At the Big Data Crossroads: turning towards a smarter travel experience

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Any views expressed in this paper are the author's own and do not necessarily represent the opinion of Amadeus IT Group.

Foreword

Big data, transforming the industry for the benefit of all

It would be almost impossible to overstate the transformative potential of big data to the travel industry.

Big data is arguably the biggest opportunity in a generation for travel businesses to embrace the changing structure of data and maximize its use. It offers the potential for a vast shift for all travel companies, empowering them to enhance both the business and experience of travel. As with any generational shift in technology, however, the opportunities arrive hand-in-hand with the potential for significant disruption, which naturally bring many challenges – competitive and creative – for our industry to consider.

At Amadeus, we are committed to understanding better the impact of major trends in our industry and to facilitate discussion on those issues most likely to deliver change.

This independent study, authored by Professor Thomas H. Davenport, highlights that the industry is at a big data crossroads: large volume, complex and unstructured datasets are beginning to reshape the industry, and so the development of big data initiatives is now a priority for many.

What is it that makes big data such a powerful idea? First, big data can provide insights that help deliver a more intelligent travel experience than has ever been possible before. Whereas structured data has historically been divided between different silos, be they systems or companies, harnessing both unstructured and structured data promises a more integrated view of our industry. This offers travel companies the opportunity to enhance current industry processes, push innovation and build better relationships with their customers.

There is an equally important opportunity to 'put the fun back into travel', which at its very heart is about improving the passenger experience. Big data can help to make travel more responsive and focused around traveler needs and preferences.

As highlighted in the study, big data can be the foundation for greater industry-wide innovation. Big data demands big ideas and the courage to implement them. Managing and analyzing data is no longer an issue for IT departments alone, instead it is driving the travel industry's business agenda.

Of course, big data will require the industry to address a number of challenges: Technology complexity; data accuracy and rights of use; business and technological alignment; the need for data specialists. These will all be key issues to address if we are to unlock the potential of big data.

There is a substantial incentive to be restless in addressing these challenges as the potential benefits are so significant. Big data means big opportunities, not just now but in the decades ahead.

At Amadeus, we look forward to supporting the travel industry as the big data evolution progresses.

Hervé Couturier
Head of Research and Development, Amadeus IT Group

Executive Summary

This independent study explores the impact of large volume, unstructured data known as big data on the global travel industry. It outlines the potential of big data to transform the business and experience of travel, and is informed by leading industry experts – many at board-level within some of the world's largest travel companies.

The study finds that travel companies are at a crucial big data crossroads: big data has a vital role to play in delivering a more efficient and tailored travel experience with benefits to both travel companies and travelers alike. However, its potential is still confined to early adopters in the travel sector, and this study calls for more widespread consideration across the industry about how new approaches to big data can yield significant opportunities.

Big data offers significant benefits for all travel companies

The benefits of big data for travel providers and travelers are explored, including:

- Better decision support
- New products and services
- Better customer relationships
- Cheaper, faster data processing

Big data in the travel industry is currently being driven by early adopters

The diverse ways in which big data is being used by early adopters in the travel industry are investigated, with a focus on:

- Optimizing revenue management
- Customizing travel distribution
- Transforming corporate travel
- Enhancing internal operations
- Boosting financial performance

Challenges need to be overcome so the industry can realize the potential of big data

The study acknowledges the technical and operational challenges associated with big data adoption in the industry, namely:

- Creating an integrated data source
- Working in a hybrid technological environment
- Overcoming the data skills shortage (an issue in all industries adopting big data)
- Maintaining competitive advantage

Maximizing the big data opportunity requires action

Finally, the study outlines a series of recommendations for travel companies preparing to embrace big data:

- Research big data
- Strategize about big data
- Don't just explore big data technology – look at the changes you will need to make to business and operational processes too
- Start assembling big data skills
- Work with partners

Case studies of big data adoption are spread throughout the study.

Introduction

Big data burst upon the scene in the first decade of the 21st century. The concept stood for a variety of data attributes—too large, too unstructured, and too fast-moving to harness traditional data management approaches. The first organizations to embrace it were online and startup firms. Arguably, firms like Google, eBay, LinkedIn, and Facebook were built around big data from the beginning. Because they had massive amounts of data in new, less structured formats—clickstreams, web server logs, social network relationships, and the results of controlled experiments—they had no choice but to adopt new technologies and management approaches.

In the travel industry, most of the players have also had access to plenty of data for many years. Every airline reservation, every hotel stay, every rental car and train reservation leaves a data trail. It all adds up to hundreds of terabytes or petabytes of structured transaction data in conventional databases—big data by any standard of measurement.

However, big data is not just about volume. It's also about the variety and velocity of data. Increasingly travel arrangements are discussed online in ratings and blog sites, liked and disliked on social networks, and complained about or praised in call center conversations. The data arrives at a pace much faster than traditional structured data ever did. To understand a customer's travel experience, a company has to add new forms of data to its repertoire.

If the travel industry wants to embrace big data, it must embrace unstructured data in a variety of formats, and data that is constantly flowing. It must convert unstructured data into a form in which it can be analyzed, and then analyze it on a continuous basis. Most importantly, it must make decisions and take actions on the data in real time. These steps are already being taken in the online segments of the industry, including online travel agencies, meta-search sites, and some travel distribution information firms. Other firms, such as airlines and hotel chains, are earlier in their big data journeys, but are increasingly employing the large volumes of structured information they generate internally.

Usage of data has always been an asset in the travel industry, and it was one of the first to embrace it for business advantage. Airlines pioneered the use of price optimization analytics, and hotels adopted the same tools with great success. Airlines also optimized the details of crew scheduling and routings. The industry also was among the first to create and take advantage of loyalty programs.

Today, however the travel industry stands at a big data crossroads. Other industries have moved beyond travel in their use of data for analytical programs and outcomes. Despite innovation from some online travel firms the passenger experience is often not targeted or distinctive. Big data can be a powerful force in transforming the industry, and some early adopters already have substantial initiatives underway. Big data could be one of the most influential initiatives since the online reservations system.

In this report, after introducing the components of big data, I'll describe in detail how big data can transform the travel industry, and how the earliest adopters are putting it to use. I'll discuss how it could improve customer service and operational efficiency in several different sectors of the industry. I'll describe both current practice and a likely future scenario for big data in the industry. And throughout I'll provide examples of big data implementation that are already underway.

About This Study

To learn about big data in the travel industry, I interviewed a variety of industry participants, including airline, hotel, rail, online travel agency, and travel management executives. In total I spoke with 21 companies. All interviews were telephone-based, and descriptions of them were reviewed for accuracy by the executives involved.

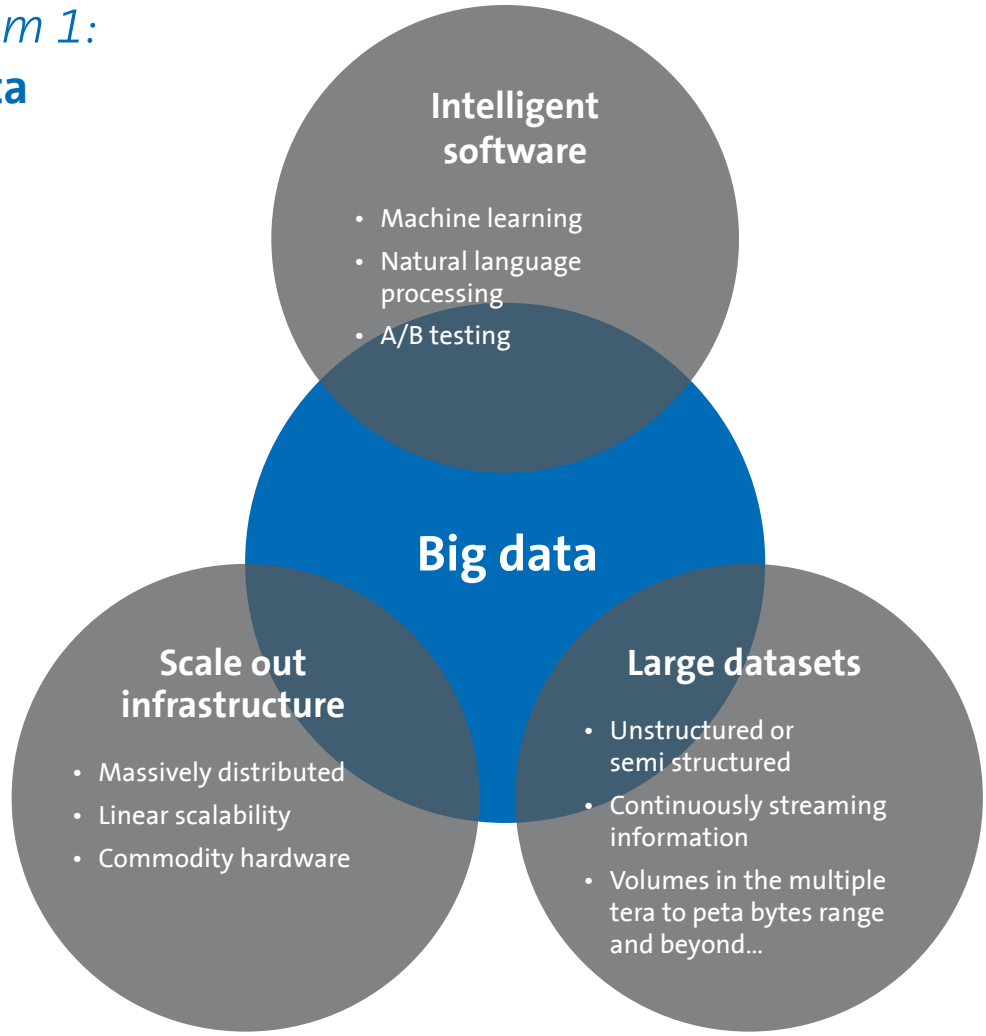
I also consulted a variety of online sources and my previous research and writing on big data and analytics.

Amadeus was the sponsor of the study, but did not attempt to structure or control the content of it. The company was one source of interviews, but I relied on others as well.

Big Data's Moving Parts

It's not just the data that's new in the big data world, but also many of the technologies for managing and analyzing it. (See Diagram 1) What's new about big data technologies is primarily that the data can't be handled well with traditional database software or with single servers. Traditional relational databases assume data in neat rows and columns, and big data comes in a variety of diverse formats. Therefore, a new generation of distributed processing tools and intelligent software has emerged to handle it. Big data users often employ Hadoop, an open-source software toolset based on the MapReduce framework for dividing up data across multiple computers. Several travel industry firms are using Hadoop, but typically on an exploratory basis.

Diagram 1:
Big data



The volume of the big data means that it can't be processed quickly on a single computer, no matter how powerful. Fortunately, the rise of big data coincides with the rise of inexpensive commodity servers with many—sometimes thousands—of computer processors. A single data processing problem can be divided across these inexpensive servers, and then united again when it's finished.

These new technologies are by no means the only ones that organizations need to investigate for big data. In fact, the technology environment for big data has changed dramatically over the past several years, and it will continue to do so. There are new forms of databases (e.g., so-called "columnar" or "vertical" databases), new programming languages (interactive "scripting" languages like Python, Pig, and Hive are particularly popular for big data), and new hardware architectures for processing data (such as big data "appliances" and "in-memory" analytics).

There is another key aspect of the big data technology environment that differs from traditional information management. In that previous world, the goal for data analysis was to segregate data into a separate pool for analysis—typically a data warehouse (which contains a wide variety of data sets addressing a variety of purposes and topics) or mart (which typically contains a smaller amount of data for a single purpose or business function, such as a customer loyalty data mart). However, the volume and velocity of big data—remember, it's a fast-moving river of information that never stops—means that it can rapidly overcome any segregation approach.

Therefore, in the big data technology environment, many organizations are using Hadoop and similar technologies to briefly store large quantities of data, and then flushing it out for new batches. The persistence of the data is just enough time to do some (often rudimentary) analysis on it. This data management approach may not dethrone the "enterprise data warehouse" approach, but it at least seems likely to supplement it.

It's also important in this section to point out what is not so new with big data, and that's how it's analyzed. The technologies I've described thus far are used to either store big data, or to transform it from an unstructured or semi-structured format into the typical rows and columns of numbers. When it's in that format, it can be analyzed like any other dataset, albeit larger.

These approaches for converting unstructured data into structured numbers are not entirely new either. For as long as we've been analyzing text, voice, and video data, for example, we've had to convert it into numbers for analysis. The numbers might convey how often a particular pattern or words or pixels appears in the data, or whether the text or voice sounds convey positive or negative sentiment. The only thing that's new about it is the speed and cost with which this conversion can be accomplished. It's important to remember, however, that such a conversion isn't useful until the data is summarized, analyzed, and correlated through analytics.

The tools that organizations use for big data analysis aren't that different from what has been used for data analysis in the past—in the travel industry and elsewhere. They include basic statistical processing with either proprietary (SAS, SPSS) or open source (R) statistical programs. However, instead of the traditional hypothesis-based approach to statistical analysis (in which the analyst or decision-maker comes up with a hypothesis, and then tests it for fit with the data), big data analysis is more likely to involve an approach called "machine learning".

This approach, which might be referred to as "automated modeling", fits a variety of different models to data in order to achieve the best possible match. The benefit of machine learning is that it can very quickly generate models to explain and predict relationships in fast-moving data. The downside of machine learning is that it typically leads to results that are somewhat difficult to interpret and explain. All we know is that the computer program found that certain variables are important in the model, and it

may be difficult to understand why. Nevertheless, the pace and volume of data in the big data world makes it important to employ machine learning in some situations. It is particularly common in the online travel agency environment, where firms such as Orbitz and KAYAK use it to rapidly develop predictive models about what targeted hotel search results and rank orderings to show customers (see the case study, "KAYAK").

There is good news and bad news for the travel industry about all of this new (and, in some cases, not so new) technology. The good news is that many big data technologies are free (as with open-source software) or inexpensive (as with commodity servers). The technology is also often available "in the cloud" and can be bought "by the drink" at relatively low cost. The downside is that big data technologies are relatively labor-intensive to architect and program. They'll require a lot of attention from technologists in travel organizations, and even some attention from senior managers. It used to be that for most organizations, there was only one way to store data—a relational database on a mainframe. Today and for the foreseeable future, there are many new technologies to choose from, and considerable planning and study will be required to choose among them.

Case study:
KAYAK

KAYAK, a travel search site that was recently acquired by Priceline, relies heavily on big data and analytics for both internal decisions and customer offerings, and employs a variety of big data technologies. It handles over a billion searches each year, so it has plenty of data to analyze. In terms of customer offerings in search, there are considerably more analytics required in search and result rankings for hotels. Unlike airline flight results, which are typically displayed in order of price, hotel rankings consider such variables as distance from the customer's specified preference, facilities, and the pricing deal compared to alternatives.

In air travel search, KAYAK uses analytical models to ensure that prices displayed on its website are consistent with those on airline sites, since there are sometimes synchronization issues across data sources. KAYAK has also recently introduced flight price forecasting, which predicts whether the price of a particular flight will go up or down in next seven days. It also provides a statistical confidence level behind the prediction.

In its internal operations, KAYAK makes extensive use of randomized testing in its website decisions—known as "A/B testing". Every day between 30% and 50% of users are participating in some type of test. Such testing is the only way to establish cause-and-effect relationships behind which features of the site lead to better results.

KAYAK makes use of a variety of big data tools and capabilities. Given the amount of data it processes and analyzes, it makes heavy use of Hadoop, and has found it much faster and cheaper than alternative technologies. When Giorgos Zacharia, the company's chief scientist, first joined KAYAK, producing a training data set for the personalization algorithm would take between three and four days; now, with the Hadoop cluster, it takes only a few minutes. The company uses big data scripting languages, and a variety of open-source statistical analysis tools.

KAYAK also has an experienced group of data scientists. Several, like Zacharia, have Ph.D. degrees; Zacharia himself has a Ph.D. from MIT in computer science, and three other MIT degrees. Steve Hafner, the company's CEO, is also highly analytical, and manages the company daily from a detailed spreadsheet.

The Benefits of Big Data in Travel

What's the payoff from big data in the travel industry? There are several potential benefits, most of which also require business changes in addition to big data technologies. These benefits are consistent with those from previous information technologies, but the specific big data applications, of course, are different from the past. They include:

Better decision support—Many travel firms are using big data not just to speed up decisions and data processing, but to make better internal or customer-focused decisions. In some cases these also benefit from the increased speed of big data processing offered by new technologies. In many cases the relevant data is internal. These systems contain a variety of customer data, for example, which can be used to improve marketing and service processes (see the case study, "British Airways").

External big data also offers the possibility of improving other types of travel industry decisions, with benefits involving efficiency and safety. Forecasting consumer demand, for example, could be improved through the analysis of macroeconomic and weather data. Several airline executives mentioned the possibility of predictive maintenance of planes, engines, and other equipment based on sensor data, but they were not yet pursuing such applications. However, firms like GE have major initiatives underway to analyze sensor data for maintenance and service applications in jet engines and locomotives. These will presumably be adopted at some point by GE's customers in the travel industry, and could both reduce maintenance costs and increase safety.

New products and services for customers—One of the most exciting possible benefits from big data is the creation of new products and services for customers. Outside the travel industry, this benefit has been pursued aggressively by firms such as Google, LinkedIn, and Facebook. Within the travel sector, the most likely creators of data-based products and services are online travel agencies, travel search firms, and leading technology providers. Amadeus, for example, has developed the Featured Results and Extreme Search capabilities for its customers to improve the travel search experience. The travel search website Hipmunk has developed new features like the Agony Index for rating airline flights, and the Ecstasy Index for hotel searches. The travel meta-search site KAYAK has developed a predicted price offering (see the case studies about both of these organizations).

Since travel distribution is one of the most data-intensive aspects of the industry, it's likely that many products and services from big data will address that process. However, it's quite conceivable that external vendors will provide data-derived products and services that address operational processes in travel. Aircraft component vendors can provide predictive maintenance services. Vendors of energy management systems to the hotel industry could also gather and manage "smart building" data, and optimize energy consumption. Travel management services vendors could provide new data-based products and services to individuals and corporations.

Case study: **Amadeus**

As travel becomes both more democratized and more complex, customers need increasing help in navigating through the options. So a major focus of Amadeus' efforts to provide value to travel agencies involves easing the search process and delivering to its customers solutions that enable them to present consumers with targeted options—product/service innovation with big data. One such offering is Extreme Search, in which a consumer enters such data as her overall budget, the number of passengers, the length of time for the trip, and the minimum temperature at the destination. Extreme Search returns proposals for such a trip. Amadeus also analyzes what requests have been asked for, and works with tour operators to integrate related services into packages.

Amadeus has developed for its customers another consumer service called Featured Results. Faced with a business challenge of rising importance—the fast-increasing "look to book" ratio, or the number of online queries per airline ticket booking—Amadeus needed some way for travel distributors to make desirable offers to customers. Based on data from various databases, Featured Results presents four possible itineraries in which consumers may be particularly interested.

The IT organization at Amadeus has been implementing technologies for internal operations—non-relational databases, open source data management tools, and distributed commodity server architectures—to achieve both cost reduction opportunities and minimized response time for customers.

Finally, Amadeus is working with its travel provider customers to deliver better decision outcomes. It works with airlines, for example, on how to optimize their websites through testing of different versions, and what customer preferences are for booking channels, kiosks vs. human agents at airports, baggage check-in times, and many other issues.

Big data helping players in the travel industry form better customer relationships—Since customer relationships have historically been fragmented across a variety of systems and databases, data aggregation should create better customer relationships, and more revenue from customers from better-targeted products and services. Through predictive analytics, the most-favored destinations, lodging and dining preferences, ancillary services needs, and tourism experiences can be identified for each passenger. Online analytical services such as price prediction and desirability rankings can increase the likelihood of purchase.

The most advanced approaches to customer targeting involve various forms of online travel advertising. Online travel agencies, aggregators, and review sites all practice ad targeting based on customer behavior. Most travel providers employ some type of intermediary, such as Criteo or Facebook, to place their online ads. Criteo has found that when a relevant, personalized ad is displayed, there is an eight times greater click-through on banners than for an untargeted ad, and customers are eight times more likely to engage with an ad to buy a ticket or package. Criteo has a collaborative filtering algorithm that lets the company predict the most attractive travel package, air route, or hotel.

A relatively new development in online travel advertising is social-based advertising. Firms such as Facebook have not only very large user numbers, but also the ability to target ads across social networks (see the case study, "Facebook").

Cheaper, faster data processing—New generations of information technology have always been adopted in part because they offer better price/performance ratios. Given the enormous amounts of data that travel companies have to churn through, and the relatively thin profit margins in the industry, the appeal of cheaper, faster big data technologies is obvious. Clusters of commodity servers running Hadoop and other open-source software can process data at costs fifteen to twenty times lower than previous generations of data warehousing technology.

However, for the travel industry this on-paper benefit is not easy to adopt—at least outside of online businesses. Airlines and hotel chains, for example, depend heavily on big data for operations, and the Hadoop-based architectures are not as reliable and secure as previous technology generations. Secondly, integrating Hadoop-based architectures with the existing "legacy" technology architectures will be challenging. Nonetheless, some mainstream travel companies, such as Air France-KLM, have begun to experiment with it and plan to use it for production applications.

Seeking multiple benefits—While many organizations seek a single particular benefit from big data, there are, of course, firms that want all of the benefits of this resource—even all at one time. It's too early in the big data era for most airlines to undertake multi-pronged big data programs, but the most aggressive hotel chains are doing so (see the case study, "Marriott").

Case study: **Facebook**

In 2012 Facebook established a focus on several vertical industries, including travel. The goal was to apply Facebook's ad targeting and social marketing capabilities to travel industry advertisers. Online travel agencies, tourism boards, airlines and hotels have all made use of the Facebook ad platform. Since travel experiences are often shared across social networks, social marketing is inherently appealing to the travel industry.

Facebook has over 1.1 billion customers, so any analysis of them qualifies as big data. Targeting algorithms address keywords in user profiles and other social signals, and are constantly being adjusted for better targeting. Facebook also employs data from third parties such as Axciom and Epsilon to improve targeting. Recently it also developed a new tool called Custom Audiences that allows travel companies to use their own lists of loyal or prospect customers, and target them with Facebook ads while still preserving customer privacy. Facebook Exchange, another new tool, allows real-time bidding on ad placement and retargeting.

MGM Resorts is one travel industry company that has made extensive use of Facebook ad services. The company established Facebook Pages, made targeted offers to its friends, used Custom Audiences and Facebook Exchange, and employed Sponsored Stories in the News Feed of friends of users who had accepted offers. MGM estimates between a threefold and fifteen-fold return on its ad spend through these different Facebook ads products and tools.

Lee McCabe, Facebook's Head of Travel in Global Vertical Marketing, says that the greatest barrier to the travel industry's use of Facebook is organizational. He notes:

When companies view social marketing as a separate theme, and connect it only with PR, it limits their effectiveness. Our most successful customers include social marketing in a matrix with other sales and marketing functions, including CRM, brand, and advertising.

Big Data Challenges for the Travel Industry

Many of the specific challenges that the travel industry faces in big data result from its long-term usage of information systems for key processes. One consequence of this is that key data is often fragmented across multiple functions and units. For example, airline data on the passenger experience is spread across flight operations, baggage, loyalty programs, complaint databases, and external sources like social media. In order to make effective decisions about how to promote offers to customers and recover from service failures, airlines need to combine all of this information into one data warehouse and one set of algorithms. This would require considerable investment, although some mainstream travel firms, such as British Airways, have made the investment for customer data.

Creating an integrated source of customer information is not only expensive, but difficult no matter how large the available budget. And of course navigating the related data privacy issues will always be a challenge. Individual customers typically have several different identities across different systems. It is particularly difficult to combine online or social media data with data from internal transaction systems. Third party data providers can assist with this data integration problem, however.

Another result of the long-term use of information systems in large, established travel companies is that big data technology architectures will have to coexist with existing hardware, software, and databases. Those "legacy" tools and the data they contain are still necessary, and will still be useful in analyzing and improving travel operations and passenger relationships. Big data technologies may be the only technologies for startup and purely online travel firms, but large companies will have a hybrid environment for the foreseeable future. This will lead to challenges of IT architectural cohesion and efficient functioning of all these new and old systems.

In addition, the real-time IT architectures used by many travel industry companies can't run on Hadoop or other open-source environments; called TPF for Transaction Processing Facility, they were developed by IBM in the 1960s and 70s, and have been refined ever since. Some firms, such as Amadeus (see the case study, "Amadeus"), are decommissioning TPF in favor of open-source systems, but many airlines and some hotels still use TPF. These systems could not be ported over to a big data-style platform, but would have to be completely replaced.

Diagram 2 depicts the changes involved in moving to a big data technology platform capable of processing a petabyte or more of data. TPF is an example of a traditional Online Transaction Processing (OLTP) environment with a Symmetric Multi-Processing (SMP) architecture of multiple processors accessing one main memory—as used in mainframe computers for decades. Most modern analytical systems access data from a large data warehouse, which still employs a relational database model, and a massively parallel processor (MPP) with data spread across processors and storage in "shards" that can be reassembled. Unstructured big data is often stored in a distributed online transaction processing environment (DOLTP), using the "NoSQL" (not only SQL, the Structured Query Language used to query and retrieve data stored in relational tables) model. Finally, big data is often processed using the bottom figure in Diagram 2. The MapReduce framework uses distributed analytical engines to break a problem down, process it across many distributed processors and storage sites, and reassemble it when the problem is completed. Hadoop is the most popular version of this framework.

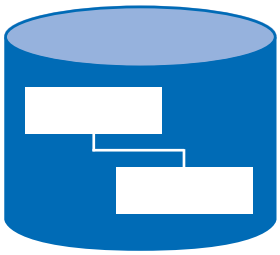
Some other big data challenges are not specific to the travel industry, but will nonetheless pose obstacles to travel firms desiring to pursue big data initiatives. One is the skills shortage for people who are skilled in big data manipulation. Often called "data scientists", they have not only data management and programming skills, but also the ability to analyze data, and an understanding of business processes problems. Since there have been no formal training programs for data scientists in the past, many who currently perform the role have scientific backgrounds and Ph.D.s. Locating such individuals is difficult, and they may have a preference for working in data-rich online businesses and entrepreneurial companies over large, established travel firms.

Although mainstream travel firms do have employees with analytical skills in areas like revenue management, they may not be familiar with the analytical approaches used with big data. Big data analytics tends to involve machine learning, visual analytics, and text processing—all skills that were not widely employed in, for example, revenue management.

One final challenge for travel firms, as well as businesses in general, is the difficulty of maintaining a sustained competitive advantage from big data.

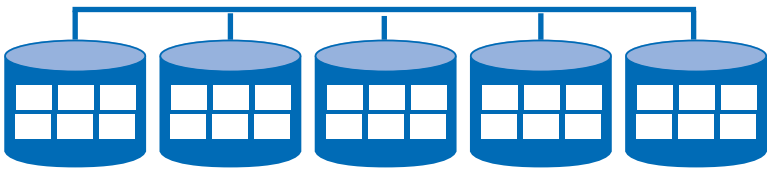
Some U.S.-based airlines, for example, developed early competitive leads in such areas as revenue management and customer loyalty analytics. Today, however, such programs are widely distributed throughout the airline industry, and are common in hotels and passenger rail as well. Maintaining competitive advantage requires continual innovation, unique data, or experimentation with new technologies.

Diagram 2:
Database Landscape



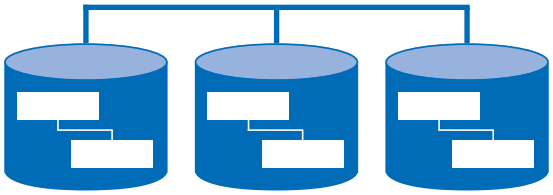
OLTP RDBMS

- Relational model
- Row-based storage
- SMP architecture



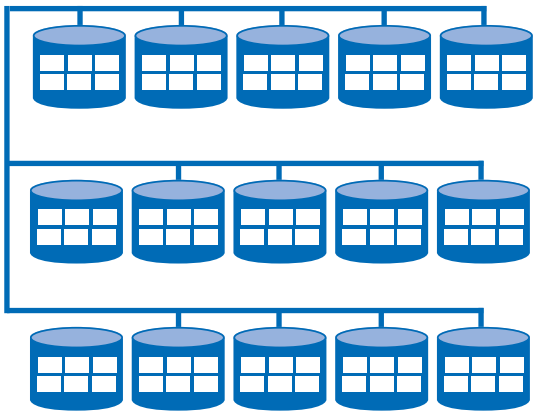
OLTP NoSQL

- Non-relational model
- Key/Value or Column based storage
- Data shards



Data Warehouses

- Relational model
- Row or Column-based storage
- MPP architecture
- Data shards



Distributed analytical engines (MapReduce)

- Non-relational model
- Unstructured or Column-based storage

Low volumes
Structured data

1TB

100TB

1PB

Large volumes
Unstructured data

Big Data Usage and Possibilities in Travel Industry Processes

In this section I'll describe existing usage of big data by major players in the travel industry. I'll separate this usage by major process: Revenue management, distribution, travel management, internal operations, and financial performance management. Because many segments of the industry are just getting started with big data, I'll describe not only current usage, but some opportunities for applying big data in that process in the near future.

Revenue Management

Revenue management—Optimized pricing for the perishable commodities offered by the travel industry, such as airplane seats and hotel rooms—is one of the most popular areas for application of analytics. Historically the data employed by revenue management applications has been relatively small and structured. There is a trend, however, to incorporate more and more data—some of it externally-sourced—into revenue management. In the case study on Marriott, I mention several new sources of data, such as food and beverage spending, that are being included into revenue management systems.

Airline revenue management systems have been widely adopted across the industry, and it may seem that achieving competitive advantage or share gains would be difficult given their pervasiveness. However, airlines have found ways to exploit advantages; for example:

- *Swiss International Airlines* has been able to achieve substantial gains in revenue and margins with its revenue management system, particularly in European markets where the absence of code sharing and alliance relationships allows more pricing flexibility. Swiss' success in revenue management derives from two capabilities it developed beginning in 2003. First, it combined the two organizational processes that make up revenue management—pricing and capacity management—into one integrated process. The company brought all relevant pricing aspects into its revenue management algorithm. Secondly, the company can make fast pricing changes. They enter a new price into an online tool, and it is immediately reflected in the price seen by consumers through all channels. And if Swiss receives a request for a fare from a travel agent or online site, it makes an immediate, real-time decision on what price to charge, and replies with booking availability.
- *Air France-KLM* is taking advantage of its combined scale to develop a new revenue management system across all its airlines, which is in its final stages. The system contains considerably more data than previous systems, including all relevant passenger data over two years. The system calculates and optimizes the revenue for origin/destination itineraries, and bases pricing on passenger profiles. It also estimates the likelihood of cancellation and no-shows on flights, and thus how much overbooking to allow. The system runs on the big data operating system Hadoop, and it is the company's first major use of that technology. Earlier tests suggested that the amount of data and functionality in the system would make traditional technologies totally infeasible. Early tests suggest a substantial improvement in revenue management performance over existing systems.
- *Lufthansa* is also testing the use of big data technology in its revenue management system. It is running a "proof of concept" with in-memory technology (SAP's HANA system). In-memory technology allows organizations to load more data and application functionality into memory—rather than from disk—and thus to dramatically improve application performance. Revenue optimization calculations can be made in real time, rather than in batch mode.
- *Frontier Airlines,* a relatively small carrier based in Denver, Colorado, has to be nimble in its revenue management practices to survive competition with much larger carriers. Gregory Aretakis, who heads revenue management as well as several other functions for Frontier, argues that competitive advantage "is partially the information you have, partially your brain power and your ability to intuit information, and partially the ability to understand your competitor". His group tries to create small niches of pricing advantage for short periods based on its knowledge of competitors' disinterest. The company establishes new prices for short periods before competitors notice them and respond.

In the future, it's likely that revenue management algorithms will incorporate a variety of new data sources, and will make real-time decisions based on that data. The data might include a variety of external

factors influencing consumer demand, including weather, the prices of other goods and services, and consumer confidence. Pricing could increasingly incorporate individual consumer behaviors, including loyalty and lifetime value, past purchases of ancillary services, and Internet shopping activity. Again, attention to privacy considerations will continue to be a relevant consideration in such expanded use of consumer data.

Traditional pricing will be mixed with alternative means of clearing perishable inventory, including customized offers to customers and auctions. Some airlines are already employing software to auction available seats that it predicts won't sell through traditional pricing approaches.

Distribution

Distribution has long been the area of travel in which computers, data and analytics were most advanced. It will probably also be the domain of the industry in which big data has the greatest impact.

One key trend that is already apparent within distribution processes is personalization. Some distribution offers from particular travel providers are already somewhat personalized based on loyalty status and past behaviors, although most offers remain a moderate fit at best with customer desires. And search results are tailored on some search sites based on past search behaviors. However, there are many possible ways to increase personalization which may be valued by travelers, including:

- Personalization based on customer behaviors or the absence of them ("We are sorry we missed you this week on the Dallas-Chicago flight after twelve straight weeks of enjoying your company!");
- Personalization based on social media relationships ("Several of your Facebook friends have recently enjoyed visits to Bermuda, so we're offering you 20% off to try it yourself");
- Personalization with regard to ancillary sales ("We know you've enjoyed our great restaurant in the past, so when you visit next week, here's a coupon for a free appetizer at it");
- Personalization involving the entire journey, not just a segment of it ("We hope you enjoy your flight to Phoenix next week. Can we interest you in a rate of $199 at the Scottsdale Princess? We'll include the limo transfer");
- Personalization based on location: ("We see you have just arrived in Frankfurt Flughafen, and your final destination is Heidelberg. Did you know there is a Deutsche Bahn train that can get you there in 45 minutes?")
- Personalization based on schedule disruptions: ("We are sorry to observe that you are likely to miss your flight departure. Would you like a seat in first class on the next one at 3:15PM?").

Obviously this would be a considerable step above what is currently feasible with personalization options, but it is all technically possible today. Of course, this level of personalization, which is receiving considerable attention in the press and by regulators, might well exceed the "creepiness factor" unless it were done with permission, transparency and with delicacy. And given the fact that passengers are a relatively captive audience during travel, personalized offers for inflight or in-journey merchandising and entertainment, and for post-arrival travel and convenience opportunities, are also possible options.

For distribution offers and search results while traveling—and even often when customers are at home—the mobile channel is increasingly the preferred one for delivery. For the millennial generation in particular, mobile and social channels are the dominant ones in their lives. According to one study on millennials by *Tnooz* and *American Express Insights*, they exhibit these attributes:

- Visit 10.4 sources of online information before buying;
- 75% have a social media profile;
- 83% sleep with their mobile phones by their bedside;
- 84% say user-generated content has a real impact on their travel decisions;
- 57% update social media every day while traveling.

This suggests that a distribution strategy that does not heavily emphasize social and mobile channels—and the analysis of big data derived from them—will fail.

Travel providers may provide personalization based on their own customer data received by them, or they may turn to third parties that aggregate travel information across multiple journeys and providers. For example, Sojern partners with a variety of travel data providers to create more than 100 million traveler profiles, and billions of travel "intent data points", or digitized representations of consumers' intention to travel to a particular destination.

Case study: **British Airways**

Faced with competition from low-cost carriers on the low end, and country carriers backed by sovereign wealth on the high end, British Airways (BA) has focused on achieving competitive advantage through customer insight. It had accumulated substantial customer information from its Executive Club loyalty program and its website, and has incorporated the data into a customer data warehouse for analysis. Recently, the company decided to put customer big data to work in its Know Me program. The goal of the program is to understand customers better than any other airline, and to put the customer knowledge accumulated across tens of millions of touch points to work for the customer's benefit.

BA's analytics team is enhancing its big data program with support from a big data analytics firm, Opera Solutions. The airline is using data and applying it to customer decision points with the three pillars to the Know Me program being:

- *Personal recognition*—This aspect of Know Me involves recognizing customers for being loyal to BA, and expressing appreciation with targeted benefits and recognition activities;
- *Service excellence and recovery*—BA will track the service it provides to its customers and attempt to always keep it at a high level. Given that problems happen in air travel, BA also wants to understand what problems its customers experience, and do its best to recover a positive overall result;
- *Offers that inspire and motivate*—BA's customers are busy people who don't have time for irrelevant offers, so this pillar of the program analyzes customer data to construct relevant and targeted "next best offers" for their consideration. BA hopes that customers will consider it more a service than a marketing program.

The information to support these objectives is integrated across a variety of systems, and applied in real-time customer interactions at check-in locations and lounges. Even on BA planes, service personnel have iPads that display customer situations and authorized offers. Some aspects of the Know Me program have already been rolled out, while others are still under development. Early results are very positive; customers have expressed pleasure at BA's understanding of their air travel needs.

Case study:
Marriott

Marriott was one of the first hotel chains to adopt analytics in the form of revenue management, which it began about 25 years ago. Revenue management is the process by which hotels establish the optimal price for their rooms—the industry's "inventory". If a hotel can predict the optimal price at which to fill all its rooms, it will make more money. And if a hotel management company like Marriott can persuade property owners that they will get more revenues using the Marriott brand than with competitors, they will tend to adopt it.

In order to improve its revenue management capabilities, Marriott combined two separate systems, made revenue management accessible over the Internet, improved revenue management algorithms, made the system work faster so that revenues could be optimized more frequently, and extended revenue management into the restaurant, catering, and meeting space areas. These capabilities are used by a global team of corporate, regional, and local "revenue leaders" who have tools to measure the effectiveness of their decision making and override the system's recommendations when there were local factors that couldn't be predicted.

Marriott also uses analytical approaches to the offers it makes to its frequent customers, and to understand their likelihood of staying with Marriott or defecting to competitors. The company was also an early adopter of web analytics, and uses A/B and multivariate testing to improve its website. Finally, Marriott has experimented for several years with a variety of personalization options for visitors to the web site targeted to both loyalty members and the broader population of visitors to the web site. This is its primary foray into big data.

Most recently, Marriott has been analyzing big data from its web site activity to create a robust marketing attribution model. The ultimate goal is to understand which sales and marketing activities really drive the sale to a customer.

Case study:
Hipmunk

Hipmunk is an online travel website co-founded by Steve Huffman, a co-founder of Reddit. The site searches for and ranks flights, hotel options, apartment and room rentals, and Amtrak rail journeys along a variety of criteria. Its big data activities involve both customer-facing offerings and internal operations, and their creativity is typical of the innovative cultures in online travel startups.

On the customer-facing front, Hipmunk has created some proprietary algorithms to rank flights and hotels by criteria in addition to price. Airlines, for example, are ranked on an Agony Index, which takes flight duration and the number of stops into account. For hotel rankings, Hipmunk has an Ecstasy Index algorithm, which combines a hotel's price, amenities and customer ratings. These ranking criteria set Hipmunk apart from the many other online travel sites.

For internal operations, the primary big data activity at Hipmunk is testing, the purpose of which is to understand user behavior on their site. The company logs every single user click, and records the entire stack of pages that were clicked on. As a result, the company can go well beyond the usual A/B testing, and can understand the entire online environment that is driving user behavior. For example, the company conducted experiments on how prominently travel prices should be displayed, and found it a relatively unimportant factor in conversion.

Some experiments result in small changes, such as making the hotels button a little larger. Others result in substantial breakthroughs, such as realizing that a class of users that was running one search and never booking a flight was actually a "bot" used maliciously by hackers. Hipmunk was sufficiently committed to testing to develop its own testing software, although there are considerable options available commercially.

Travel Management

Travel management—The business of booking and managing employee travel for corporations and organizations—has not been an avid user of big data thus far, but there are opportunities for using data and analytics to transform the entire process. Some travel management firms are beginning to explore this transformation. A senior executive in one of the largest global travel management firms commented on the shift toward big data in an interview:

Our most analytical clients are increasingly interested not just in reporting on the past, but on predictive models and forecasts of their employee travel behavior. We're not sure how rapidly the adoption of big data will take place, but we see it as essential to the effective management of corporate travel.

How might travel management be affected by big data? One could imagine a future scenario such as the following:

Lynda Peters, an IT architect at insurance firm Tranquilife, was going to a business conference in March of 2016. After registering for the conference, all the logistics—city, hotel, beginning and ending times—were automatically downloaded into Lynda's scheduling application. They were then transmitted—again automatically—to the travel management system that Tranquilife had chosen. Without any action on Lynda's part, she received a proposed itinerary with the following components:

- A flight on Lynda's preferred airline, with a frequent flyer upgrade already arranged;
- A hotel reservation for all the nights of the conference;
- A self-driving rental car reservation at the airport (because the conference hotel was 40 miles away, and the travel management application had compared the cost at prevailing rates of taxi, limo, and rental car for that distance);
- A reservation at the best Italian restaurant in the conference city—Lynda's favorite dining option—for the "on your own" night of the conference, with three suggestions for dining companions (and three alternate suggestions) who were valued members of Lynda's social network who would also be attending the conference; Lynda needed only to touch her tablet screen once to invite them.

Lynda's self-driving car delivered her to the conference hotel with no problems; the travel management system had downloaded her destination address, preferred air conditioning temperature, and favorite satellite music station to the car. Lynda's only complaint about self-driving rental cars was that antiquated regulations forced her to sit in the driver's seat, which limited her tablet access.

On the way to the conference, Lynda noted on her tablet that one invited member of her dinner party would be unable to attend the conference, so her travel management app was recommending an invitation to the first alternative.

Lynda enjoyed the conference, and after she returned to work, she received an email from the travel management system noting that all of her travel expenses—even an estimate of her hotel tips—had been submitted to her company for reimbursement.

Perhaps it will be later than 2016 by the time these capabilities come to pass, but they are not entirely unrealistic. And Google describes the self-driving car as a big data project, so it is perhaps appropriate to include it in the scenario. And while the travel industry has not made much progress toward the facilitation of intermodal travel by passengers, some organizations, including airports, are planning to address the issue (see the case study, "Munich Airport").

Case study:
Munich Airport

Munich Airport (Flughafen München) is the second busiest airport in Germany and a hub for Lufthansa. The airport's management has a goal of facilitating "seamless travel" for its passengers. Since passengers are customers of airlines but are not generally known to airports, and since nearly half of airport revenues come from retail, food and beverage sales, and parking, the airport would like to know more about its passengers, and eventually hopes to individualize services for them. In effect, this would constitute a loyalty program for airport customers.

In addition to being an airline hub, the airport is also a center of rail and automobile service. Michael Zaddach, the Chief Information Officer of Munich Airport, would like to integrate information on the multi-modal travel plans of passengers. The airport hopes to be able to offer navigation from the passenger's home to his gate, or from the gate to other modes of transport. These initiatives are being planned but are not yet implemented.

Of course, every trip that starts at an airport ends at another airport. Today every airport is developing its own smartphone apps. Munich would like to develop solutions that can be used at or with other airports and transport modes. To that end, Munich is working with other airports to develop standards for passenger and journey information. The airport is also working with Lufthansa and Amadeus to explore approaches to sharing statistical data.

Internal Operations

Another class of uses for big data in the travel industry involves making internal operations more efficient and effective. As with other categories, the use of data and analysis in internal operations is not new. Airlines pioneered the use of analytics for routing, crew scheduling, and maintenance logistics decisions. Hotels have pioneered the installation of energy management systems. However, it is undeniably true that the availability of big data will lead to a new generation of transformational applications.

Perhaps the first operational transformation from big data will come from sensors in large transport devices. GE, for example, is aggressively placing sensors in jet engines, hoping that the data from them will allow both more efficient operations and more timely maintenance. GE hopes to capture the resulting data to better optimize its own service contracts, and the businesses of its travel provider customers. Even small benefits provide a large payoff when adopted on a large scale. GE estimates that a 1% fuel reduction in the use of big data from aircraft engines would result in a $30 billion saving for the commercial airline industry over 15 years.

Energy consumption is also an important focus of big data in hotels. With new providers of "smart grid" and energy management services coming onstream, substantial new opportunities will emerge. For example, two San Francisco InterContinental hotels are already using capabilities from Stem, a big data for energy management startup. Stem's software gathers data from more than 50 different sources — including weather data, electricity rates and a building's energy consumption — to build a comprehensive building energy profile. Through a cloud-based, predictive analytics algorithm, the software can fine-tune whether power comes from the grid or an onsite battery module. InterContinental's management expects to reduce energy costs by 10 to 15%.

Although the travel industry initiated the use of analytics for crew scheduling, there are other frontiers in human resource analytics that it has not explored. Some other industries, for example, try to match the personality characteristics of front-line associates with the task (e.g., selling) or the inferred or observed attributes of the customer (e.g., difficult or angry). Other goals include identifying the attributes of prospective employees that are most likely to be correlated with high performance on the job, or identifying those employees who are most likely to quit. Since travel is a service-oriented business, it is likely that these types of analytical interventions would improve service levels and customer satisfaction.

Financial Performance and Investment Management

A final process to which big data and analytics can be applied is financial performance management and the evaluation of capital investments. The travel industry—particularly hotels and resorts—has been among the early adopters of analytics to assess the drivers of financial performance. Thus far the data used for these initiatives has been relatively small and structured, but it's possible that other big data sources could be incorporated into existing models.

In the mid-1990s, academic researchers and executives of service industry companies began to explore the "service-profit chain". This idea specifies that as companies invest in employee satisfaction and training, they deliver better service to customers. Customers respond with higher satisfaction and higher purchases, which leads to greater investment resources—a virtuous circle.

One of the researchers, Gary Loveman, became CEO of Harrah's (now Caesars) Entertainment, and employed the service-profit chain and other analytical initiatives to make the company the world's largest gaming firm. Caesars carefully monitored employee and customer satisfaction, and added a strong focus on customer loyalty. Using these variables, Caesars was able to accurately predict increases in market share, revenues and profits, and even its share price.

At about the same time as the service-profit chain ideas were published, other researchers began to write about the "balanced scorecard", which specified that organizations should work to understand what factors drive organizational performance, and report them on a simple scorecard. Some of the measures reported were similar to those in the service-profit chain, especially for services companies.

Hilton Hotels was one of the more aggressive users of the balanced scorecard, and eventually was named in the "Balanced Scorecard Hall of Fame" by the firm that promoted the idea. One of its breakthroughs was similar to that of Caesars. By correlating the factors in its scorecard over several years, it was able to find significant correlations between customer satisfaction and loyal customer behaviors. An analysis of data from 42 Hilton hotels over five years showed that a 5% increase in customer loyalty in a given year leads to a 1.1% average increase the next year at a typical property. These sorts of measures and relationships can be very helpful to managers in planning ways to increase financial performance over time. With the availability of more external big data, travel industry firms can begin to use other measures of consumer demand to refine their predictive models.

Another set of analytical techniques can be used to determine what types of capital investments pay off. This approach, referred to as "randomized testing" or "Test and Learn", involves making investments in test groups, but not in control groups. The hotel industry, which is well-suited to the approach because of the number of separate facilities that can serve as test and control sites, has begun to employ it on a broad basis. It can test such investments as remodels, conference facilities, new restaurant formats, and even wall colors—all on a relatively small scale. Full rollout of the tested features only happens if the test group substantially outperforms the control group. The chief marketing officer of InterContinental Hotels Group (IHG) commented:

Our executive team is now both comfortable and confident in relying on Test and Learn to inform decision making. As a result, we have an accelerated rate of innovation within IHG and leverage a consistent framework for making large dollar investment decisions across the company.

Applied Predictive Technologies, a vendor of Test and Learn software, reports that 13 of the 25 largest global hotel brands are using their capabilities.

These randomized testing techniques are the same ones that are used to test different website versions—known as A/B testing in that domain. In the future, as big data technologies mature, we are likely to see testing of a large variety of combinations of marketing and capital investment activities.

Summary and Recommendations

Big data is already having a substantial impact on key processes in the travel industry, but its influence is clearly in the early stages. Some sectors and companies are already testing or using big data on a production basis, but many others have yet to even dip a toe into the water. Out of all the companies interviewed and researched, however, none contradicted the hypothesis that big data has the potential to dramatically reshape the industry.

The key now, of course, is to move from potential to reality—at least on a small scale. In order to do so, travel industry firms can pursue the five recommendations:

1. Research big data—At a minimum, every organization in the travel industry should begin investigating and following the movement of big data. Are competitors adopting it? Are customers beginning to use it? What is the trajectory of big data adoption and use within your segment of the travel business? And most importantly, can you afford to be a follower rather than a leader in this area?

2. Strategize about big data—Company executives need to consider what is happening with big data in the industry, and how they might participate in the trends. Where in the business is there a need for much better data and better decisions? Where is there already data that could be useful either internally or to customers, but is currently being ignored? Considering both questions rigorously can yield a plan of action for big data.

3. Don't just explore big data technology—As with other potentially revolutionary technologies, seizing the potential of big data is not just about implementing technology. To make effective use of big data, organizations will have to change business and operational processes, decision styles, employee skills, and corporate cultures. Continuous data flow, for example, requires a continuous decision-making process. The level of change may well be dramatic, but so is the potential benefit.

4. Start assembling big data skills—Since data science skills are the scarce resource with big data, organizations need to begin assembling them now. If you don't want to hire them internally, start exploring what vendors or consulting firms can supply them to you. Make sure they are adept at data management, analytics, and solving and communicating about business problems. If you have to hire a team to compile all these skills, make sure they work well together.

5. Work with partners—The travel needs of today's customers are intermodal, international, and interactive. No single travel provider is likely to meet any customer's needs for a seamless experience. Start now to partner with other firms to provide the big data experience that your customers want.

List of Organizations Interviewed

- Air France-KLM
- Amadeus
- Applied Predictive Technologies
- Bangkok Airways
- British Airways
- Caesars Entertainment
- Cathay Pacific
- Criteo
- Eurostar
- Facebook
- Fairmont Raffles
- Frontier Airlines
- Hipmunk
- InterContinental Hotels Group
- KAYAK
- Lufthansa
- Marriott
- Munich Airport
- Opera Solutions
- Swiss International Airlines
- Thai Airways

Sources and Suggestions for Further Reading

Davenport, Thomas H,
"How to Design Smart Business Experiments",
Harvard Business Review, February 2009.

Davenport, Thomas H., Paul Barth, and Randy Bean,
"How Big Data Is Different",
MIT Sloan Management Review, Fall 2012.

Davenport, Thomas H. and Jill Dyche,
"Big Data in Big Companies",
International Institute for Analytics Research Report,
http://www.sas.com/reg/gen/corp/2266746

Davenport, Thomas H. and Jeanne G. Harris,
Competing on Analytics: The New Science of Winning
(Boston: Harvard Business Review Press, 2007).

Davenport, Thomas H. and D.J. Patil,
"Data Scientist: The Sexiest Job of the 21st Century",
Harvard Business Review, October 2012.

Manyika, James et al,
"Big Data: The Next Frontier for Innovation, Competition, and Productivity",
McKinsey Global Institute Report, May 2011,
http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation

Mayer-Schonberger, Viktor and Kenneth Cukier,
Big Data: A Revolution that Will Transform How We Live, Work, and Think
(Houghton Mifflin Harcourt, 2013).

McAfee, Andrew and Erik Brynjolffson,
"Big Data: The Management Revolution",
Harvard Business Review, October 2012.

SOCAP International,
"Now Arriving: Big Data in the Hospitality, Travel, and Tourism Sector",
April 23, 2013,
www.socap.org.

Vivion, Nick,
"Mission Millennials: Capturing a Lucrative Cohort for Life",
Tnooz website, http://www.tnooz.com/2012/08/06/how-to/mission-millennials-capturing-a-lucrative-cohort-for-life/

About Amadeus

Amadeus is a leading transaction processor and provider of advanced technology solutions for the global travel and tourism industry.

Customer groups include travel providers (e.g. airlines, hotels, rail, ferries, etc.), travel sellers (travel agencies and websites), and travel buyers (corporations and individual travelers).

Amadeus has central sites in Madrid (corporate headquarters), Nice (development) and Erding (operations – data processing center), and regional offices in Miami, Buenos Aires, Bangkok and Dubai. At a market level, Amadeus maintains customer operations through 73 local Amadeus Commercial Organizations covering 195 countries.

Amadeus is listed on the Madrid, Barcelona, Bilbao and Valencia stock exchanges and trades under the symbol "AMS.MC". It is a component of the IBEX 35, STOXX Europe 600 Index, and the Dow Jones Sustainability Index (DJSI).

For the year ended December 31, 2012 the company reported like-for-like revenues of €2,910.3 million and EBITDA of €1,107.7 million. The Amadeus group employs around 10,000 people worldwide, with 123 nationalities represented at the central offices.

To find out more about Amadeus, please visit www.amadeus.com

To visit the Amadeus Investor Relations center, please go to www.investors.amadeus.com

To download a copy of the report, please visit www.amadeus.com/blog/tag/big-data

Previous publications

The Amateur-Expert Traveller

Three important trends in travel which are being accelerated by the recession

www.amadeus.com/amateur-expert

From Chaos To Collaboration:

How transformative technologies will herald a new era in travel

www.amadeus.com/upload_ineed/userfiles/file/Amadeus%20study%20From%20chaos%20to%20collaboration.pdf

The Austere Traveller

The effect of corporate cutbacks on hotels
A report from the Economist Intelligence Unit

www.amadeus.com/amadeus/austere_traveller_form.html?id=lpage&cmp=feb09

Open For Business:

The value of Open Source Software in transaction processing

www.amadeus.com/airlineit/docs/open_for_business_17092012.pdf

Future Traveller Tribes

Report for the Travel Industry
Developed by Henley Centre Headlight Vision in partnership with Amadeus

www.amadeus.com/travellertribes

The Travel Gold Rush 2020:

Pioneering growth and profitability trends in the travel sector

www.amadeus.com/amadeus/documents/corporate/Travel-Gold-Rush-2020-EN.pdf

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