansa to survive and compete. IT innovations are needed for business transformation including cutting operation costs, providing excellent customer experience, expanding ancillary revenues, delivering mobility and self-service solutions, differentiating from other PFSPs, and managing disruptions. And big data, through an extensive innovation process, has been identified by Lufthansa to enables all these desired innovations, and more, to be integrated into a new business model, which we call "Amazon in the Air" to be described next.

4. New Business Model: "Amazon in the Air"

"Aircraft and new 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." Roland Schütz, CIO, Lufthansa

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 due to the fostering of their IT capabilities to provide differentiating quality products and services and to build customer loyalty. Like Amazon, Lufthansa transformed from selling tickets to their new customer-centric business model—everything revolves around how to make the customer experience the best. They are aiming to become the first "five start" carrier in Europe [22]. They have made investments in upgrading aircraft (to have lie-flat seats in 100 aircraft), purchasing new aircraft, and installing new Premier Economy Class, but leveraging IT innovations to provide the best personalized travel experience has been their strategic focus. Their customer experience design does not start when customers enter the departure gate and does not end when customers leave the terminal. Their strategy is end-to-end. It's not about "selling" premier and ancillary services but about predicting and meeting customers' needs beyond their expectations: to provide personalized services when they are least expected—pre-travel, en-route, in destination, and post-travel. These are not the traditional CRM (customer relationship management) or newer Social CRM [10] tactics. This is reframing Lufthansa's purpose in relation to its customers, shifting from goods dominant logic to service dominant logic (SDL) [11] in which customers are seen as the brand co-creator.

There are two perspectives for the consideration of service(s): (1) goods-dominant (G-D) logic views goods (tangible outputs embedded with value) as the primary focus of economic exchange and "services" as either a restricted type of (intangible) good or an add-on that enhances the value of a good. (2) Service-dominant (S-D) logic considers "service" – a process of doing something for another party – in its own right, without reference to goods, and identifies service as the primary focus of exchange activity.

CRM was intended to be a customer-centric, service-oriented information system since its conception in late 1990s. We suggest that a key reason for CRM failures is the G-D logic trap that services are intangible units of output and relationships are defined in terms of repetition in selling these units to a given customer [10]. Thus, CRM based on G-D logic becomes more of an operation-centric, transaction-based, efficiency "machine" to process customers as "goods." This G-D logic perspective predictably leads to superficial attempts at a relationship such as addressing people by name, and personalizing product recommendations, but falls short of true relationship building. While these activities sometimes lead to convenience-based repeat purchases, they do not build emotional loyalty with customers. G-D oriented CRM is used for "little more than manipulation of consumer data in ways intended to create an illusion that the provider is presenting a customized response to an individual consumer's needs [and] is fundamentally an inauthentic play for a consumer's attention" [29]. S-D logic calls for a genuine reconnection to the original roots of CRM, focusing on the "C"—Customer—and the "R" —Relationship [10].

Congruent with SDL principles, big data is being leveraged to manage the entire customer engagement cycle, using resources of customers, logistic network partners, service partners and others to co-create the best customer experience. "Travel is a trigger for the opportunity to provide services to the customers. We are competing, in this way, with Google and Amazon," stated the CIO of Lufthansa. Equally important, big data is used to improve operational efficiency and disruption management that are essential to better customer travel experiences. Most importantly, big data is being mined to discover innovative service provision and operational optimizations that were not possible before. We will illustrate these points in the next section and make clear the role of big data in Lufthansa's new business model.

5. Big Data Primary Use Cases

"Until now, we only had structured data, transaction-oriented. Our data currently is about 30TB in our data warehouse. But now we want to link with unstructured and semi-structured data from social networks, etc. We need to know about customer likes/dislikes, etc." -- Roland Schütz, CIO, Lufthansa

Figure 2 describes the high-level big data systematics and data flow at Lufthansa, integrating new (NoSQL database) and old (relational datawarehouse) systems. From *everywhere*, data-in-motion, data-at-rest, and data in different formats are being ingested, cleaned and integrated through an ETL (extract, transform, load) process. Quality data are being stored in the MDM (Master Data Management) system. Data-in-motion are being 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.) "landed" as raw data and are archived in a Hadoop system that can handle the large volume of data. MapReduce is then used to retrieve the archived data for analytics. An integrated exploration process then utilizes data from the real time stream combined with data from the Hadoop system and data warehouses/marts. The data and results from three modules (Real-time Analytics, Landing, Analytics & Archive and Integrated Exploration) are finally displayed in Intelligence Analysis, Decision Management, BI & Predictive Analytics, and Navigation and Discovery modules that interact with managers.

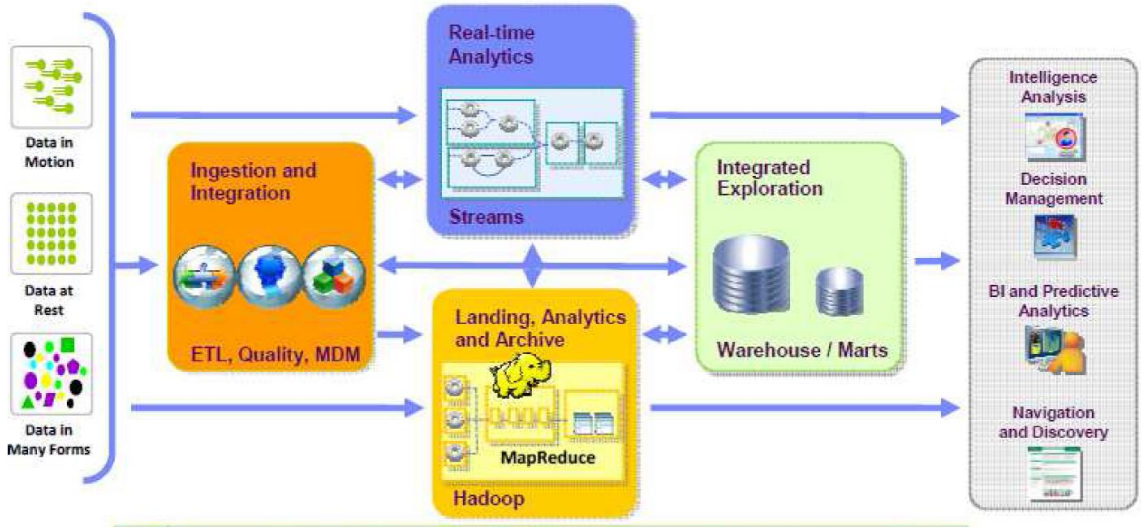

Figure 2. Big Data Systematics and Data Flow at Lufthansa

As shown in Figure 2, the potential of big data comes from the variety of data from various sources that could be explored to provide insights that previous "small" (structured, Relational) systems could not support. Traditional, small database/datawarehouse systems perform analytics on only interna1, structured, and mostly transactional data. That is very limiting. In fact, 80% of an organization's data exists outside of the structured data in files and databases and most of this data reside outside of the organization, very likely in unstructured form. There is immense potential to harness these data and combine them for innovative use in marking/sales, customer service, operation optimization and brand differentiation. For instance, by including a customers' social data, it is possible to form a 720 degree view (360 degree external behaviors and 360 degree internal psychometrics view of customers). Lufthansa thus knows their transaction history with the company and with other companies, their shopping preferences and history, their hobbies, what products they buy and recommend, their product reviews, their political views, where they live and what they like to do. In this way, they can predict what their customer is going to need (e.g., travel to Asia to see their parents, business trips) or want (e.g., vacation in Hawaii,) and to do (e.g., order a movie on the flight) or buy (e.g., an expensive anniversary gift).

Moreover, not all big data is new data. Lufthansa has a wealth of internal data that were not utilized before as they were not captured or not in the structured format that could previously be integrated for analytics easily. For instance, (1) a customer's queries in various channels, such as on the phone with the reservation department or in person with the luggage department to find lost luggage and (2) the pilots' handwritten notes about flight experience.

New analytics on existing data can also provide insights to improve cost savings and innovative services. For example, a flight plan is generated for each flight, meeting all safety and regulatory requirements. Optimizing these by comparing historic plans with actual performance and mining flight histories can generate insights to minimize flight time, improve aircraft productivity and minimize maintenance time while reducing operational costs such as fuel. Optimal flight plans will ideally be automatically generated based on the environment at both time of departure and during the flight.

In what follows, we described four primary use cases of big data implemented at Lufthansa that address

their transformation requirements, demonstrating the values discovered from big data and the scope of big data innovation at Lufthansa. There were initially hundreds of use cases generated in Lufthansa's innovation process. These four use cases are the ones that prompted the adoption of the big data system at Lufthansa. Most companies in our first stage research struggled to find innovative use cases. It is valuable for other enterprises to learn from these use cases for devising their own.

(1) Personalize Customer Experience

Traditional CRM or Social CRM all aim at personalization. However, their instruments can be blunt. Prior interactions were designed primarily to sell, not to engage or build relationships and trust between customers and the brand. Although the objectives do not appear significantly different from normal CRM programs, the difference is having access to new data and tools that allow more effectiveness in all areas. For instance, Lufthansa already has a customer loyalty program—"Miles and More"—that has customer profile information and is augmented with external data including social media data for personalization. Lufthansa uses big data to

a. Remember all customers' interactions
b. Recognize customers (online or in person), especially high value customers such as first class, frequent flyers, brand influencers, etc.
c. Use what was learned about customers to service all their travel needs
d. Learn to anticipate customer preferences and be proactive
e. Make it convenient and natural to interact with customers using the channels they prefer
f. Be there when the customers need them, in real time.

Data, millions of individual treatments, are delivered in real time, to ensure content is presented at the right time, in the right channel, in the most digestible and actionable form. The expected outcome is to increase customer loyal and revenue, improve marketing and sales effectiveness and reduce cost of customer service delivery.

(2) Handle Irregular (IRREG) Situation

Big data can be used to see and react immediately to activities on Facebook and Twitter, and other social media. For instance, the LAX shooting on Nov. 1, 2013 was a strong lesson. The impact that a ten minute event can cause is shocking:

- 1 casualty (TSA agent)
- Over 118 flights en route to LAX were canceled or rerouted
- 135 flights scheduled to depart from LAX were canceled
- 127 flights were delayed at least fifteen minutes

Information was 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 mitigated business impact.

(3) Predict Departure Delays and Proactive IRREG Recovery

Airlines are only 73.9% on time. Delays are another kind of IRREG operation. Delays are obviously not just operational issues. There are impacts to passengers and employees. The major impact, however, is to the bottom line. IRREG recovery has three aspects: aircraft, crew, and passenger re-accommodation. The complexity of solving these three dimensions simultaneously and quasi-optimally often calls for a technological solution. It requires dynamic assessment of the current situation and real-time decisions. IRREG recovery is the most challenging form of airline operational management. The same people, plans, procedures, policies and technologies that facilitate a "typical" day of flying become critical during IRREG. Big data can help recovery by, for instance, knowing where each employee is, especially eligible flight crew, to position them optimally in real time for returning to full operations.

There are many causes for delays to an airlines' schedule. However, only a quarter of irregular operations are within its control. Big data analytics can be used to help planning schedules to maximize revenue but can be robust enough to allow for IRREG recovery. In addition, a proactive handling resulting from big data predictive analysis is preferred. For example, huge storms were predicted and all flights would be cancelled leaving JFK airport. All affected passengers were notified the day before the storm actually hit. The passengers were offered an alternative departure time before the storm.

Lufthansa uses big data to minimize delays:

- Predict network behavior and departure delays of aircraft throughout the day, taking into account
  - Reactionary delays, rotation oriented, and
  - Weather and congestion at airports.
- Learn delays from historical patterns and today's real-time info.
- Learn optimized flight routes from past flight data.

Benefits include:

- Decreasing financial loss due to delays,
- Pleasing passengers: Shortening flight times and minimizing waiting times,

- Saving fuel,
- Complying with Crew Duty Times, and
- Protecting the environment.

(4) Predictive and Preventive Aircraft Maintenance

As safety of passengers and crew members is the number one priority for all airlines, predictive and preventive aircraft maintenance is critical. The big data approach includes:

- Collecting and evaluating aircraft status information to predict failures of parts.
- Aircraft are connected to the ground permanently.
- Making data available in real time and searching for patterns indicating failures, especially of engines (which are most expensive and potentially life-threatening).
- Scheduling of predictive maintenance events, avoiding flights to destinations short of spare parts, etc.

Benefits:

- Downtime prevention, reduced schedule interruptions,
- Safer, long-lasting planes,
- Savings by adapting maintenance to wear,
- Improved spare part handling and logistics,
- Less unplanned delays for passengers.

6. Critical Success Factors in Innovating with Big Data

Lufthansa's success in innovating with big data for new business model is predicated on many factors highlighted below. The quotes below are all directly from the CIO of Lufthansa.

(1) Effective Value Discovery Process

Lufthansa went through 3 years of a Value Discovery process before adopting big data. Value Discovery includes 3 phases: Innovation Process, Use Case Development, and Strategic Development Planning, including cost-benefit analysis, sourcing decisions, talent management etc.

Innovation and digitization has been Lufthansa's strategic focus. An innovation fund was launched to support innovative solutions and technologies and an innovation hub was established in Berlin to strengthen links with relevant start-up companies. "Innovator Awards" are given to employees for developing and implementing innovative ideas and projects.

A formal innovation process was applied 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. The extensive process resulted in well-defined "values" derived from big data, which enabled the new "Amazon in the Air" business model. In November 2014, an outsourcing agreement was signed with IBM to deploy a system for this new business model.

(2) Direct CEO Involvement

"Normally airlines are quite conservative and risk averse. We normally use systems and applications for a long time. But things are changing now." IT innovation front and center for Lufthansa. Specific to big data, "IT has a more strategic role than in the past. I [CIO] 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."

(3) Service-Orientation Mindset

Although much progress has been made in business toward service-orientation, many developments are often adaptations of goods-dominant (G-D) logic, rather than a full transition to a service orientation. This more fundamental shift has sometimes-subtle but profound implications for how Lufthansa conceptualize IT-enabled service initiatives and how they approach business transformation and service innovation. While shifting from the old model of selling tickets to providing best "experience," Lufthansa could still be trapped in G-D logic. For example, Lufthansa has a unique asset—the passenger sitting in their seats for hours (often bored). They know this passenger individually and they can "***(Blank)***." To fill in the blank, the answers could be

(A) Sell advertising, for example, based on knowing this person and thus targeting advertisers. Or

(B) Help the customers utilize the time, in their own preferences, for instance, to conduct their businesses continuously, to do on-line shopping, to book activities in travel destinations, etc.

Answer (B) could still "sell" ancillary services and may sell more than Answer (A), but that is the byproduct of genuine, excellent customer services.

(4) Not Blindly Following IT Fashion

IT Fashion or "hype" is a transitory collective belief that an information technology is new, efficient, and at the forefront of practice [33]. Fashion setters create hype around innovations and promote them as 'must-deploy or fail' opportunities in an effort to influence the

adoption of the innovation [1]. Lufthansa, however, is not jumping on the 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." To Lufthansa, big data is "not a quantum leap in technology" as painted by the media. There is not much difference from previous SOA (Service-oriented Architecture) hype. "This is just handling more data, faster, and handling unstructured data." Most importantly, their adoption of big data was "driven by business cases, not by technology."

(5) Architectural Foundation for Growth and Integration

Lufthansa's application landscape is complex. Their infrastructure is geographically distributed and placed in several data centers. They run more than 350 complex applications. A top priority for improvement is data management. The Lufthansa group has several airlines. It is important to be careful about the "scope" of data—which airline does the data belong to? One of their big data efforts is for personalized experience applications and customer profiling. The challenge is to consolidate their data to create a "single point of truth for all customer info." Right now data is scattered all over the application landscape.

One of Lufthansa's major achievements has been implementing SOA. SOA is the primary technology that major corporations see as a key to cost-effectively obtaining organizational agility and aligning business and IT. The technical tenets of SOA are: open standards for interoperability, loose coupling, reuse of shared services, and dynamic "orchestration" of component services [9]. SOA is a solid infrastructure foundation for future growth and integration. With a SOA in place, Lufthansa has a large ESB (Enterprise Service Bus) that allows them to connect legacy applications to newer ones. For instance, in big data system implementation, due to constant rapid technology changes, new and old systems need to be integrated continuously. Their current leading datawarehouse technology is Teradata. They have been working with them for 2 decades. And they are also using Oracle 11 and will be using Oracle 12 when it is mature enough. For unstructured data, they will complement the existing system with new Hadoop-based systems and other emerging technology. "We have been good at integrating these old technologies."

(6) Confident Outsourcing & Vendor Management

Lufthansa employed outsourcing as their main strategy for big data deployment. In November 2014, Lufthansa signed an outsourcing deal worth $1.25 billion with IBM who will take over Lufthansa's IT infrastructure services division and staff. 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.

"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."

"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."

(7) Talent Planning

Lufthansa has many data specialists in command and control centers. They are continuously working to improve their data to "steering" the data. "Of course some resources, such as data scientists, might be in short supply and recruiting them might be tricky and expensive." This has been taken into careful consideration in the strategic deployment planning.

7. Discussion

Although the present study sheds light on why and how to innovate with big data, the generalizability of our results may be limited due to the inherent nature of the case study methodology [32]. In particular, Lufthansa is a large enterprise with over 118,000 employees. Organizational characteristics (firm size and industry) and the IT maturity have been identified as factors in technology adoption [18], therefore, insights drawn from this case have limited application for smaller enterprises with different characteristics.

Second, the present study focuses on the adoption of big data for enabling a new Amazon-in-the-Air business model. The success of this business model and the new big data system is dependent on many socio-technical factors that are not included in this paper. The organizational complexity in implementation is implied here but not discussed. The outsourcing strategy employed by Lufthansa mitigates some development complexity induced by the 5Vs [8] but creates new complexities, such as managing 200 providers and ensuring that all system components interoperate. Lufthansa's previous SOA implementation addressed many issues of IT-Business alignment [9]. In many other cases in our first stage research, we saw failures of adoption due to Business/IT misalignment, political problems such as fighting over data ownership and which department should host data scientists and analytics. Although Lufthansa is confident, the final big data innovation outcomes remain to be seen in the

future. (They have a 3-year vision for full implementation.)

This study contributes to theory and practice. First, it sheds light on firm-level technology (and innovation) adoption issues, including innovation process, the role of CEO, IT fashion, IT/IS maturity, existing infrastructure, strategic deployment planning, outsourcing strategies. Second, it contributes to Design Science and Service Science by explicating the difference of design intents (G-D oriented or S-D oriented) and their different influences on customer experience design and innovation outcome. Big data or not, without true service orientation, any CRM or is ineffective. With a S-D mindset, the ethical use of private data for personalization is expected.

In addition, as many companies are struggling with big data adoption, our study helps by showing crucial use cases that harness the value of big data and chart the course for successful deployment. To further help with value discovery, we call for research on: (1) methods for modeling the circumstances in which big data can and can't make a big difference; (2) methods for gauging the dynamic "value" of big data and return on "innovation," not the traditional ROI [19]; (3) innovative use cases for different industries: perhaps this can be crowdsourced for open innovation.

The shift of big data adoption foci from technology to business model and from problem solving to innovation also calls for research and invites redesign of CS/IS curricula. Research is needed to help enterprises deal with paradigm shifts and complexity in big data adoption and, most importantly, to support design for innovation. "Futuring" techniques [7] that encourage creativity for value exploration, experimentation and design are needed.

Finally, this study has two practical implications: First, to innovate with big data, while it is important to incorporate new semi- or unstructured data driven by use cases, integrating existing data is crucial. Blending the old with the new is a challenge in big data and requires a thoughtful architectural approach. Second, do compete on analytics and build an analytical culture. Only 0.5 percent of all data is ever analyzed [27]. Some of the most useful data isn't being captured, or is inaccessible. We would also caution against "Hadumping" (Hadoop dumping) in which enterprises just collect big data and do not use it for analytics.

8. Conclusion

Big data represents tremendous opportunities for business innovation but thus far few enterprises have successfully moved from experimentation to deployment. This study demonstrates how big data values can be harnessed to enable a new business model, called "Amazon in the Air," for Lufthansa to survive in a fiercely competitive business environment. The success of this business model is hinged on a transition from G-D logic to S-D logic such that genuine customer relationship-building propels innovative customer experience design enabled by big data. With the S-D mindset, Lufthansa has transformed from "selling" tickets and ancillary services to be a sincere quality travel partner for their 106 million passengers, anticipating and serving customer needs in the entire engagement cycle. It seems that Lufthansa will soon compete with Amazon or Google in more ways than expected.

In Lufthansa's case, the adoption of big data is driven by business cases, not technology. Four primary use cases (out of hundreds considered) were presented to illuminate how big data can provide business value, enabling the new business model: 1) to gain insights into customers to co-create best personalized travel experience; 2) to increase operational intelligence in handling extreme IRREG situations; 3) to proactively handle IRREG operations to benefit passengers and minimize losses by predictive airline delay analysis and optimal IRREG recovery; 4) to optimize aircraft safety, fuel-cost savings, and prevent IRREG by predictive and preventive aircraft maintenance.

The present study further reveals 7 critical success factors in innovating with big data at Lufthansa: (1) effective value discovery process, (2) direct involvement of the CEO, (3) service-orientation mindset, (4) not blindly following IT fashion, (5) architectural foundation for integration and growth, (6) confident outsourcing & vendor management and (7) talent planning. These factors contribute insights for helping enterprises to innovate with big data.

We expect big data will continue to grow and more innovative ways of using it will result. Those who want to compete on analytics will find the "new oil" with careful exploration and a bit of imagination and creativity.

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