Master thesis:
Business Intelligence Outsourcing
in the Airport Industry

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by:

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Business intelligence (BI), airport industry, BI outsourcing, outsourcing decision factors, Frankfurt Airport, Brisbane Airport, Philadelphia International Airport, Nice Cote d'Azur Airport

Abstract

This paper explores business intelligence outsourcing in the airport industry. The focus is on investigating the decision factors that lead airports to either outsource or produce their BI in-house. 4 airports (Frankfurt, Brisbane, Philadelphia and Nice) serve as a sample to investigate the importance of airport size, location constraints, the competitive environment and the focus on aeronautical versus non-aeronautical revenue in the BI focus and outsourcing decision.

The paper elaborates on findings from the literature on the make versus buy decision with its benefits and challenges, business intelligence with its multiple definitions and decision factors, the airport industry and its specificities as well as on the general BI market. Then, four case studies are giving an insight into the general economic environment and the specific BI situation of the airports. These case studies are used to investigate the four hypotheses defined on different decision factors. As an outcome, recommendations for BI vendors are given to help them address the airport market. Finally, the paper concludes on the findings and gives an insight into the industry's outlook.

Mots clés et Abstrait

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Abstrait

Ce document explore l'externalisation de la veille économique dans l'industrie aéroportuaire. La recherche cible l'étude des facteurs de décision qui influencent les aéroports à externaliser ou à produire leur veille économique en interne. Quatre aéroports (Francfort, Brisbane, Philadelphie et Nice) servent d'échantillon pour tester différents facteurs de décision et l'impact de ces facteurs dans la décision d'externaliser la veille économique : taille de l'aéroport, contraintes d'emplacement, l'environnement concurrentiel et les revenus aéronautiques et non aéronautiques.

Ce document développe les conclusions de la revue de la littérature sur l'externalisation ou l'internalisation d'activités avec ses avantages et ses inconvénients, la veille économique avec ses multiples définitions et facteurs de décision, l'industrie aéroportuaire et ses spécificités ainsi que le marché de la veille économique. Ensuite, quatre études de cas donnent un aperçu de l'environnement économique général et de la situation spécifique de la veille économique des aéroports. Ces études de cas sont utilisées pour étudier les 4 hypothèses définies sur différents facteurs de décision. Ce papier développe des recommandations afin d'aider les fournisseurs de veille économique à répondre au marché des aéroports. Enfin, le document conclut sur les résultats et donne un aperçu des perspectives de l'industrie.

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Executive Summary

This paper aims at investigating the make vs buy decision factors for BI activities in airport industry. Furthermore, the objective is to establish the influencing factors specific to airport regarding the decision to outsource or produce BI in-house. The outcomes will give insights to airport business intelligence managers to make more informed decisions with a view of the different decision criteria used by their colleagues in other airports. Furthermore, the findings inform BI vendors about how to best serve the airport segment.

The paper is structured into three large parts, namely the literature review, the case studies and the hypothesis discussion and the conclusions and recommendations. To answer the research question, first, the literature review informs about the general decision factors in the make versus buy decision. It also discusses business intelligence and how and why it can be outsourced to external providers. Then, the airport industry is discussed and finally, a section on the sizing of the BI market and the one for airports in specific concludes the literature study. After discussing the research methodology, the four case studies are outlined, followed by the discussion of the four hypotheses based on the case studies to understand the airports' general business environment and efforts in terms of business intelligence and what influences their decisions regarding BI outsourcing. Moreover, interviews with people from other areas connected to the airport industry help to broaden the horizon of this paper and add important insights.

The paper concludes by summing up the findings and giving recommendations for BI vendors as well as an outlook into the future of BI.

The findings are the following:

- The competitive environment as well as the need for being innovative as compared to the competition seems to be the strongest influencing factor for whether airports outsource or produce their BI in-house.
- Airports focusing on non-aeronautical revenue have a stronger focus on BI than those focusing on aeronautical revenues. Hub airports are more likely to produce BI in house as the retail business is a major part of their revenues and as offering the right products and services to customers presents a strong profit opportunity.
- The location constraints and airport size are not decisional factors for outsourcing BI activities in the airport industry.

The case studies cross-analysis highlights that the budget available is the largest criterion to consider when deciding to outsource versus developing internally, but also other criteria such as the internal capacity/competency available, the data security, assessing the type of need, the reliability of supplier, the business model of the company, the time scope, the level of innovativeness, and the current BI maturity are of relevance.

No significant difference between the influencing factors for the make versus buy decision as in the literature review as compared to the framework of BI activities in the airport industry has been found. Two influencing factors are specific only for BI activities in the airport industry, namely innovativeness and BI maturity.

There is a larger difference when comparing the general BI outsourcing decision influence factors compared to those in the airport industry. The general BI outsourcing decision factors do not consider the budget, data security and innovativeness factors relevant in the airport industry. On the opposite, the airport industry BI outsourcing decision influence factors do not consider the level of IT integration.

The main advantages for producing BI in-house are: keeping full control of the data, accommodation of specific needs, and it can be the only solution when companies face a lack of off-the-shelf solutions. The main disadvantages are: the cost involved, and the fast-changing technology environment that impacts BI systems life cycles.

Following the findings, BI vendors are recommended to offer highly tailored solutions to sub-segments of the airport industry to address specific needs based on the airport's environment and specific business challenges: airports' competitive environment, their existing systems and BI maturity, and their future ambition for development. It is suggested to adopt a consultative approach by using BI based on airport's existing system to develop a solid knowledge of their data and perform sophisticated forecasts and scenario planning for building a long-term relationship with their customers. Furthermore, the integration of data from third party sources (GDS, IATA, MIDT…) could add high value to BI vendors' offerings. This recommendation fits perfectly with future trend to mix internal BI activities with external provider products and solutions providing services.

To conclude the research, Machine Learning and how it is used by Lagardere Travel Retail at Charles de Gaulle Airport and the benefits of using Machine Learning are discussed. Furthermore, further research will be needed to extend the finding by involving more airports in the study to be able to validate and generalize the findings.

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1 Introduction

Over the past few decades, most companies have faced the strategic decision to either perform certain activities in-house or outsource them. Managers from different industries are facing this decision-making process but may argue that decision factors differ for their industry. As Business Intelligence is becoming more and more important and used in companies due to technology advancement and proven efficiency, it is highly interesting to investigate the make versus buy decision factors for BI activities. Although no research has been conducted on this subject, sizing this topic to a specific industry is relevant to provide exhaustive research in a specific industry: the airport management industry. This industry collects large amounts of data, and a stronger focus on BI could be used to generate competitive advantage. In addition, airports are facing more and more intense competition on a global scale forcing them to rethink their competitive positioning.

The research first covers an extensive literature review to better understand the Make versus Buy theory with both empirical studies and case studies based on concrete examples. Business Intelligence, Business Intelligence outsourcing, Airport industry overview as well as BI Market sizing completes the literature overview. This literature review gives necessary background to understand the research proposal.

The research proposal includes the research question, research objective, research methodology, data analysis and limitations. The research question is: What are the make versus buy decision factors of BI activities in airports? Which airport specificities are influencing the choice of outsourcing versus in-house BI development? The research objective is to find if there is any divergence from the general decision factors as outlined in the literature that are specific to the airport industry, as well as to explore specificities of the industry and derive a make versus buy framework for BI software in the airport industry. The research also aims at providing BI software vendor the decisions factors that influence the sales of industry-specific BI software.

In order to answer the research question, the case study method is used, based on a convenience sampling approach and built from semi-interviews conducted with key people. The research derives four case studies: Nice Cote d'Azur Airport, Frankfurt Airport, Brisbane Airport, and Philadelphia Airport. The research also discusses external validity and reliability

of the data collected. The cross-case analysis method is then applied to allow data interpretation across case studies. The research acknowledges its limitation

After discussing the research methodology, the four case studies are outlined, followed by the discussion of four hypotheses based on the case studies. The paper concludes by summing up the findings and giving recommendations for BI vendors as well as an outlook into the future of BI and introduces the Machine Learning.

2 Literature Review

2.1 Make versus Buy theory

Should a company produce 100% of its products or services themselves or should it outsource the production or parts of it? Many professionals when making strategic decisions have raised this question. According to Jauch and Wilson (1979:56), this question should be answered by top managers instead of the procurement department to avoid limitations of strategic alternatives and to prevent a less desirable strategic choice by making a decision without having the strategic overview of the entire business.

In the literature, the concept of transaction cost plays an essential role in the decision-making (Raunick and Fisher, 1972; Meijboom, 1986; Bassett, 1991; Poppo *et al*., 1995; Padillo-Perez *et al.*, 1999). Based on Coase's (1937) previous work, Williamson (1981) establishes the concept of "transaction cost economics" (TCE). This model explains "the comparative costs of planning, adapting, and monitoring task completion under alternative governance structures" (Williamson, 1981:552). He is the first scholar to deal with the make-or-buy decision as an economic decision based on "minimization of the one-time and total costs incurred in buying or producing the product" (Mantel *et al.*, 2006:823). He translates this decision making into a "markets" or "hierarchies" theory, with the idea that markets (buy) should be used for sourcing products or services when transaction costs related to sourcing are low. Hierarchies (make) should be used when there is a high transaction cost for sourcing the specific product or service from the market. Another important theory on outsourcing is the "resource based view" model (RBV) established based on previous work of Wernerfelt, Prahalad and Hamel, Peteraf, Barney and many others, where the company is defined as a combination of assets and resources and if they are employed in distinctive ways, they can create a competitive advantage (McIvor, 2009:46).

However, Welch and Nayak (1992) explain that focusing only on cost led many firms into "competitive tragedy", and that companies must take other factors relevant for their industry into account in the decision-making process.

Agreeing with Welch and Nayak (1992), various authors highlighted the importance of other factors to consider in addition to cost such as: core competencies, internal and external capabilities, dependency on knowledge and production capacity, and the availability of

suppliers and competition between them (Welch and Nayak, 1992; Venkatesan, 1992; McIvor *et al.*, 1997; Probert, 1997; Cox, 1997; Fine, 1998; Baines *et al.*, 1999).

The different models mentioned earlier have some limitations: some of them have been tested on specific industries and specific products. As a result, the findings cannot be generalised and compared. Indeed, Venkatesan's (1992) strategic sourcing process aims to make sourcing decisions focusing on highly engineered product, while Welch and Nayak's (1992) framework focuses mainly on strategic and technological factors in the technology industry. Also, some models are useful only if the company decides to outsource, as they deal solely with the outsourcing process. For instance, Bajec and Jakomin (2010) are proposing a three-step process framework, with the first step being the evaluation of sourcing options, then determining what functions should be outsource as well as clear definition of performance expectations, and finally using defined selection process in the evaluation and selection of the right suppliers.

However, most of the authors cited above have concluded that firms should exploit the activities in which they have a sustainable competitive advantage, and externalize the activities in which competitors have a specific competitive advantage (Bustinza *et al.*, 2010:277).

2.1.1 Influencing factors for make-or-buy decision-making

Leigh and Breedlove (2013) highlight that due to the opposite nature of make-or-buy strategy, decision makers can easily identify factors to help them in the decision process. They explain that a company that desires to focus on its core business functions should consider the "buy" option and outsource, as well as a company that does not have the technical capabilities and desires to offer products that are at the cutting edge of technology. At the opposite, a company that desires to avoid loss of control should consider the "make" option and produce the product itself. While Gartenstein (n.a.) includes only four factors influencing make-or-buy decision process: quality, quantity, convenience, and marketing, Kashyap (2016) includes more detailed factors such as the volume of production, cost analysis, utilization of production capacity, integration of production system, availability of manpower, protection of patent right, fixed cost, availability of competent suppliers, and quality and reliability of vendors.

Mantel *et al.* (2006:832) and Hopp (2004) stress the importance of the human in the make-or-buy decision. Mantel *et al's.* (2006:832) recent research introduces the idea that behavioural

biases from psychological studies are impacting the make-or-buy decision. Biases, such as the "availability heuristic" (Tversky and Kahneman, 1974), the failure to adjust to new information (Sanbonmatsu *et al.*, 1998), and the overestimation of the representativeness of information and inaccurate conclusions (Bazerman, 2005) influence behavioural decision-making. The expected utility model states that decision makers would prefer a larger gain rather than a smaller gain. However, research shows that this model is violated because decision-makers are more likely to accept a smaller gain that is predictable rather than the possibility of having a larger gain that is uncertain, and they are more willing to risk larger loss if there is a possibility that no loss occur at all (Mantel *et al.*, 2006:825). As cited by Mantel *et al.* (2006:825), the Ellsberg's paradox (Ellsberg, 1961) demonstrates that decision makers prefer outcomes "with known probabilities over outcomes of unknown risk". In the make-or-buy decision, the perception of importance is an essential factor, as it increases the motivation to make a good decision. However, according to Mantel *et al.* (2006:825), this factor is not enough to increase judgmental accuracy. The result of Mantel *et al.'s* (2006) research is that "vividness of the information and perceived risk may be linked to deliver a decision that is different from one that would have been predicted in the expected utility model" (Mantel *et al.*, 2006:835). It has been found that by focusing on biases, top managers can de-bias the behavioural bias that affect humans in decision-making processes.

2.1.2 Benefits of outsourcing

In addition to developing a close relationship between the supplier and the firm, many other benefits arise from outsourcing (Miles and Snow, 2001). Kimura (2002) argues that outsourcing enables companies to "reduce and monitor operating cost" through economies of scale and distribution of the cost among customers. Both, Quinn and Hilmer (1994) and Sislian and Satir (2000) agree that outsourcing allows firms to focus on "their core activities and competencies". Mullin (1996) and Harris *et al.* (1998) go beyond by explaining that outsourcing is more than a simple cost saving decision, but a "strategic decision that increases the firm's main capabilities" (Bustinza *et al.*, 2010:277).

Outsourcing also enables a firm to respond to demand changes without modifying the internal structure. Lankford and Parsa (1999), as well as Kakabadse and Kakabadse (2005) explain that outsourcing also prevents the company from dismissing personnel on whom it has made large investments in terms of training and education, if demand diminishes at some point. When talking about benefits linked to outsourcing, Campbell (1995:22) focuses on benefits

related to the quality of products or services. According to him, outsourcing allows the company to benefit from new ideas and improvements from suppliers as well as from the depth, expertise and sophisticated technical knowledge necessary to create specialized capabilities, and it provides greater flexibility (Campbell, 1995:22). He also mentions that contractors usually have superior quality practices, as well as specialized equipment that provide better quality at lower price (Campbell, 1995:22).

2.1.3 Pitfalls for outsourcing

Campbell (1995:22) categorizes the pitfalls for outsourcing into three categories: the loss of critical skills or developing the wrong skills, the loss of cross-functional communication, and the loss of control over a supplier. In addition to agreeing that outsourcing can reduce control over the company's activities, Bettis *et al.* (1992) argue that outsourcing can reduce organizational innovation, and as a result, that outsourcing may destroy long-term competitive advantage. Also, there is a risk that when suppliers have access to the manufacturing of a product, they can use this knowledge to market the product themselves (Prahalad and Hamel, 1990). Gilley and Rasheed (2000:767) also discuss that foreign suppliers may seem attractive due to cost advantage based on low wages, but this remains advantageous only as long as the home currency stays strong. Gilley and Rasheed (2000:767) argue that when a firm outsources, it requires a modification in the overhead allocation to the products and activities that remain in-house. Both Gilley and Rasheed (2000:767) and Bettis *et al.* (1992) agree that this modification of overhead costs reduces the financial performance of the remaining products and activities, which can then be in their turn vulnerable to potential outsourcing. Dess *et al*. (1995) also warn firms that tariffs as well as the difficulty to bring back outsourced activities to the firms are dangers to consider when deciding to outsource. Markides and Berg (1988) conclude that transferring activities from one supplier to another one may delay the acknowledgement that something is wrong within the firm and delays a sustainable solution.

2.1.4 Outsourcing and performance

Various studies have been conducted to examine the effect of outsourcing on performance. Jiang *et al.* (2006) find a positive relationship between outsourcing and cost savings, but fail to proof the impact on productivity and profitability. Görzig and Stephen (2002) affirm that outsourcing increases productivity in manufacturing firms, but not in outsourcing services. These findings contradict Kimura's (2002) findings on Japanese manufacturing firm, where he did not find any relationship between outsourcing and performance. Görg and Hanley

(2004) discuss that although outsourcing increase performance in large manufacturing plants, it decreases in small ones. Giley and Rasheed's (2000:788) research indicates that companies looking for cost leadership and innovative differentiation strategies searching form performance are likely to benefit the most from outsourcing. They also argue that outsourcing leads to performance increases for firms operating in a stable environment. Finally, Rothaermel *et al.* (2006) conclude that rightly balancing outsourcing and vertical integration benefits the company's product portfolio, which increases the company's performance.

2.1.5 Outsourcing and the size of the company

Only one study conducted by Arbore and Ordanini (2006:85) explores the relationship between the size of companies in information and communication technologies (ICT) industry and outsourcing. A link can be established between ICT and business intelligence tools, as they are both highly technical tools. The study contrasts two sizes of firms: the small to medium enterprises (SMEs) (less than 250 employees) and the large ones (above 250 employees). The study highlights the benefits of outsourcing for SMEs, especially when they cannot justify the cost for hiring ICT specialists or in-house training. The study also highlights the advantages of outsourcing for SMEs, as it does not require owning servers, as well as a support data centre. Arbore and Ordanini (2006:85) conclude that for SMEs facing internal and environmental constraints, ICT outsourcing is an external way to facilitate the adoption of new technologies, thus preferred to making tools in-house.

2.1.6 The role of contracts in outsourcing

When outsourcing, a contract is used to legally protect both parties in the agreement, the contractor and the client. The role of contract is essential for companies deciding to outsource (either a service or a function) to cover certain risks. Jones (2009:1) lists the risks involved when outsourcing: unforeseen fees or charges, poor performance by the contractor, property damage or data loss, and termination of the contract.

Researchers have two separate opinions regarding the contract importance in outsourcing. The first view acknowledges that the contract is "the most important part in the client-vendor relationship" (Levitin and Cullen, 2010). This view encompasses Jones's findings where both clients and contractors have specifications of their rights, duties, policies and responsibilities (Levitin and Cullen, 2010). The second view insists on the importance of the relationship between the client and the contractor. Authors argue that a contract itself cannot produce

results. Only an experienced contract management team understanding common interest, cooperation, and earning trust over long-term partnership deliver sustainable results (Levitin and Cullen, 2010).

There is no agreement from the literature stating who is responsible for preparing the contract. Some large contractors have their own contract, and sometimes the clients have their own contract drafted. Depending on the service or the function outsourced, elaborating a contract can vary from months to years. The contract must be agreed by legal entities from both parties and sent for review at each stage of the process. In addition, Cohen and Young (2005) mention that contracts are often renegotiated, and that companies must be aware of this possibility when entering in the original agreement. Also, due to the terms and conditions that can be exhaustive, contracts are very difficult, and time-consuming to change. This can be a problem for companies that have decided to outsource to be more responsive to growth and adapt quicker to business needs.

Jones (2009:2-5) covers the key points to discuss in a contract. This description is an example and can vary from one company to another. First, the standard of the service serves as a clear description of the services the contractor will provide. This section includes the service levels, with key KPIs (Key Performance Indicators) to assess and measure whether the standards have been met, the termination rights, and the service credits. This part can also include the RFP (Request For Proposal), as well as the service schedule.

The section liability and insurance covers the protection of the client in the even that the contractor “causes loss or damage to property, to data or injury to persons” (Jones, 2009:2). The details in this section are very specific to the business of the clients, with indemnity agreed by both parties. To avoid the risk of insufficient resources from the contractor to meet a claim, a suitable insurance must be included in this part.

Another section of the contract is the prices and fees, which include a clear pricing mechanism the clients will pay to the contractor for the service. With long-term contract, the client can require to include a benchmarking mechanism to ensure the client is not charged above market rate.

The employment issues section covers staff-related issues, such as insurance that the staff provided are suitable to conduct the work properly.

Finally, the section other provisions includes many different points such as: logistics of transition, term of the contract and termination rights, change control, continuous performance improvement, exit management and cooperation on termination, client's responsibilities, equipment, contract management and dispute resolution, key individuals, sub-contracting, third party contracts, force majeure and disaster recovery, parent company guarantee, and boilerplate (Jones, 2009:5).

2.2 Outsourcing benefits and challenges – practical examples

There are many case studies on the benefits and challenges in outsourcing. Our aim in this section is to discuss about specific case studies built from our own experience or studied by professionals to cover the topics of long term strategy, the problem of opportunism and the continuum between markets and hierarchy.

2.2.1 Outsourcing: A Long Term Strategy – Total Case Study

This case study is based on Lena's professional work experience at Total. She was part of the logistic team (Aircraft, Support Vessels, and Underwater Operations categories) within the Contract and Procurement Department at Total.

Background

Total is a French multinational integrated oil and gas company. Total is the 4th largest international oil and gas major, with operations in more than 130 countries. Through its integrated business model, Total covers the entire oil and gas chain, from gas exploration and production, transportation, refining, petroleum product marketing, to international crude oil and product trading. The company's internal organisation is composed of four branches: Exploration Production, Marketing & Services, Refining & Chemicals, and Gas, Renewables & Power. This case study will only cover the Exploration Production branch.

Within the Exploration Production branch and the Contract and Procurement department, teams are confronted to outsourcing decisions, as well as contract negotiations with suppliers. Total's policy is, within the logistic team composed of three categories: Aircraft, Support Vessels, and Underwater Operations, to outsource the activities related to the categories.

The activity related to the Aircraft category is mainly staff rotation. Rotorcraft engine are used to transport passengers from the country staff basement to the offshore platform.

The activities related to the Support Vessel category are various and specific boats are required depending of the activity: passenger transportation with surfers boat, anchor handling needs with AHTS boat, equipment transportation and storage with PSV boat, and underwater operation needs with MPSV boat.

For the Underwater Operations category, the perimeter concerns two segments of activities: ROV (Remotely Operated Vehicles) and diving.

Total's strategy for outsourcing

Total does not only sub-contract the equipment for these categories, the company outsource a full-service package from the operator. The package encompasses the pilot of the engine (rotorcraft and boat), the required number employees to perform the work needed, and the various tools needed for work completion.

Total has decided to outsource the activities related to the categories Support Vessel and Aircraft for several reasons. The first reason is the high investment required to own the equipment (boat and rotorcraft). Bourbon, a world leader in marine services for offshore oil and gas platform, owned in 2016 around 514 boats, with its plant and equipment net depreciation amounting to 2,437.6 million euros (Bourbon Press Release, 2017). Although Total does not require the same vessel fleet, the investment required to own boats and rotorcraft engine remains high, especially when specific work requires specific type of boat. Also, Total revenue is highly dependent of crude oil value that fluctuates every day. It is not in Total's best interest to commit to high investment as if a drop price in crude oil occurs, Total will continue to pay its equipment with lower revenue, thus threatening the well-being of the company. In addition, when purchasing the equipment, the clients have to wait for a long period of time for the delivery of the equipment. This is due because very few second-hand and old vessels or rotorcraft are purchased in this industry due to safety concerns. Clients are purchasing new tailored engines that require several years to be built before delivery. This is an issue for Oil and Gas Companies such as Total, because exploration projects are usually based on at least two years of research and it is only after this exploration phase that the decision of using a drilling rig is made. Thus, it is impossible for Total to evaluate middle term needs for these types of equipment, as some exploration project will succeed and other will fail. In addition, the Exploration Production branch is present in the five continents, and is active in at least 30 countries in the world. The demand in boat and rotorcraft varies with the amount of work to be performed. This amount of work depends on

the budget, the evolution of the oil platform, and the maintenance work. But other factors, such as the repair work, cannot be predicted. The need of a vessel and the intervention in this case are immediate, and depending of the current mapping of active offshore operations, the mobilisation of a vessel in a short notice is impossible.

Another main reason Total has decided to outsource these categories is because of the management issues that these three categories represent. Indeed, for the Support Vessel category, managing a vessel park when it is not the core business of the company is highly complicated. This is mainly due because Total has offshore oil platforms in the five continents. Each country has a unique regulation and policy regarding the offshore activities, thus it is highly complex to put in place synergies between the different oil platforms that are not operated in the same country.

For the Aircraft category, managing a rotorcraft park is also very complex due to legislation. The main problem is that if a rotorcraft accident occurs, all rotorcraft in the world having the same model of the damaged engine are grounded until the authority has not found the exact cause of the accident. In the case of the fatal accident with the H225 model operated by CHC on the 29th of April 2016 in Norway all H225 model have been grounded until the 7th of October 2016, when EASA (European Aviation Safety Agency) decided to lift the temporary suspension. Suspensions of a specific model can directly impact the rotorcraft park, thus impact the offshore operations that would cost a lot of money for an Oil and Gas company to suspend temporarily.

For the Underwater Operations, the main issue is the multitude of tools required to perform the work. Some tools are disposable while most of them are not. Several years ago, Total's strategy has been to buy the non-disposable equipment for this category. But Total faced so many inventory issues for the category that they decided to outsource it. Indeed, some tools were broken but not identified as broken, some were missing, the in-house stock management system was not efficient, and it negatively impacted the offshore operations. Also, the tools synergies between affiliates were poorly managed because of the mobilisation and demobilisation fees required when moving it from one affiliate to another one.

In addition, Total has outsourced these categories because it requires personnel training, investment in local plants for equipment storage, and maintenance costs. To be financially interesting, it also requires equipment utilisation optimization, which is hard to achieve with

vessels and rotorcrafts, as well as mobilisation and demobilisation specialized service to cover all operations (vessels, aircraft, and underwater operations tools). By outsourcing, Total benefits from flexible contracts with expert providers, while protecting its brand image, if an accident happens. Also, “third-party beneficiary contract” have been implemented with other Oil and Gas companies to optimize the resources provided by the contractor.

The companies that outsource these services are benefiting from economies of scales by performing it for most Oil and Gas majors. They offer full-service package with no initial investment required from customers, provide brand image protection if accident occurs, and are flexible for adapting to their customer needs. However, outsourcing these types of service is very expensive, and the price depends on many different factors. These factors include the region of operations, the model of equipment, the staff experience, and the mobilisation and demobilisation fees based on previous location of equipment. Even though the price of this service is expensive, it remains interesting for Oil and Gas majors to outsourcing these risky operations to experts that have the skilled workforce and necessary equipment.

Conclusion

The mid-2014 drop in oil price has forced Total to limit its cost of operations. Most exploration phases have been delayed, and current offshore operations have been reduced when possible. By outsourcing these three categories, Total has avoided major losses of owning unused equipment, as operations have diminished. Besides, the group has also decided to modify the strategic sourcing of these categories, as outlined by the Underwater Operations category for the ROV segment, by creating different type of contracts and processes for award. Also, the group has renegotiated most of their current contracts with service providers for cost saving opportunities.

Unfortunately, this drop in oil prices has also impacted Total’s service providers. But, as Total’s outsourcing policy requires a diversification from service providers to limit the risk of offshore operations shortage, Total’s global activities have not been impacted. Indeed, even if the companies Ethos Offshore US (vessels) and Bristow (aircraft) who had several contracts with Total have entered under chapter eleven, it did not have not much impacted Total’s global activities.

2.2.2 Outsourcing: The problem of opportunism – Empirical Evidence from Coal Markets

This case study is based on Joskow's work in his papers "Vertical Integration and Long Term Contracts: The Case of Coal-Burning Electric Generating Plants" (1985) and "Contract Duration and Relationship-Specific Investments: Empirical Evidence from Coal Markets" (1987). This case study illustrates the problem of "opportunism" as termed by Williamson and reflects the monopoly power used by one party over the other to not maximize joint profits and appropriate its wealth (Joskow, 1985:37).

Background

According to Joskow (1985:40), the main market for coal in the US is the electric power industry (80%), the coke plants (10%), other industrial sector (9%), and the commercial sector (1%). The coal suppliers can be grouped into four areas: "the Appalachian region, the Interior (Midwestern) region, the Western region (often divided into the North Plains and Mountains regions), and Texas" (Joskow, 1985:40), with differences across four areas in terms of "coal quality and optimal mining techniques and scale" (Joskow, 1985:40). Most of the coal produced is transported by railroad and some areas like the Interior and Western regions as no other option but to use the railroad to mine-mouth operations. Although the coal supplies market is competitive, monopoly problems may arise because of the railroad limits.

Different coal plants strategies

In the coal markets, the coal-burning plants contain physical asset specificity, because when those plants are built, they can burn only a specific type of coal (construction design thermal efficiency differs and will impact the quality of the coal if modified). Once the coal-burning plant is built, the operator is then committed to burn a specific type of coal, but the buyer is not committed to a specific supplier. Joskow (1985:45) identifies four possible types of plants design strategies, transportation strategies and procurement strategies:

- Case 1: The utility plant purchases coal from many existing mines in a large geographical area and uses spot market purchases with short-term contracts for both coal purchase and delivery of the coal to the utility plant. The transportation arrangements are flexible with railroads and barge companies. The utility plant is designed to receive coal with variable quality from mines in the area (Joskow, 1985:45-46).

- Case 2: The utility plant purchases coal from a small number of "existing mines located close to one another and producing similar types of coal" (Joskow, 1985:45). The mines have other buyers and to meet the demand must make investment to increase its production capacity. The utility plant expects to buy coal from these mines for several years but if economic opportunity arises, the plant will switch suppliers. The plant relies on two railroads, but other alternative exists at an extra cost. The boiler to burn coal is designed to burn the coal extracted from the mines nearby (Joskow, 1985:45-46).
- Case 3: The utility plant expects to buy coal from two specific mines during the life of the plant. The mines are currently supplying other buyer and require investment to increase their capacity. There are limited suppliers in the area and the coal quality in the area differs from the one in the two mines. The utility plant uses a single railroad to transport the coal and plan on investing in unit trains to reduce delivery costs in the long-term. The plant includes specific investment and is designed for optimal burn of the coal extracted from the two mines (Joskow, 1985:45).
- Case 4: The utility builds a mine-mouth plant and expects buying coal from one or two adjacent mines. The plant is designed specifically for burning the coal from these two mines. The "mine would not be built but for the promise of purchases from the adjacent plant, and the plant would not be built but for the availability of coal from the adjacent mine" (Joskow, 1985:47). The utility must make extensive investments in "transmission capacity to move the power from mine to load centers" (Joskow, 1985:46).

The cases 2, 3, and 4 have potential for opportunistic behaviour by the buyer and the seller. For case 2, the buyer as well as the seller have other alternatives as well, so the opportunistic behaviour is constrained. For case 3, the problem of opportunism is more serious mainly because of the transportation arrangement that is unique: there is a serious potential for the railroad to act opportunistically. Case 4 illustrates the most severe form of opportunism (if the coal mine decided to increase prices, the utility company had no other choice but to buy it).

Conclusion

In order to avoid this problem of opportunism, Joskow's (1987:169) discusses the importance of establishing long-term contracts including the terms and conditions of future transactions. A coal contract would include the price the buyer would pay at each delivery, the quantities the seller must deliver and the buyer must purchase, when the transaction occurs, the quality

of the coal the seller must deliver, the source of the coal, and "the period of time over which the contractual provisions are to govern the terms and conditions of trade" (Joskow, 1987:169). Joskow (1985:48) also acknowledges that sometimes vertical integration is preferred to avoid problem of opportunism (for case 4 for instance).

2.2.3 A continuum between markets and hierarchies – Tata Motors and Fiat Case Study

This case study is based on Fiat and Tata Motors joint venture (JV) to answer the growing market demand for passenger cars in the Indian market. This case study illustrates the benefits and pitfalls of a JV, a substitute to outsourcing.

Fiat & the India Market

Fiat (Fabbrica Italiana Automobili Torino) is an Italian engine and automobile manufacturer owned by FCA (Fiat Chrysler Automobiles) since 2014. Fiat has a long history trying to penetrate the India market. First, in 1905 Fiat decided to import and sell its vehicle through its sales agent at the Bombay Motor Car Agency. In 1951, Fiat moved forward its interest in conquering the India market by entering into a license and service agreement with Premier Automobile. In 1995, Fiat established a wholly-owned subsidiary and presented its Uno model which received "the best-ever initial response for a new car in India" (Purkayastha and Abdul Samad, 2013:1). Right after, Fiat and Premier entered into a 51:49 joint venture. In 2001, repetitive labor and service issues as well as a severe strike forced Fiat to close its plant. In 2004 Fiat ended its JV partnership with Premier.

Tata Motors

Tata Motors (former TELCO, short for Tata Engineering and Locomotive company) is a leading multinational automotive manufacturing company based in India and part of the Tata Group. In India, Tata Motors is the leader in the commercial vehicles segment and rank among the top three players in the passenger vehicles segment. In addition of having seven manufacturing plants dispersed in the country, Tata Motors relies on a strong network with over 3,5000 consumer touch-points (dealership, sales, services, and spare part network) to stimulate its sales (Purkayastha and Abdul Samad, 2013:2). Through global acquisition, subsidiaries, and associate companies, Tata Motors has built over the years a global presence with operation in South Korea, Thailand, South Africa, Spain, and the UK (Purkayastha and Abdul Samad, 2013:2).

Tata – Fiat JV

In 2005, Fiat's situation in India is far from being great: they lost the Premier network dealership on which they relied to derive sales, and their brand image remains negative among Indian buyer, because Fiat cars are losing more value for resale than any other car manufacturer. Fiat's strategy is to find a local partner with market expertise on the car passenger market to penetrate the India market.

Tata Motors, on the other hand, continues its global expansion by "signing agreements with international players to manufacture and supply vehicles" (Purkayastha and Abdul Samad, 2013:2). However, the "Indica model needs new power train to compete with the newer models of cars being introduced in the (Indian) market and comply with newer environmental rules" (Mishra and Surendar, 2010). The cost estimated for designing a new engine was estimated at Rs. 1,500 Crore and the time delivery was between three to for four years.

Fiat and Tata Motors signed in September 2005 a Memorandum of Understanding (MoU) to explore opportunities in product development, manufacturing, sourcing, and distribution. Early 2016, Fiat and Tata Motors agreed to share 28 dealers network (25 Tata Motors dealers and 3 Fiat dealers) across 11 Indian cities. This agreement encompassed all passenger car available in the India market for both brands (Palio and Palio Adventure for Fiat, and Indica, Indigo, Indigo Marina, Sump, and Safari for Tata Motors). In exchange of its dealership network, Tata Motors would access to Fiat's technology and facilities such as the Kurla plant to paint the Tatamobile pickup.

In July 2006, Tata Motors and Fiat signed another MoU to establish the JV "FIAL" (Fiat India Automobiles Ltd.) to produce vehicles, engines, and transmissions for domestic and foreign markets of both brands. Kurla (Fiat's plant) is been moved to Ranjangaon to increase the facility capacity to produce over 100,000 vehicles, and 200,000 engines and transmission of both brands, while produced cars are sold through Tata Motors dealer network. This new agreement also encompasses the Iveco, Fiat's truck unit, that is now sold in Tata Motors dealer network. By forming this strategic alliance, Tata Motors increases its current offer with additional range of products. Relying on Fiat's expertise, Tata Motors enhances its product

line by improving the performance of its powertrains and aesthetics of its vehicles. Tata Motor also benefits from Fiat's production in Cordoba, Argentina, to penetrate the South America market for utility vehicles and pick-up (Purkayastha and Abdul Samad, 2013:3).

On October 2007, Tata Motors and Fiat signed a 50:50 JV which aims at using the strengths, objectives and values of both brands to better address global markets.

Expected Benefits from the 50:50 JV

Fiat's expectations from the JV is to improve its brand image, rely on a strong and successful dealership network, and profit from Tata market expertise to increase sales. Fiat also relies on additional revenue for sourcing components from its overseas operations to Tata Motor and learning their cost efficiency production process to better use resources and cut the manufacturing cost in the Ranjangaon plant (Purkayastha and Abdul Samad, 2013:3).

Tata Motors's expectations is to increase the production capacity for its Indica and Manza vehicles at the Ranjangaon plant as their manufacturing facilities are at full capacity. In addition, Tata Motors relies on upgrading its petrol engine technology by accessing to Fiat's latest engine technology the "1.3 Liter Multijet", and gains from Fiat's expertise in vehicles design to improve its current line (Purkayastha and Abdul Samad, 2013:3). Finally, Tata Motors expects to have market exposure in Europe and South America market using Fiat's manufacturing facilities and distribution network.

In 2006, the JV was giving great outcomes for Fiat; the dealership network increased to 42 in and planned to reach 100 in 2008 and Fiat's profits increased by 56% on the second quarter. In 2008, the Ranjangaon facility was ready to operate and produce the Grande Punto, Linea and Palio Stile Fiat's vehicles.

The end of the agreement

Tata Motors' expansion in the South America and European market has not been a success due to the quality issue in its vehicles (e.g. the Indica). Regarding the Indian market, Tata Motors omitted to display in the joint dealership the Petra of Fiat to avoid hinder sales of its Indigo model. In addition, it appears that the Linea was a challenger to the Manza and the Punto was in the same product category as the Vista. This cross-selling situation made dealers

to push Tata Motors' vehicles as they were cheaper and had a higher resale value (Purkayastha and Abdul Samad, 2013:6).

Fiat did not meet its sales projection and the JV did not break even in 2011-2012 as expected (Purkayastha and Abdul Samad, 2013:5). In addition of cannibalization of products between Tata Motors and Fiat, the low portfolio of product displayed by Fiat in the Indian market was insufficient to cover all segment of the market. By 2010, Fiat had sold only 47,000 units with vehicles being displayed in 175 dealerships across India. While Tata Motors sold 174,000 units between the second and third quarter in 2010, Fiats sold only 11,863 vehicles. Industry experts explain this poor performance: "customer still lack confidence in the Fiat brand due to its past successful entries into the Indian market, poor after-sales record, and lower resale value" (Purkayastha and Abdul Samad, 2013:5).

With Tata Motors acknowledging that the JV had improved the selling performance of the Vista and Manza with Fiat's engine, and Fiat's poor performance in the India market, Fiat decided to pursue the partnership but changing the terms. In 2013, Tata Motors and Fiat decided to end their agreement to sell Fiat's car through Tata Motors dealership network, but continue the manufacturing agreement at Ranjangaon plant. Fiat will from now sell its vehicles through its own dealership. In 2015, Fiat India Automobile has a net profit after tax of Rs 400.4 Crore (Baggonkar, 2015).

Conclusion

Fiat and Tata Motors JV demonstrates the gained benefits from a JV when the expertise from one brand complement the other brand and vice versa. The benefits from this JV include the market expertise of Tata Motors, the performance know-how of Fiat, and the economies of scale derived from the partnership. The JV also highlights the pitfalls of using economies of scope for function dealing for the end-user on similar products.

2.3 Business Intelligence

The IBM Centre for Applied Insights conducts an annual study about the major business technology trends that will impact the future of enterprises by surveying decision makers in the field. In its 2012 Business Tech Trends study, it has identified Business analytics as one of the 4 main trends for the future. Only half of the 1447 respondents had adopted business analytics in their business in 2012, while by 2014, already 70 % had done so (IBM Corporation, 2014). With the new trend of big data and the large amount of data available as

outlined in the Business Tech Trends report (2017), the importance of business analytics is magnified.

2.3.1 Definition

The term business intelligence is a very broad and poorly defined one that many scholars define slightly differently. Often, the terms business intelligence, competitive intelligence and knowledge management are used interchangeably (Agarwal, 2006), even though there are some nuances in the terms.

McGonagle and Vella (2002) define intelligence as "an analytical process that transforms tumultuously gathered competitor and market information into actionable knowledge about competitor's capabilities, intentions, performance, and position; as well as the final product of that process." Competitive intelligence uses public sources and analyses all the data collected in order to generate actionable information that is seen as a knowledge asset (Agarwal, 2006). Gilad (2011) argues that closely watching the competition can be a trap leaving companies missing out on important changes in the environment that can influence their business through new opportunities or risks. He is urging companies to focus on strategic intelligence. They need to concern themselves with making their strategy more unique and monitoring indications for changes threatening their unique strategic positioning, instead of following what competitors do.

Knowledge Management as defined by Macintosh, Filby & Kingston (1999) refer to identifying and analysing the knowledge assets and related processes that are available and those that are necessary and to plan and execute actions to develop those to achieve organizational goals. As knowledge assets mostly reside in people's minds, the people's participation and company culture are key to successful knowledge management. In today's world economy that is driven by information, knowledge assets as compared to physical assets are more and more important because they can bring most value to companies (Agarwal, 2006 citing Santosus & Surmacz, 2001).

Williams and Williams (2007) argue that BI is not just a standalone product, technology or a methodology. There are many BI products available; however, it would be a mistake to assume that these can simply be installed to solve all the problems a company is facing. BI involves a strong methodology and numerous technological tools such as data warehouse tools, relational databases and interface tools. BI needs to include a combination of all three

as well as organizational processes that allow the usage of this information to increase sales and profits and reduce costs.

SAP as cited in Agarwal (2006) states that BI "enables organizations to reach into their vast supplies of data and rapidly turn them into information for knowledge management".

Gerald Cohen, CEO of Information builders as cited in Dempsey (2004) suggests that business intelligence is "a way of democratising the process of extracting information from underlying data". It is a set of tools allowing non-specialists themselves to extract reports and data analyses to help them in their daily work without having to contact the IT department.

Companies engaging in selling IT solutions have strongly shaped the term Business Intelligence to fit their own products and thereby given an often solely technological meaning to it in order to fit their products. Some companies even use the term for describing any decision support system (Arnott & Pervan, 2005).

For the purpose of this paper, we will define business intelligence in a very practical way as the value that can be derived from a company's data through proper interpretation and usage.

2.3.2 Historical evolution

Historically, BI has evolved since the 1970s from Decision Support Systems to Executive Information Systems following high-level management's desire for better information. This need was tackled by improving IT solutions and the development of enterprise applications for managing resource planning, customer relationships and the supply chain. Since then, technology has advanced rapidly to become ever more powerful. In 2001, Peter Drucker (2001) noted that "information technology so far has been a producer of data rather than a producer of information".

Annie Green (2007) argues that nowadays companies collect large amount of data due to the rapid development in IT infrastructure and powerful data warehouses, but that without the right tools to use this data, the organization will be unable to deduct actionable insights and therefore will not be able to increase performance and profits. In order to use that data for making better business decision and developing better products in a faster and cheaper way, it needs to be accessible and retrieved in a form that allows usage to non-specialists (Green, 2007; Williams & Williams, 2007).

In the past, BI development has been driven by technology. Nowadays, a more business-centric approach to BI is being adopted because at its core, BI is about driving profits. In order to achieve this goal, business strategies need to be aligned with BI efforts and business needs to participate and take ownership in BI efforts (Acebo *et al*., 2013; William&Nancy, 2007).

2.3.3 BI benefits and success factors

By surveying 423 organizations in the US and Europe, KPMG (1999) has identified the outcomes that companies expect when engaging in BI activities. They are expecting that BI makes them better in making decisions, handling customers and responding to important business issues. Moreover, they believe that BI helps in improving productivity, employee skills, market share and profits, reducing costs, sharing best practices and developing new ways of working. Watson and Wixom (2007) argue that BI helps to diminish costs related to IT infrastructure through the consolidation of data marts. Additionally, they mention that having better information leads to better decisions being made and time savings of data suppliers as well as users. BI also helps to improve business processes and when used by mature users, can support them in strategic decision making and the achievement of strategic goals.

As mentioned above, BI necessitates alignment between business needs and the usage of the right IT solution to address these needs. To achieve this alignment, top executive support and sponsorship for BI projects and a clear strategic business vision are vital. Furthermore, data must be viewed as a cherished corporate asset and its use through analytics must be anchored in the organizational culture (KPMG, 1999; Watson & Wixom, 2007, Yeoh & Koronios, 2010). Moreover, an effective structure including processes, committees and people need to be put in place to govern and support BI efforts. For achieving the benefits mentioned above, people as the BI users need to have the appropriate access to BI tools, training and support to use the tools effectively (Watson & Wixom, 2007). Yeoh and Koronios (2010) similarly mention that change management oriented towards the users is key in implementing BI systems. They also add the importance of the quality and integrity of data in the source system as an important success factor for BI tool implementation. Smyth and Walker (2006) also suggest the implementation of 5 best practices for BI, namely the creation of a business information governance program, an enterprise information strategy, information quality programs, enterprise data warehousing and BI competency centres.

2.3.4 BI challenges

In their study, KPMG (1999) found that when comparing the expected benefits to the realized benefits, it can be noted that benefits have been realized, but that they are significantly lower than the ones that have been expected. KPMG argues that this might be due to the fact the companies often associate BI solely with technology and overlook the human aspect to sharing knowledge and best practice as well as the wider organizational impact of such activities. Yeoh and Koronios (2010) state that when the key success factors as mentioned above are not achieved, the implementation of BI systems is likely to fail. Smyth and Walker (2006) argue that the most important reasons for BI failing to achieve its objectives are the unwillingness of users to adopt BI, a lack of completeness and accuracy in communicating the requirements of business and the lack of connection between BI and performance management in the company. Watson and Wixom (2007) state that the most common reason for BI failure is the lack of data of high quality that is not trusted by the users.

2.4 Business Intelligence Outsourcing

In their paper on Outsourcing IT: The strategic implications, Willcocks *et al.* (1995) define IT outsourcing as "handling over the management of some or all of an organization's information technology (IT), IT systems (IS) and related services to a third party.

2.4.1 Potential benefits and challenges

The benefits of IS outsourcing can be divided into operational, tactical and strategic ones (Shang & Seddon, 2002) referring to Anthony, 1965; Hicks, 1997), Reynolds, 1992 and Schultheis & Sumner, 1989). IS outsourcing is mostly associated with the benefit of reduced cost and/or increased quality and effectiveness. Based on the "core competency" concept in strategy, companies should retain core activities in-house, while outsourcing non-core ones to vendors who can perform them better due to economies of scale, optimal capacity utilization, expertise specialization, access to a low-cost labour and the competitive forces in the market. On the tactical level, IS outsourcing allows for greater flexibility as it exchanges fixed costs associated with building capabilities internally against variable costs for the purchase of the activity as a service. This also allows for greater scalability in case of demand changes and gives access to the vendor's set of activities that is larger than the one of the individual company (Clark, 2012). Based on Schoemaker and Snyder (2009) and Brown and Eisenhardt (1997), Clark (2012) states that on the strategic level, IS outsourcing allows for dealing with

uncertainty as the vendor network can act as an intelligence-gathering network helping to understand changes in the firm's environment and giving quick access to new capabilities when they gain in strategic importance without developing them internally. Thomas (2009) argues that access to skills is an important benefit of BI outsourcing because keeping its IT people up to date on the technological development through training courses or the hiring of external experts is costly for companies. By outsourcing such activities, companies can buy-in expertise and skills from the vendor.

In their study, Willcocks, Fitzgerald and Feeney (1995) found that the major arguments against BI outsourcing concerned information confidentiality and ownership issues, the unwillingness to sacrifice the benefits of existing relationships between in-house IT groups and business user discontent with the cost/service levels provided by vendors. Furthermore, the management of outsourcing contracts can pose a challenge to management as it requires the capabilities to select vendors, negotiate and draw up contracts, manage relationships with vendors and with business users and their needs and to manage the evolving organizational needs.

2.4.2 Outsourcing decision factors

Willcocks *et al*. (1995) argue that for taking the right decision regarding which activities to outsource and which ones to keep in-house, a strategic approach to outsourcing needs to be adopted. Companies need to evaluate how IT and IS fit with the business activities and how they are managed. In doing so, there are several factors that need to be considered as illustrated in the table below:

2.4.2.1 Potential contribution to business positioning

Differentiator activities are the basis for differentiation between firms and for creating sustainable competitive advantage. An IS application becomes a differentiator when it is highly sensitive to competitive exposure, when it is important to retain intellectual property, when it requires a large amount of business knowledge and when the business environment is highly competitive. Commodity activities do not allow for any differentiation from the competition in performance and offering even though they are well executed.

2.4.2.2 Relationship of the activity/service to business strategy

Strategic activities are critical for the firm to achieve its objectives and future strategic direction, so firms need to retain control of these. Useful activities can incrementally contribute to a firm's bottom line, but do not influence its competitive positioning. Payroll

applications for example might be seen as mandatory in most industries, but they are not strategic. Also, in the PC industry, many software packages are "nice to have" items, but they are not mandatory and even less so strategic.

2.4.2.3 Uncertainty about long-term IT needs

Business uncertainty inhibits the prediction of the business' future environment and IT needs and therefore makes outsourcing risky, unless the outsourcing contracts involve very short-term engagements.

2.4.2.4 Technological maturity associated with the activity/service

A "user focus" is needed for situations with low maturity, when a technology is new and its specifications, functions and performance are still unstable, when an established technology is applied in a fundamentally new application or when there is little in-house expertise available for applying a certain technology in a certain application. A "specialist focus" can be applied in less problematic situations with clear goals when maturity is high. In this case, activities can be outsourced to IT specialists.

2.4.2.5 IT Integration level

Activities that interact with the organization's systems environment and its users through a simple technical interface can be isolated easily and therefore outsourced rather easily. Highly integrated activities that interact extensively and in a complex manner with other systems also interface with business users in a complex way and therefore impact the service level that they experience.

2.4.2.6 In-house IT capabilities compared to those available on the market

Activities where the organization has high in-house capabilities as compared to what is available on the market and where the tasks performed are of high added value are most likely to be kept in house. Activities for which the company lacks in-house capabilities and that the market can supply at a lower cost should be outsourced. Also, companies choose to outsource activities that add little value to the business such as for example data processing when considering opportunity cost.

Following the factors above, it can be said that outsourcing should be considered for non-core activities (commodities and useful activities) with low business uncertainty, high technological maturity and a low level of IT integration and little relative in-house expertise. In order to limit risk, short-term contracts of 1 to 5 years are preferable in the face of rapid technological change. On the contrary, core activities (differentiators, strategic activities) with

high business uncertainty, low technological maturity and a high level of IT integration and high relative in-house expertise should be kept in-house.

However, situations are rarely as clear as outlined above, which is why most organizations apply a selective approach towards BI outsourcing. Willcocks, Fitzgerald and Feeney (1995) found in their study that the key to successful BI outsourcing is to focus on a market logic instead of trying to outsource IT problems or simply outsource to save costs. Companies need to evaluate how the market can help them in achieving an organizational advantage and then they can selectively outsource only unproblematic, non-core activities that do not negatively influence the company's competitiveness. Even in a situation where all IT and IS are classified as non-core and therefore outsourced, certain IT/IS capabilities related to defining business demands and strategy and for managing contracts need to be kept in-house.

2.4.3 BI outsourcing readiness

Baars *et al.* (2007) have conducted a Europe-wide web based survey interviewing BI practitioners about their perceptions regarding BI outsourcing in order to determine a framework for outsourcing BI services. Among the 136 respondents, 66 % stated that BI is a crucial part of their business strategy. Companies mainly consider outsourcing because their in-house capabilities are deemed to be only "satisfactory" due to problems in the areas of data delivery from operational systems, BI tools manufacturer support and system integration. The survey has found that companies consider outsourcing only certain related to operations and maintenance of their infrastructure and software applications. However, they are largely sceptic about outsourcing activities that require an understanding of the company's unique IT environment or specific operational data and semantics of the business. The largest concerns voiced by the respondents related to data quality and security of business-critical data.

2.5 Airport industry overview

Graham (2008) defines airports as an essential element in the air transport system as they provide the infrastructure for enabling "passengers and freight to transfer from surface modes of transport to air modes of transport". By providing runways, apron space, taxiways, gates, passenger as well as freight terminals and ground transport interchanges, airports can accommodate airlines for landing and take-off. They also provide services including air traffic control, security, fire and rescue in the airfield and handling facilities allowing for passengers, their luggage and cargo to be processed in the terminals and to transfer between terminals and

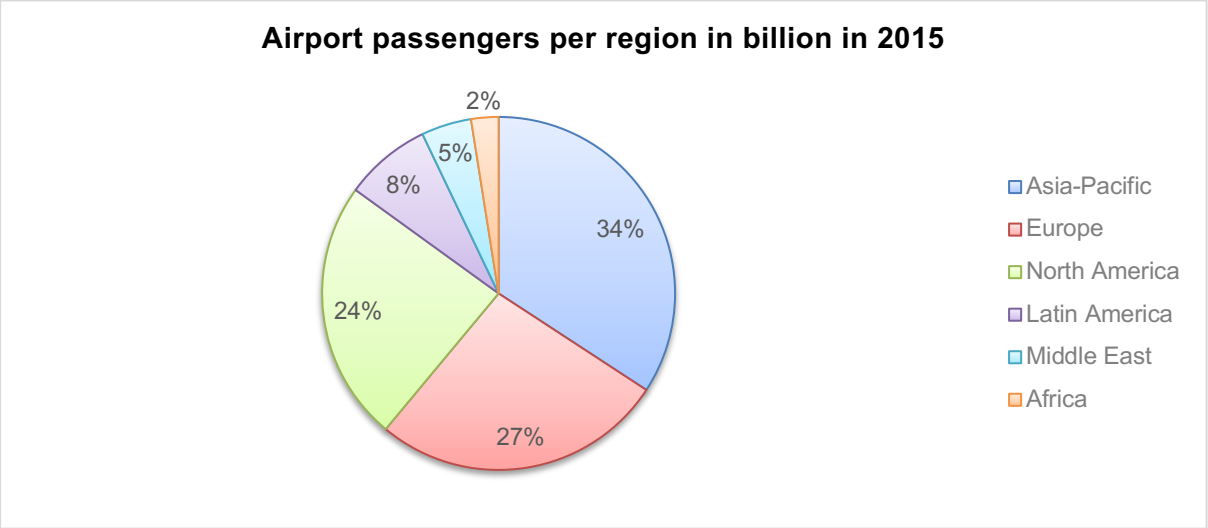
planes. Furthermore, airports host various commercial facilities including restaurants, shops, hotels, conference facilities and business parks.

Angela Gittens (2017), the director general of the Airports Council International (ACI) highlights the strategic importance and challenges of airports by stating that “airports play a crucial role in the economic and social health of communities, countries, regions and the world at large”. By providing connectivity, airports facilitate employment and economic development in the regions they serve, especially as they are becoming more and more integrated with the general transportation system through connections to high-speed rail and road networks. However, they also have to respond to the substantial changes that the aviation market is going through and operate in an environment that is increasingly competitive (Graham, 2008) (Gittens, 2017).

ACI’s World Airport Traffic Report reports that there are 41,788 airports including airfields and aerodromes for civilian as well as military purposes worldwide. 17,678 of these carry out commercial activities including the reception of airliners as well as business and cargo aircraft. The highest concentration of airports can be found in the United States (aeronewstv.com, 2015).

In 2015, almost 7.2 billion passengers passed through the world’s airports, representing an increase of 6.4 % as compared to 2014. The passenger numbers have grown in all 6 regions of the world with developing economies growing faster at a rate of 8.1% as compared to advanced economies‘ growth of 5.2%. This strong growth led to emerging markets capturing 44% of global airport passenger traffic. As illustrated in the graph below, Asia-Pacific, Europe and North America register 85% of global passenger traffic. Asia-Pacific and the Middle East are on a strong growth trajectory with 8.6% and 9.6% of growth respectively capturing an increasing share of global traffic. The top 30 airport cities in the world led by London (155 million passengers passing through 6 airports), New York (123 million passengers passing through 3 airports) and Tokyo (113 million passenger) handled nearly one third of global passengers.

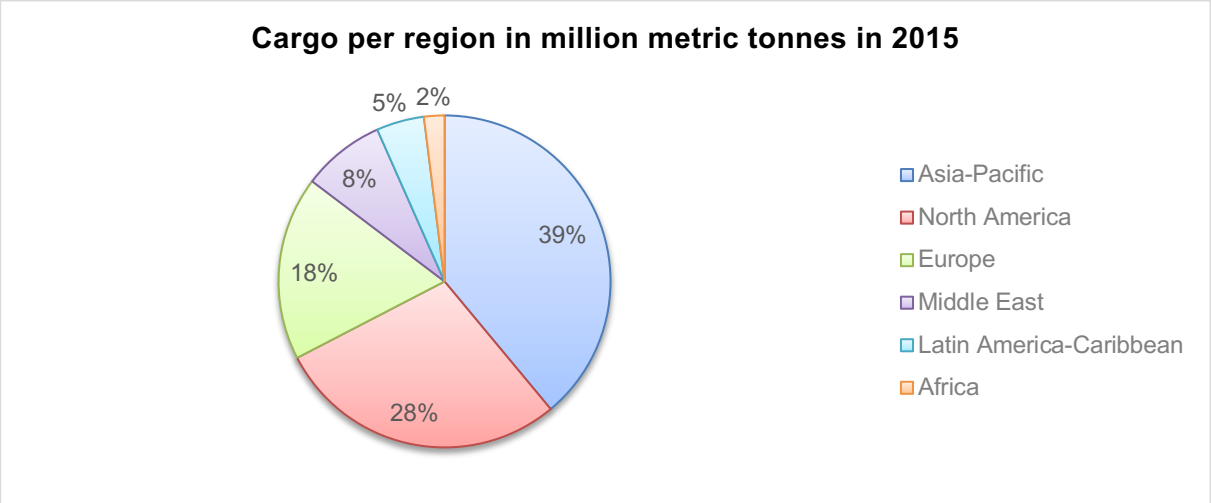
Figure 1: Airport passengers per region in billion in 2015



Source: Adapted after ACI World Airport Traffic Report, 2015

Global air cargo has grown by 2.6% to 106 million metric tonnes in 2015. As illustrated in the graph below, also when considering cargo volumes, airports in Asia-Pacific, Europe and North America capture 85% of global cargo traffic. However, the growth rates vary much more across regions. The Middle East airports lead the growth ranking with 9.9% growth followed by African and North American airports with 3.5% and 3.1% growth respectively. The Latin American airports have experienced a decrease in cargo traffic by 1.3%, while European airports registered a slight growth by 0.5%. The air cargo market is much more concentrated than the passenger market with the top 30 air cargo city markets led by Hong Kong (4.46 million metric tonnes of cargo), Memphis (4.29 million metric tonnes) and Shanghai (3.71 million metric tonnes) handling 58% of the world's air cargo (Airport Council International, 2016).

Figure 2: Cargo per region in million metric tonnes in 2015



Source: Adapted after 2015 ACI World Airport Traffic Report

The aviation industry has experienced continuous growth since the Second World War. However, the average annual growth rate has fluctuated between 5.1 and 2.4 between 1990 and 2005 due to economic downturns and events such as the Gulf War and the 9/11 terrorist attacks. The historical development of the airport industry has been closely tied to the one of airlines as those are the most important customers for airports. Since the 1970s, airlines have gone through major structural and regulatory changes because of privatization of airlines, globalization trends and the emergence of airline networks and airline deregulation allowing for low-cost carriers to enter the market. These changes have not only plunged airlines into a rapidly changing environment, but airports too had to adapt to the new economic conditions. Historically, airports have been under public sector ownership and subject only to national requirements. They have been subsidized by their governments to be run as public infrastructure entities. Nowadays, airports become more and more commercialized and moved from being public utility companies to being run like private companies with a strong business focus. Airports have moved from being simply infrastructure providers to entities providing facilities with the aim to meet their user's needs. Furthermore, many airports that have previously been State-run entities became privatized and the airport management as well as often ownership have been transferred to private sector enterprises entailing an increased focus on efficiency and service quality. With the increasing withdrawal of States from managing their airports, airport ownership has become increasingly diversified with new types of investors and airport operators such as infrastructure enterprises and financial investors entering the industry. Thereby, a previously national industry has become

dominated by privately owned and global players. These major changes in the industry strongly affected the operating mode of airports and its competitive landscape.

2.5.1 Airport privatization

In the 1990s, airports started to be privatized. Graham (2008) defines airport privatization as "the transfer of the management of an airport, and in many cases the ownership as well, to the private sector". Airports were traditionally seen as public infrastructure that had to be managed by States because they had strategic importance in the economic development and required large amounts of investments. Handing over airport management to the private sector has always been a politically sensitive topic as it appeared that States were selling out their national assets to private entities. However, the growing demand for air transportation and the resulting need for increased airport capacity paired with the reluctance or inability of States to finance major airport investments in many countries, led to privatization becoming a decent option for developing airports. The case for privatizing airports was built on the anticipated advantages of private ownership such as increased efficiency, better competitiveness, improved incentives for staff to perform well and wider share ownership that can be achieved when reducing government control and allowing an organization to diversify. The opponents of privatization insisted on the downsides of private-sector ownership including overcharging due to the creation of private monopolies, poor service standards, inadequate investment and a lack of consideration for environmental and social externalities. The increasing number of privatizations that have taken place since the 1990s have in many cases led to airports being managed in a market-oriented way delivering growth and increased profitability. Vienna airport, Brussels airport, Aéroport de Paris and many others across the world have turned into successful privately-run businesses. Depending on the specific goals pursued by privatizing airports, governments have chosen different modes for allowing private-sector involvement in the industry. These modes include share flotation, trade sale, concession, project finance privatization and management contract. They differ in the degree of control that is handed over to the private-sector partner, the type of partners that are brought on board and the time frame of the contract.

2.5.2 Airport revenue structure

Airports in general earn healthy profits. The leading 100 airport groups in the world registered an average profit margin of 16 % in the financial year 2006/07, which is rather high compared to the major 150 airlines who earned only a profit margin of 4 % on average. This profitability

gap between two industries that are strongly interdependent can be explained by the much stiffer competition that airlines face compared to airports as well as by the general lack of airport capacity in many countries, while airlines are facing overcapacity which is pushing prices down. Moreover, airports have a more diverse revenue base as they derive not only passenger-related revenues, but also revenues from other customers such as shops, conference centres, and many more. Due to this diversification, airports are less affected by economic downturns and changes in fuel prices, which strongly affect airlines. However, airports are required to invest heavily to provide the infrastructure required to run an airport.

In order to raise money for investing into infrastructure, airports derive revenues from two main areas. Aeronautical or aviation revenues include passenger fees, landing fees, aircraft parking fees, handling fees and other aeronautical fees such as lighting, air bridges, air traffic control, etc. These fees are directly related to the operation of aircraft and the processing of freight and passengers and therefore depend on the number of aircraft and passengers that pass through an airport. Non-aeronautical or commercial revenues include rents, concessions, direct sales of catering, shops and other services offered by the airport operator, recharges for water, electricity and gas, car park revenues and other commercial revenues such as business and visitor services, consultancy, property development, etc. A study of the revenue and cost structure of European airports shows that between 1983 and 2007, the average aeronautical revenues have decreased from 59 to 52%, while the non-aeronautical revenues have increased steadily from 41 to 48 %. On the cost side, labour costs have decreased from 46 to 33% due to the outsourcing of certain services to external providers or due to a more productive workforce in some cases. Depreciation and other operating costs complete the large picture of the costs that airports face, while depreciation has remained rather stable and other operating costs have increased strongly from 36 to 47 % of an airport's total costs. The revenue and cost structure of individual airports can vary considerably though as it depends on the type of activities that the airport performs and the amount of staff that is needed to perform these and also on national regulations as to which charges are allowed.

There are several factors that significantly influence airport profitability. Firstly, the **volume and nature of traffic** are essential. When passenger and freight volumes increase, the cost per unit decreases. Moreover, the nature of traffic plays an important role. Hub airports register peak and through times in their traffic, which makes it more difficult to handle traffic, and consequently increases cost. Airports that handle mostly leisure passengers face the problem of seasonality and uneven capacity utilization which also increases cost. Airport

handling international passengers compared to domestic ones also incur higher costs due to the additional space, installations and personnel needed for customs, etc. However, these passengers usually also spend much more time and money in airport shops, which leads to most international airports' strong focus on commercial revenues. Another major influence factor is **economies of scale**, which can be achieved especially by smaller airports. In large airports, the potential for economies of scale are limited due to the need for replicating services and facilities in different terminal buildings. Furthermore, the **service level** that airports provide to its customers strongly influences their cost structure, which is why many airports have created specific terminals for example for low-cost airlines in order to adjust service levels and cost structures for different customers. Airports also face costs related to their location and geographical situation related to environmental restrictions such as night traffic restrictions and specific weather conditions necessitating the provision of additional services such as snow removal and de-icing facilities. Also, the **differences in accounting practices and tax regimes** in different countries make it hard to compare airport profitability internationally.

2.5.3 Challenges facing airports

2.5.3.1 Airport competition

Even though airports enjoy rather monopolistic business environments in many countries and locations, most of them are in competition for airlines and passengers with other airports nearby. Especially point-to-point and secondary airports increasingly come under pressure because point-to-point players, who are primarily low cost carriers (LCC), are flexible and can move away their operations rather easily to improve their profitability. By threatening its airports to withdraw traffic, they can exercise significant pressure to keep fees low or refrain from introducing new fees and taxes. Hub airports usually enjoy a more favourable situation as they have symbiotic relationships with their hub airlines, meaning that switching airports is very difficult for them (Malighetti, Paleari, & Redondi, 2016). The operations and airline marketing business unit at Nice Cote d'Azur Airport is marketing the airport as an attractive destination for airlines from all over the world. By offering different incentives and promotional schemes, the airport needs to retain its competitiveness compared to its most important competitors, namely the Venice, Geneva and Barcelona airports.

In their paper, Bao *et al.* (2016) cite accessibility, the number of air routes, per capita income and GDP as the main variables influencing airport development. Airport accessibility is a main decision criteria when choosing air transportation as opposed to other modes of land

transport. Airport destinations that can be reached by passengers in a cost-effective, fast and convenient way through land transportation are more competitive than those lacking advanced infrastructure and connectivity. The importance of the external transport system becomes apparent especially in locations where the general road and rail networks are not well established. In these circumstances, an improvement in the external transportation system by 1 % can bring an improvement of 2 % in passenger numbers and airport competitiveness. For improving the external connections, airports are increasingly aiming to integrate other means of transport such as rail and bus services to establish themselves as multi-modal transport hubs.

2.5.3.2 Commercialization through new technologies

Airports are under increasing pressure from their shareholders and airline customers to be profitable and offering competitive prices at the same time. Focusing on the development of commercial revenue can help to achieve both objectives. New technologies have greatly facilitated this trend at airports. Mobile internet started to being used for travel information search in 2000 and since then, many airports have adopted this innovation and use applications to communicate with passengers, sell additional services such as car parking, food and beverages, foreign currency and other goods to them and tailor their customer experience. Nowadays, most airports offer free wifi and mobile applications to optimize customer interactions and develop commercial opportunities (Martin-Domingo & Martìn, 2016). While passengers can use these for free, the big advantage for airports is the collection of data related to these services. At Nice Cote d'Azur airport, for example, passengers are required to input whether they are visitors or residents at the Cote d'Azur and where they come from to access the free wifi. This gives the airport valuable insights on its user structure that it would otherwise not be able to collect.

Airport terminal beacons are another innovative mean for driving commercial revenue. Beacons are small devices installed around the airport that allow to broadcast information to be used by apps for staff and passengers. Beacons can send notifications such as welcome messages, notifications about flight departure time, baggage arrival and many others. As they allow to define a passenger's location, they can push information for example about special promotions when a passenger comes into the proximity of a certain shop or about additional airport services that are available nearby. Furthermore, in combination with for example the airport's mobile application, beacons facilitate indoor positioning and provide information

such as the walk time to the gate, the location of airport staff as well as estimations of security check queuing time (Airports Council International).

2.5.3.3 Passenger flow management

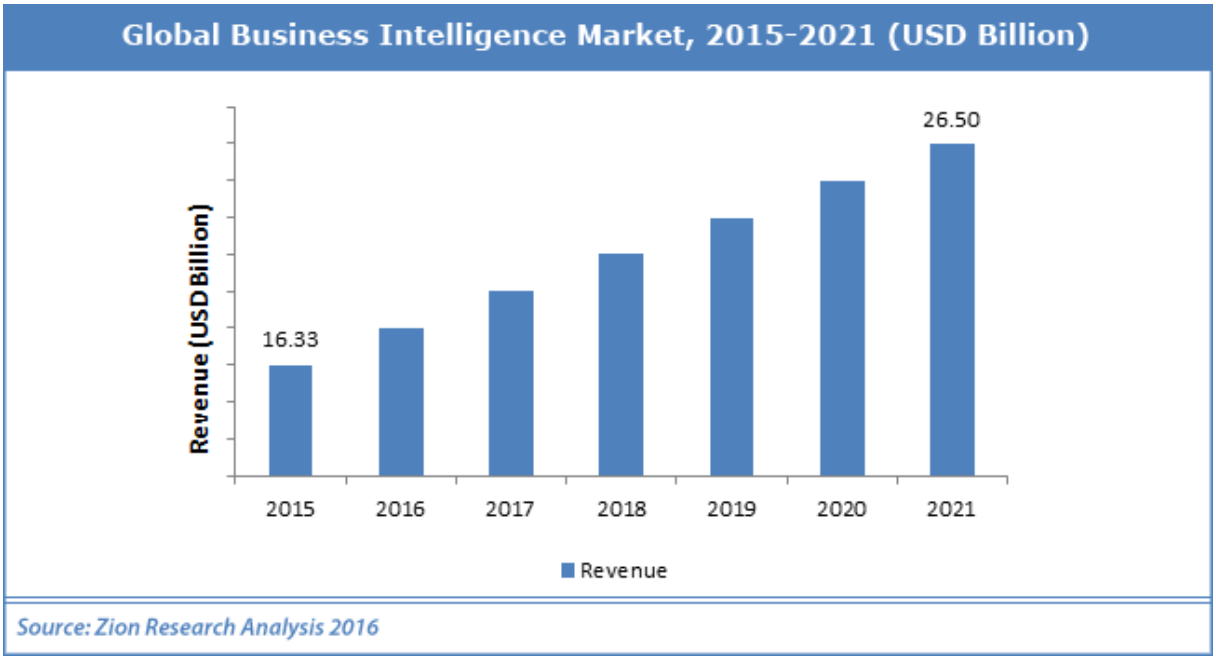
Keeping passengers moving through the different checkpoints and areas within an airport is a major challenge. Agglomerations of people in specific places within airports, such as the check-in and baggage drop counters and the security checkpoint represent potential security threats. The terrorist attacks at Brussels and Istanbul airports have showcased that the clusters of people in these unsecured zones of airports are vulnerable as potential attackers can come to these zones carrying firearms or other weapons without any difficulty. However, keeping passengers moving briskly is not only important for avoiding security threats. Long waiting times when queuing for check-in, baggage drop and the security check and the hassle of removing coats, shoes and electronics, liquids and gels from hand luggage are major reasons for passenger dissatisfaction. In their article, Karp and Nensel (2017) present innovations that could allow to make check-in and security procedures much safer and faster in the future. Sophisticated computer tomography technology already used for medical applications could provide 3D images of passengers and the content of their hand luggage without taking out any items. Using this technology, security screenings could be performed on the go with passengers hardly stopping on the way through the airport. Sophisticated algorithms can identify suspect passengers who can be check in more detail in a dedicated location without interrupting the flow of people. Furthermore, biometrics could be used to identify passengers and replace boarding passes and passports in check-in and boarding. Self-service kiosks for checking in already exist at many airports, however, in future, also self-service baggage drop will become a reality. Through innovation, the touchpoints between the passenger and the airport are diversified and spread out, which allows for passengers moving fluidly through the airport and a providing a better customer experience. The technologies mentioned above are currently being tested and whether they will be adopted on a large scale by airports across the world largely depends on regulatory approval (Karp & Nensel, 2017).

The challenges mentioned above and many others that airports are facing can be addressed by leveraging data. Business intelligence is an important source of competitive advantage when it is exploited to increase sales, generate customer intimacy and improve profitability.

2.6 BI market sizing

According to MarketsandMarkets, business intelligence and analytics is the sub-market of the IT industry that is growing the fastest at a compounded annual growth rate of 8.4%. From 17.9 billion USD in 2014, the market is expected to grow to 26.78 billion in 2019 (Schmidt, 2016). Gartner (2017) estimates that the revenue achieved related to Business Intelligence and Analytics globally will grow from 18.3 billion USD in 2017 to 22.8 billion USD in 2020. According to Zion Market Research (2016), the global market for business intelligence will expand from 16.33 billion USD in 2015 to 26.5 billion in 2021 as illustrated below.

Figure 3: Global Business Intelligence Market Forecasted (USD Billion)



The global BI market size is forecasted differently by different market research companies. However, it can be said that the market amounted to about 18 billion USD during 2014/2015 and is expected to grow to a range from 22.8 to 26.78 billion USD by 2020. Also, the different companies agree that the market will be growing strongly in the near future.

The market is highly fragmented and the top vendors in the market are: Oracle 16.4 %, SAP 13.1 %, IBM 10.3 % followed by Microsoft, SAS, Teradata, Salesforce.com, Adobe, Tableau Software, Informatica. Together these top 10 vendors serve nearly 65% of the market (Vesset *et al,* 2016)

2.6.1 Airport BI

2.6.1.1 Airport IT spending

According to Airports Council International (ACI), airports generated revenues of 150 billion USD in 2015 compared to 134 in 2014. 5.21 % or 7.8 billion of this revenue has been spent on information and communication technology. For 2016, ACI has forecasted further airport revenue growth by 5.3 % to reach 158 billion and projected global airport IT spend to reach 9.07 billion, representing 5.7 % of total revenues. Between 2012 and 2015, airport CIOs have witnessed a growth in their budgets by 8.41 % (compound annual growth rate) outstripping the growth of airport revenue of 6.36% during the same time.

2.6.1.2 Business Intelligence in airports

A SITA survey (2016) showed that today, airports use business intelligence mainly for 2 goals, namely operational efficiency by locating airport resources, increasing non-aeronautical revenue, improved reporting, etc and improving the customer experience by providing more accurate information to passengers. For achieving these goals, airports have already or plan to implement new technology initiatives, of which cloud technology, sensors, Wi-Fi transmission via Hotspot 2.0 and Near Field Communication are the most important ones. The key outcome of BI at airports is increased revenues through better resource planning, customer experience, customer loyalty and decision-making as well as the monetization of better customer management, increased passenger spend and concessions performance.

Most airports are still at the beginning of this journey to increasing value through investment in BI. In the 2015 Airport IT trends survey conducted by SITA (2015), it has been found that only 36% of airports use BI tools to optimize and manage revenues, about 30% use them to improve operations and better utilize airport resources, 27% use them to manage passenger flows, 25% for baggage operations and around 19% for improving airport security. These numbers are forecasted to increase drastically until 2018. By then, the BI adoption rate is forecasted to double and triple for some applications. The most important investments are planned for managing passenger flows and optimizing revenues with more than 80% of airports planning BI initiatives in these areas.

3 Research Proposal

3.1 Research Question

As outlined in the literature review, there is a strong rational for outsourcing certain BI tasks for diverse reasons promising different benefits and posing strategic challenges. There is a general lack of research on BI in the air travel industry and none related the make versus buy decision of BI tools for airports. In this research, we want to investigate the specific BI outsourcing environment in the airport industry. The focus is on investigating the historical development of the use of BI tools for a sample of airports to understand the influence factors that lead to the decision of outsourcing or keeping in-house certain BI activities.

Our research question is: What are the make versus buy decision factors of BI activities in airports? Which airport specificities are influencing the choice of outsourcing versus in-house BI development?

We aim to test the following hypothesis that are based on both literature review and interviews conducted with airport experts allowing us to understand the specificities of BI in the airport industry:

- Small airports are more inclined to outsource BI than large airports

  The only study conducted examining the correlation between outsourcing and the size of companies in the literature has found that SMEs are more inclined to outsource compared to larger companies[1]. Our objective is to compare the results of this study with BI outsourcing in the airport industry. In addition, our first interview with Nice airport (small airport) confirmed the hypothesis as they outsource their BI activities. We decided to test this hypothesis for the other airports to either confirm or reject the hypothesis.

- The constrained airports (in terms of expansion potential) focus more on BI than unconstrained ones.

  As such airports cannot grow their traffic due to the geographical constraints from being surrounded by cities, villages or the sea, they can only increase revenue from increasing their operational efficiency. We understood from our interview with Nice airport that this airport is constrained by both Nice city and the sea. In order to drive

[1] Please refer to Arbore, A. and Ordanini, A. (2006). "Bradband divide among SMEs: The role of size, location, and outsourcing strategies" *International Small Business Journal* Vol 24(1): 83-99

additional revenue, this airport must optimize its existing resource and relies on BI to increase both its revenue and better manage existing resource. As seen in the literature, BI is used in airports mainly for operational efficiency and customer experience improvement. We believe the expansion constraints factor is interesting to study, as it could be useful for BI vendors to know if the expansion constraint is a decision factor for outsourcing. Finally, the fact that our airports sample contains both constrained and unconstrained airports is allowing us to test this hypothesis. From our sample, Nice, Philadelphia and Frankfurt airport are defined as constrained, and Brisbane airport is defined as unconstrained.

- Airports facing high competition focus more on BI than those having a lower competitive environment.

  The literature informs that the market environment for airlines as well as for airports is becoming increasingly competitive and that competition strongly drives strategic decisions[2]. Therefore, it would make sense for airports that face high level of competition to invest in BI for customer experience improvement and operational efficiency to grow customer traffic and satisfaction. On the other hand, airports facing little to no competition can afford to not be excellent in customer experience and operational efficiency as the customers do not have the option to switch to another airport.

- Airports focusing on non-aeronautical revenue (retail, real estate…) have stronger focus on BI than those focusing on aeronautical revenues (fees related to planes landing and departing).

  As indicated by Graham (2008)[3], aeronautical revenues are driven by the number of planes that start and land at an airport. This number is strongly related to the attractiveness and business activity in the region around an airport. Non-aeronautical revenue is derived from all other non-airplane related business generated at airports including retail shops, real estate, etc. It is expected that this type of revenue can be optimized through the use of data. By using for example passenger flow data, airports can optimize the placement of shops at locations where certain types of passengers

[2] Please refer to Graham, A. (2008). Managing airports - An international perspective (Vol. 3rd edition). Oxford: Elsevier Ltd. and Gittens, A. (2017, May). Message from Angela Gittens. ACI World Report, pp. 6-7.

[3] Please refer to Graham, A. (2008). Managing airports - An international perspective (Vol. 3rd edition). Oxford: Elsevier Ltd.

pass. Also, by using passenger date, they can make tailored offerings to travellers for additional on-site purchases relating to car parking, lounge access, etc.

3.2 Research Objective

The aim of our research is to find whether there is any divergence from the general decision factors as outlined in the literature that are specific to the airport industry.

By testing the different hypothesis, our objective is to explore specificities of the industry and derive a make versus buy framework for BI software in the airport industry.

Our research intends to provide BI airport managers a framework to make more informed decision when deciding to outsource versus in-house developing. Our research also aims at providing BI software vendor the decisions factors that influence the sales of industry-specific BI software.

3.3 Research Methodology

The literature review includes the make versus buy decision, business intelligence and business intelligence outsourcing. The airport industry is also defined and explained for better understanding of the industry.

To answer the research question, the case study approach is used. The group of study is founded on a convenience sampling approach from personal and professional networks. Case studies will be drawn up based on interviews with key people. Interviews conducted are semi-structured with a section discussing the general environment of the airport and another section discussing the business intelligence. Although the interviewees were asked the same questions, we are open in exploring other aspects impacting airports' decision factors and adjust our hypothesis. The research encompasses four case studies:

- Nice Cote d'Azur Airport
- Frankfurt Airport
- Brisbane Airport
- Philadelphia Airport

The use of several case studies is justified to allow cross-case analysis for richer theory building. The cross-case analysis is based on Miles and Huberman's (1984,1994) work to

manage and present qualitative data. The benefits of using this methodology is that it is a "highly systematic method, that allow the inclusion of diverse evidence types and that can be used for theory-building" *. The methodology consists of three steps: data reduction, data display, and conclusion drawing.

Also, semi-structured interviews with people from other functions in the airport industry have been conducted to gain knowledge of their expertise and validate or refute findings from case studies.

To ensure design quality of the research, external validity and the reliability of the data collected are examined. External validity is about generalization of our findings to the entire airport industry. To improve the external validity of our data, we interviewed different people originated from a variety of places at a different time. The interviewees have different characteristics (gender, age…) but have in common at least ten years of experience in the industry. The interviewees come from different place: the USA, Australia, the EU. Finally, the first interview occurred end of May 2017 and the last interview occurred mid-October 2017. To improve the reliability of the data collected, interviews have been recorded and summarized within the next three days to avoid data bias and notes have been sent to interviewees to be approved.

3.4 Data Analysis

To analyse case studies insights, the cross-case analysis method is used to allow interpretation across case studies. First, the data reduction allows to narrow the data to answer the research question. The data display reflects the "compressed assembly of information that permits conclusion drawing" (Cruzes et al., 2014). The conclusion drawing, and verification ensure that the design quality of the research is respected.

3.5 Limitations

Limitation of our research includes the convenience sampling approach based on accessibility. Another limitation is the number of airport studied. With only 4 (representing 126 million of passengers per year) out of the 17,678 airports involved in commercial activities, further investigation with a larger sample is needed to achieve generalizability of the findings and confirm our recommendations.

*For more information on the cross-case analysis, please refer to Miles and Huberman work: Qualitative Data Analysis: A sourcebook of New Methods (1984) and Qualitative Data Analysis (1994)

4 Case study analysis

4.1 Nice Cote d'Azur Airport

Interviewees: Jean-Pierre Torres, Head of IT systems department
Delphine Le Sec'h, Head of Airline Marketing
Anne-Marie Tran, Business Intelligence Manager

Date and time: 29th May 2017, 17.00 – 18.15
23rd June 2017, 17.00 – 18.15
23rd June 2017, 16.00 – 17.00

4.1.1 Airport general environment

4.1.1.1 General airport description

Nice airport is an international airport and the second largest airport in France managed by the Aéroports de la Côte d'Azur group that also manages Cannes Mandelieu and Saint-Tropez airports. The group has taken over the 60% stake in the airports formerly held by the State in 2016 and has a concession until 2044. The other shareholders are the Chamber of Commerce of Nice-Côte d'Azur at 25%, the region Provence-Alpes-Côte d'Azur at 5%, the department Alpes-Maritimes at 5% and the metropolis Nice Côte d'Azur at 5% (Dupont, 2016). The group is also the second largest in Europe for business aviation with facilities accommodating private jets and helicopters. It has welcomed a steadily increasing number of passengers over the years from 10.4 million in 2011 to 12.4 million in 2016. Nice airport benefits from its privileged location at the heart of the Côte d'Azur with large amounts of tourists visiting every year. It offers direct flights to more than 100 destinations including direct flights to Singapore, China, Canada and the USA (Aéroports de la Côte d'Azur, 2015).

The airport employs around 600 people, however considering also people employed by sub-contracting companies, there are 5000 people working at the premises.

4.1.1.2 Revenue structure

Aéroports de la Côte d'Azur boasts an annual turnover of 231.6 million € in 2016 and divides its business into 4 business units, namely Operations and Airline Marketing (including commercial aviation), Commercial (including retail shops, parking, etc.), General Aviation (including private and business aviation and the helicopter activity) and Cannes Mandelieu

Airport. About 60 % of revenues are derived from aeronautical activities, while 40% of revenues come from commercial development, retail shops, parking, etc.

4.1.1.3 Competitive environment

Nice is a "point-to-point" airport, meaning that passengers come to Nice as destination and not for connecting to other flights as in hub airports. Due to its geographical location within a strong tourist region, the airport is the largest in France outside of Paris. It also has a considerable catchment area from Marseille to Geneva that is densely populated with people who can afford air travel. However, due to its location directly at the sea front and surrounded by urban areas, the airport is constrained in terms of expansion. It faces competition especially for long-haul flights and incoming passengers from long-haul flights from airports such as Marseilles, Milan and Lyon. It also competes with other airports of European cities that are attractive tourist destinations and have a large catchment area such as Barcelona, Geneva and Venice.

Since 2014, cost reduction is a top priority at the airport which is why BI becomes more and more important.

4.1.2 Business Intelligence

4.1.2.1 Definition, place within the company

At Nice airport, BI is used on one hand for operations e.g. reporting and on the other hand for decision support and simulations. It is used only for internal data in order to find correlations between the different types of data collected through the many airport systems including exploitation data (related to aircraft management), luggage data, passenger data and commercial data (parking, retail stores, restaurants, etc.).

There is one person within the IT department that is responsible for BI. She is responsible for constructing a BI system based on the user's needs. She also supervises the infrastructure and supports it internally, acting as the interface between the internal users and the external partner Keyrus providing BI infrastructure and functionalities development.

4.1.2.2 Historical development

Nice airport started to implement a BI infrastructure in 2008, starting with a marketing application for reporting purposes followed by a resource exploitation application for managing flights, fees, etc. Currently, an application for baggage handling is being built.

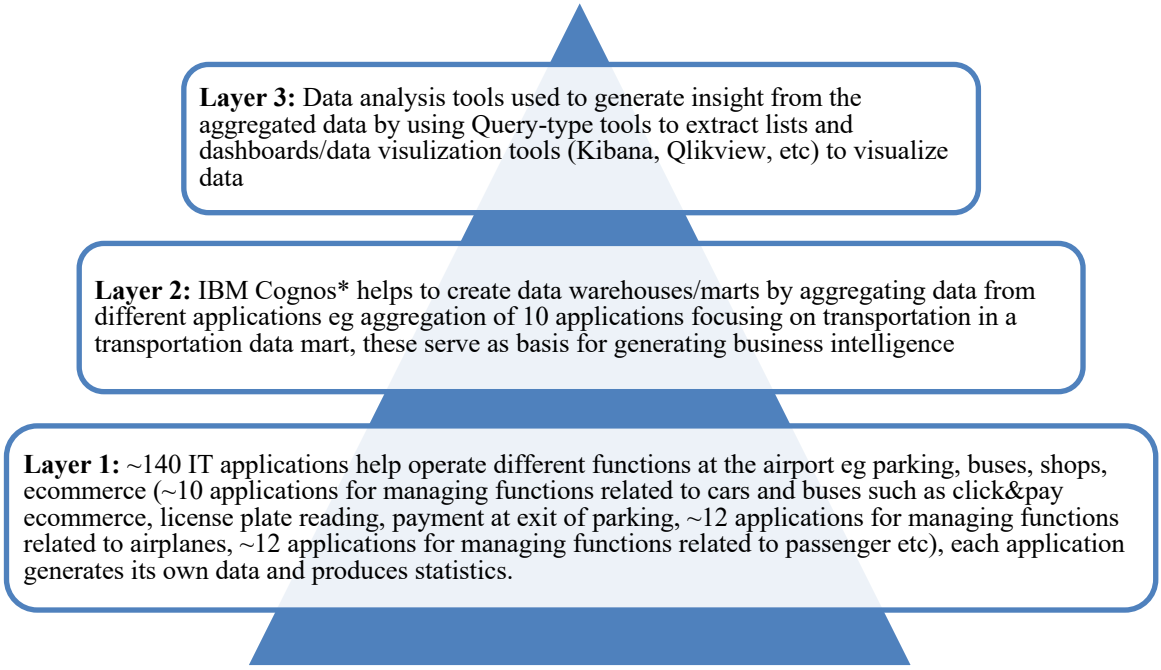
BI at the airport has developed very slowly as the airport manages to attract airlines and passengers due to its favourable location in a tourist region. Only since 2017, the company

has established a data steering committee that decides about how to use what part of the data that is collected every day at the airport.

4.1.2.3 BI systems used

Nice airport uses IBM Cognos infrastructure to aggregate the data from its around 140 IT applications running at the airport into different data warehouses. Based on the data in these warehouses, data analysis tools and visualization tools are used to extract insights in the form of lists and dashboards. The illustration below explains the 3 layers of IT at the airport in detail.

Figure 4: Nice airport IT system layers



Source: Torres, Jean-Pierre, 2017

The objective is to use BI outcomes to increase passenger spending by personalizing the offer to them, to know which products/service offerings are appreciated, to use limited space and resources most efficiently and to reduce costs through optimal resource allocation e.g. allocation of security personnel by forecasting demand for specific times of the day

4.1.2.4 Outsourcing vs internal production

Nice airport itself does very little development in-house due to limited IT resources. There is only 1 software developer internally who develops minor applications. The airport's 140 applications are either purchased as off-the-shelf solutions where systems that are meeting the requirements exist or otherwise are developed by external companies such as Sopra Steria, Cap Gemini, Avisto, Keyrus according to the airport's specifications and needs. The main

outsourcing partner is Keyrus who buys licenses from IBM and sells those as well as software development services based on IBM Cognos to the airport. The BI infrastructure is also maintained by Keyrus and the other external companies, but the applications are internally managed (for 90% of them). Furthermore, data analysis is conducted internally because it is essential to understand the business well to arrive at the right conclusions and it would take much more time to explain the business background to an external person. Furthermore, it is important to keep control over data.

4.1.2.5 Outsourcing factors

- Off-the shelf availability of applications satisfying the BI needs
- Reliability of potential outsourcing partner due to the strong dependence of the airport on the outsourcing partner.
- Control over data

4.1.2.6 BI Budget

No information received to date

4.2 Frankfurt airport

Interviewees:	Oliver Weber, Manager Business Intelligence administrative Jacqueline Dechamps, Manager Business Intelligence operative
Date and time:	16th August 2017, 13.00 – 14.30 4th October 2017, 3.30 – 9.30

4.2.1 Airport general environment

4.2.1.1 General airport description

Fraport AG is one of the leading global airport businesses offering a full range of services for managing airports. It is a publicly quoted company owned by the State of Hesse (31.32%), Stadtwerke Frankfur am Main Holding GmbH (20%), Deutsche Lufthansa AG (8.44%), Lazard Asset Management LLC (5.05%) and 35.19% of its shares are free float (Fraport AG, 2016).

The company's home base is Frankfurt airport (FRA), which has handled more than 60 million passengers and 2.11 million metric tons of cargo in 2016. The airport's facilities include a total of 4 runways and 2 terminals with another terminal being planned. The airport

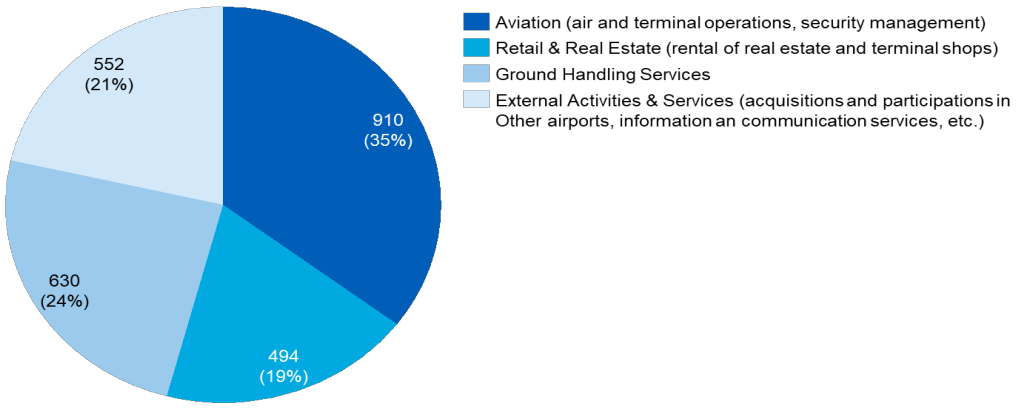
welcomes 96 passenger airlines serving 97 countries globally with 299 different destinations. The majority of these destinations are outside of Europe and 55% of passengers are transiting through Frankfurt airport, highlighting its role as a major hub in the global air transportation system with the highest transit rate among European airports. It is the largest hub in Germany, 4th busiest airport in Europe as per passenger numbers and 2nd in terms of cargo handling and the 10th largest airport in terms of international passengers globally according to Airports Council International's (2016) figures. Due to its central location in Germany, it boasts the biggest European airport catchment area with about 50% of the German population living within 200 km around the airport (Fraport AG, 2017).

Apart from Frankfurt airport, Fraport AG has majority and minority participations and management contracts with several airports on 3 continents. Fraport AG fully owns Ljubljana airport and between 50 and 70 % of the stakes in Lima, Burgas/Varna and Antalya airports. Furthermore, it has up to 30% stakes in Hannover, St. Petersburg and Xi'an airports and a full concession for 14 Greek regional airports including Thessaloniki (Fraport AG, 2016).

4.2.1.2 Revenue structure

Fraport group has generated revenues of 2.59 billion € and a profit of around 40 million € in 2016. It is an integrated airport group providing all services needed at an airport such as ground handling itself. The business activities are divided into 4 main segments as illustrated below. The strong push for international expansion since the last 7 to 8 years has led to a strong increase in revenues for the Fraport Group.

Figure 5: Fraport AG revenue structure 2016 (in million €)



Source: adapted after Fraport Annual Report, 2016

The Retail and Real estate part of Frankfurt airport's is considered a main part of the business as the airport is a real commercial "city" attracting not only people flying from or to Frankfurt, but also the local population.

4.2.1.3 Competitive environment

Frankfurt airport is very competitive as an international hub due to its central location within Europe. It is very well connected to other cities by high speed train, which is an advantage for its position as a logistics hub. It is in direct competition with Munich as the second main hub in the area and other smaller German airports in the Rhein-Main area such Cologne Bonn, Düsseldorf Frankfurt Hahn and other regional airports. These airports benefit from the rapid expansion of low-cost carriers coming to their airports diverting especially more and more business traffic from Frankfurt airport. As low-cost companies are flexible, move fast and can easily offer new targeted programs for different passenger groups, they create a rapidly changing market environment. Frankfurt airport as of today does not process any low-cost carriers and is therefore losing especially business passengers. As the airport does not want to be overtaken in the competition for business passengers by its neighbouring airports, it wants to open up to low-cost carriers by accelerating the timeline for the expansion of a part of Terminal 3 aiming at processing low-cost carriers there.

Furthermore, it is in direct competition with hub airports worldwide. As passengers tend to choose airports with modern facilities and a better offer for their connecting hubs, Frankfurt is in competition with luxury airports especially in Asia and on the Arab peninsula. Frankfurt aims at becoming a 5* airport focusing on passenger well-being and comfort.

Airports in general are facing the challenge of optimizing their processes to keep up with changes in passenger structure and their behaviour. Frankfurt airport sees its passenger numbers increasing as more and more passengers fly due to the inexpensive prices offered by airlines. They become increasingly price sensitive and selective when choosing their connecting airports, which is especially important for business travellers. Aircraft are increasing in size leading to airports seeing a decrease in arrivals and departures. These changes in the environment prompt airports to adapt their processes to fit the new needs. Frankfurt airport faces other challenges. It is operating at capacity today and faces environmental constraints as well as a limited capacity for expansion due to the villages surrounding the airport perimeter. As the airport has grown organically over time, passengers often need to cover long distances to get to their connecting flights and accept long queues when waiting at the gate or to pick up their luggage. Even when trying to improve these pain

points, the airport faces the constraint of its integrated business model. As the airport is responsible for all airside, landside and ground transport activities, optimizations can only be possible with a strong focus on the whole picture rather than on single processes. Example: A full optimization of the distance travelled by passengers might be annulled when the ground handling cannot match the speed for logistic reasons. When passengers arrive at their connecting flight fast, but their luggage is not there yet, the optimization of the distance is annulled by the additional waiting time passengers face at the gate.

4.2.2 Business Intelligence

4.2.2.1 Definition, place within the company

From the administrative point of view, Oliver Weber defines BI as primarily used for consolidating, enriching, capturing, analysing, categorising and visualizing data through many different tools/systems.

From the operative point of view, Jacqueline Dechamps defines BI as a data-driven approach that allows to gain insights for the company that are then translated into concrete recommendations, decisions and actions.

Within Fraport AG there are 2 different BI teams.

- **Administrative BI** is about predicting, planning, maintaining, cost reporting, revenue optimization and is a function close to strategy and controlling. The team produces reports concerning process optimisation related to real estate, retail shops, airport fees, airlines coming to the airport, etc. for internal clients. These reports address questions such as “Which airlines will be coming to the airport in the future generating which amount of revenue?”, “At which gate should certain types of passengers arrive?”, “How can shops adapt their special offers to the types of passengers that arrive?” eg. Russian tourists should arrive at a gate that is close to luxury boutiques, shops can run promotions on take out breakfast when busy business travellers are coming to the airport in the morning, etc. The team consists of about 15 members of which half are former SAP corporate consultants. The entire team has a business administration background rather than a technical one because the most important is to understand internal as well as general business management processes. There only few technicians because SAP software is easy to use.
- **Operational BI** deals with operational data such as aircraft movements, passenger information, ground operations data, etc. and aims at optimizing processes. The team

analyses operational data to understand the internal client's pain point and gives recommendations for improvement based on data. Typical questions include "How can the waiting time at the security check point be reduced?", "How can the distance to be travelled by passengers for catching their connecting flight be optimized?", etc. The team is about the same size as the administrative BI team. Half of the team are developers and programmers specializing in certain IT and programming languages. The rest of the team is mostly focusing on process consulting. However, also the technical people are in customer contact and participate in the end-to-end support of the internal clients from needs definition to execution.

Both teams are situated in the IT department. The administrative team is located in the IT area that develops, runs and supports the SAP modules (BW, Netweaver, etc.) and the operational BI team is located in the IT area that plans, develops and runs the operational airport systems. Additionally, there is a new transversal virtual BI analytics/data science team (Smart Data Lab) consisting of people from both BI teams and mathematicians focusing on optimizing the mathematical models used in diverse operative personnel disposition systems. This team is activated on demand and deals with questions touching at different domains.

4.2.2.2 Historical development

The BI topic has strongly risen in importance at Fraport AG since 2000. There are much more possibilities today as hardware is getting cheaper making the storage and loading of data fast and inexpensive.

The operative BI team has strongly grown in an organic way since 2004 when it was introduced and has strongly changed its focus point over time. The team started with 3 people and today counts 14-15 people.

The team started by doing "classical" BI, processing and analysing data from the day before, comparing different time horizons in the past.

However, only 3 months later, the focus already changed and people wanted to know what happens today, so Frankfurt airport was one of the first airports to move to real-time processing (data processed within max 5 min) and away from classical BI.

Until today, the operative BI team is being strongly solicited with demands from internal clients. Today, they demand BI to predict what will happen in the future based on past data and simulations, where statistical models help to build scenarios.

4.2.2.3 BI systems used

The administrative BI of Frankfurt airport is based on a data warehouse and SAP software using the NetWeaver suite of products allowing for planning, consolidation and therefore the preparation of the annual reports. 98% of the software needs are covered by the SAP suite, while the remaining 2% are covered by Smart notes software allowing for digitalisation of the annual reports, which is not possible in the SAP suite of products.

Operative BI at Frankfurt airport is based on a SAS data warehouse that has been developed together with SAS since the 1990s. BI is developed using the programming language SAS base and covers 90% of the operative BI needs (servers, computing power, interfaces). The rest is developed using R, which is a programming language used for statistical computing and allows for a rather mathematical statistical approach to BI. It is used at the airport because many of the internal customer groups are familiar with this language.

The operative BI team has also developed 2 specific interfaces themselves as they did not find the right tools in the market.

- API in Java for visualizing an interactive airport map with real-time aircraft movements for operative employees (based on data from data warehouse)
- Interface for an application aiming at predicting passenger flows at critical process points e.g. security check to improve passenger well-being and reduce stress in the terminal. The application can predict with 98% certainty how many people will be at a certain point of time in a certain check point within the airport. Employees then use this information to tell people how they can get through the checkpoints faster.

Within Fraport, 40 IT systems are connected to the data warehouse and operative BI system, including the airport operational database (AODB), ground handling services, passenger information, aircraft handling information, luggage, etc. There is also some external data that comes into the data warehouse e.g weather data, some data from SAP about settled/charged flights, baggage, cargo and sometimes airline data, but only in project mode for a limited time as airlines in general do not want to share their proprietary data.

Operative BI encompasses 2 major blocks of activities:

- Data processing control (ETL – extract, transform, load) represents 80% of BI efforts. As raw data never comes in a perfect form, the BI team needs to harmonize and adapt the data to fit a common structure and naming. Example: incoming and outgoing

aircrafts appear as one character in a certain column, but in different systems, they are called A and D for arrival and departure, in another I and O for inbound and outbound and in another one 1 and 0 mean the same. Here, the data needs to be adapted to fit the common A and O naming when bringing together different data sources.

- Processing, report and graphs production and automated decision recommendations represent 20% of BI efforts.

There is no integrated approach to connecting the administrative and operative data warehouses until now. They run parallel and only on demand they are joint on a project basis for a limited time.

4.2.2.4 Outsourcing vs internal production

Today, all IT infrastructure for Frankfurt airport is held internally in server centres on the airport premises. Also, all development regarding BI internally is conducted by Fraport AG employees within the BI teams with hardly any help from external consultants.

Fraport outsources first level support for IT problems related to administrative BI. Simple support and maintenance tasks can easily be outsourced, however when more specific software problems occur, then the internal teams working on the specific area provide second level support. Example: a report from the administrative BI team gives wrong numbers, then the team has to provide support.

There are several reasons why Frankfurt airport chooses to conduct BI in house:

- Keeping data in house is the best way to protect them and avoid high exposure to data security risks. As the airport is handling confidential data, the law (European and German data security regulations) is obliging it to protect them.
- The BI topic and teams have developed organically within the company. By producing it in house, the teams could react fast to client demands and allow for fast decision taking and thereby add high value to the business.
- Frankfurt airport's BI is strongly tied to SAP and SAS as data processing has been developed base on their technology, so a significant effort would have to be made on migration and a transition would entail high costs
- For BI to work, internal knowledge is crucial. Employees can accumulate knowledge and transmit it to their colleagues, while external consultants often leave after their mission without transmitting their knowledge. They can take it with them and potentially even sell it to other companies.

However, producing BI in house entails high cost because BI technology changes fast and updating servers is slow and costly and because employing several teams of BI specialists adds high personnel costs.

The BI market in general is moving towards standardization and the cycle of technological innovation in the BI space is shortening, meaning that outsourcing could become interesting in the future when significant potential cost savings would be higher than the inconvenience and cost related to migration.

4.2.2.5 Outsourcing factors

- Order of magnitude of the business and cost/benefit definition: This can be dependent on the size of airport, e.g. a small airport with only few flights per day do not need an AODB and sophisticated IT if movements can be tracked with an Excel or even only on paper. Sophisticated IT being imposed on Fraport's small Greek regional airports would make no sense.
- Business model: depending on the airport's business model, business intelligence will have a different importance.
    - Passenger type and volume: transit hub would be expected to do more BI than a regional airport
    - Airports with high annual revenue would focus more on BI than those with lower revenue
    - Airports focusing on providing a high level of service would focus on BI
    - Airports with an integrated business model (all airport services provided by the airport as opposed to by airlines themselves) need to focus on BI to optimize processes
    - Airports focusing on real estate revenues necessitate large BI efforts
- Consulting effort needed: When close internal customer contact is needed, airports will find it difficult to outsource
- Human Resources: The ratio of total employees to people in IT to people working on BI could give an indication about whether airports are more likely to outsource or produce BI in-house. At Frankfurt airport this ratio is 20 000 : 400 : 25 employees.

Jacqueline Dechamps believes that a good mix between total outsourcing and total in-house production needs to be found in the future. Infrastructure that is standardized can be outsourced, while BI content and development should remain in house. It might even be possible to outsource/near shore (within the EU) the data processing and harmonization part

(80% of BI effort) if this could be done by specialist companies at a lower cost. By buying this software as a service from a specialist company, the airport could significantly save on personnel cost and gain flexibility. Today this is not yet possible and its future feasibility will depend on how the new European regulation on data security will play out regarding which information can be exchanged. The challenge is to ensure data protection in a fully digitalized world.

The options to go to the cloud or use software as a service is being observed and might get interesting in the future when significant cost savings would justify a migration.

4.2.2.6 BI budget

The budget spent on BI varies year on year and depends on whether there are major investments in new database themes or other big projects. The order of magnitude of annual BI spending amounts to tenths of millions per year, representing about 1 % of revenue.

The largest part of these costs is related to manpower and licenses as there are not always large infrastructure projects ongoing. The costs on the operative BI side are only related to the business intelligence competence centre, so IT related to BI only. However, additionally there are people in the business areas that are also dedicated to work on BI, such as data scientists, etc.

4.3 Brisbane airport

Interviewee: David McDonnell, BI Manager at Brisbane Airport Corporation

Date and time: 6th July 2017, 23.00 – 00.30

4.3.1 Airport general environment

4.3.1.1 General airport description

Brisbane airport (BNE) is operated by the Brisbane Airport Corporation and the 3rd biggest airport by passenger numbers in Australia after Sydney and Melbourne. The airport is located on the East coast of Australia in the state of Queensland and handled more than 22.5 Million passengers in 2016 flying to 76 international and domestic destinations with 29 airlines. Since 1997, the airport is privatized under a 50-year lease with an option for renewal of 49 more years and operates without any public funding for infrastructure projects. The Brisbane Airport Corporation is owned to 81% by Australian institutional investors, Queensland Investment Corporation, a state-owned institution, being one of them. Moreover, Amsterdam

Airport Schiphol owns 18.7% of the stakes in BAC bringing in substantial international airport operations expertise. Since the privatization, the airport has experienced a strong growth in total passenger numbers from 10 to more 22 million in 2016 (BAC Holdings Limited, 2016).

The airport facilities include a domestic and an international passenger terminal, a general aviation and a cargo terminal, an apron as well as two runways. The airport is growing strongly with passenger numbers being forecasted to more than double by 2034. Therefore, the airport invests heavily in infrastructure projects including a new parallel runway, access and carpark facilities, an expansion of the terminal, road improvements, new aeronautical and apron facilities as well as numerous new commercial buildings (Brisbane Airport Corporation, 2017).

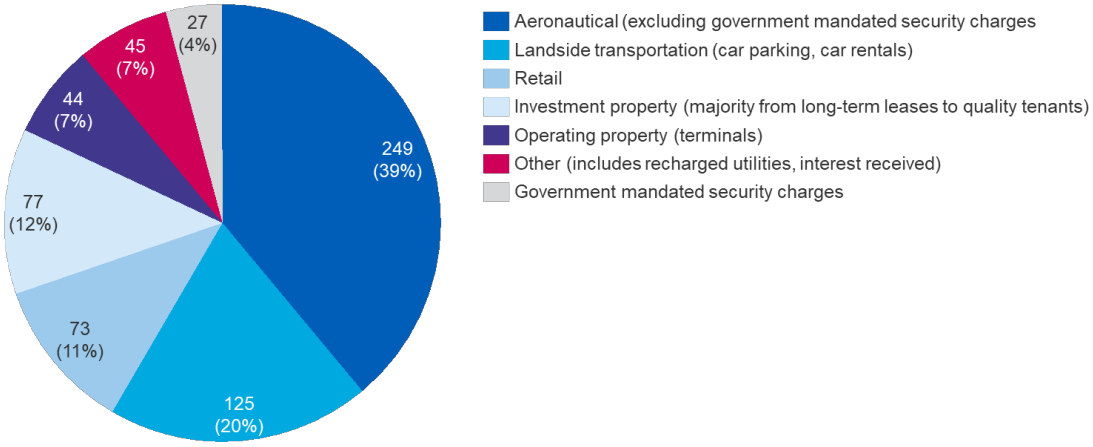
Figure 6: Brisbane airport location and destinations

Source: Brisbane Airport Corporation, 2017

4.3.1.2 Revenue structure

In 2016, BAC has generated total revenues of 640 million $, which come from different areas of the airport's business as illustrated in Figure 6.

Figure 7: BAC Holdings Limited revenue structure 2016 (in million $)



Source: adapted after BAC Holdings Limited Annual Report, 2016

The airport's focus is on growing aeronautical revenue by attracting new airlines to come to Brisbane, which explains the strong investment plans. Moreover, the car parking part of the business is a second focus point as off-airport car parking business are increasingly posing a competitive threat to the airport's parking business. Furthermore, improving customer experience, the passenger spend rate and patronage from car parkers are major goals for the future.

4.3.1.3 Competitive environment

Brisbane airport is strongly dependent on tourism as the Gold coast is a popular tourist destination. The airport faces strong demand leading to congestion at the airport, which is why the airport has large investments planned to expand. Brisbane is a comparatively expensive airport for airlines, just after Sydney, as there is a large amount of infrastructure investment ongoing that needs to be financed through increased airport fees. The airport faces strong competition from the much smaller Gold Coast airport, 100 km South of Brisbane, welcoming 6.4 million passengers annually. This airport focuses on offering relatively low airport charges to attract airlines and increase passenger volumes.

4.3.2 Business Intelligence

4.3.2.1 Definition, historical development and place within the company

Brisbane Airport Corporation follows a business approach to data and treats data as a valuable asset. The importance of business intelligence is showcased by the fact that the BI function is location in the strategic planning and development department and the business development

sub-department, rather than in IT. Before 2011, the BI manager had only a partial BI role working in operations dedicating 40% of his time to BI activities. After a restructuring and a new CIO coming in, he has been brought into a full-time BI role in strategic planning. Today, the BI team consists of 4 people including the BI manager, Analytics Lead, Business Analyst and Data warehouse Developer.

The airport's BI manager defines BI as helping business users with information needs – providing good quality business information to the right people at the right time. Thereby, it helps business managers to make fact-based decisions and ultimately to improve business performance.

The core functions of BI at the airport are:

1. Providing information to the various business and commercial units to improve business performance and support data requirements for the corporate planning department
2. Insuring that the planning function across the airport has data that supports the medium to long-term planning process across lots of metrics such as runway performance, passenger busy hour, corporate planning cycle, etc."

The BI team provides internal technical support and links business user requirements to infrastructure. They coordinate efforts and provide reporting and programming based on the corporate data warehouse (CDW) that is in their scope of responsibility.

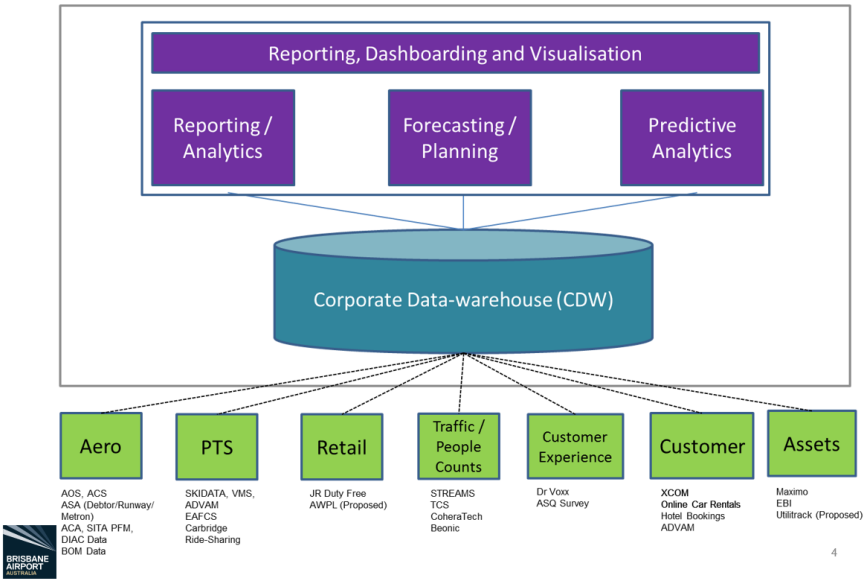
4.3.2.2 BI systems used

There are many different and disparate IT systems used around the airport including flight operations, car park ticketing systems, taxi & ridesharing systems, property management, online booking systems and operational systems to name a few. All of these systems are COTS (custom off the shelf) systems and typically provide line of business functions – many of these contain transactional datasets which are very valuable for post-analysis and to understand past performance.

Where the BI team ultimately assists the business is with integrating the various data sources captured from within these IT systems to improve data insights and to improve decision making across the organisation. For example, passenger numbers and flight movements are key pieces of information which can be joined with retail point-of-sale data sets and car parking transactions to determine metrics such as PSR (passenger spend rates) and ATV (average transaction value).

The CDW bring together the data generated by the different systems mentioned above. It is key to ensuring that data is captured and stored consistently in a central repository that serves as the single source of truth. On top of the data warehouse, different tools are used to make use of the data and deliver insights to end users. The main BI tools used is IBM Cognos including dashboard functions, a self-service analytics studio and traditional reporting. Furthermore, a scorecard tool as well as Microsoft Power BI are used to complement Cognos BI functions.

Figure 8: Brisbane airport BI environment



Source: McDonnell, David, 2017, Brisbane Airport Corporation

4.3.2.3 BI challenges

There is a strong internal demand for more configurable self-service tools and improves access to data across the organization. To achieve this, the airport is in the process of introduction Qliksense, a tool allowing for highly flexible data discovery. The challenge of allowing wider access to data is a potential issue concerning source of truth, which is why the process is being tested carefully with 20 power users before being rolled out to all employees.

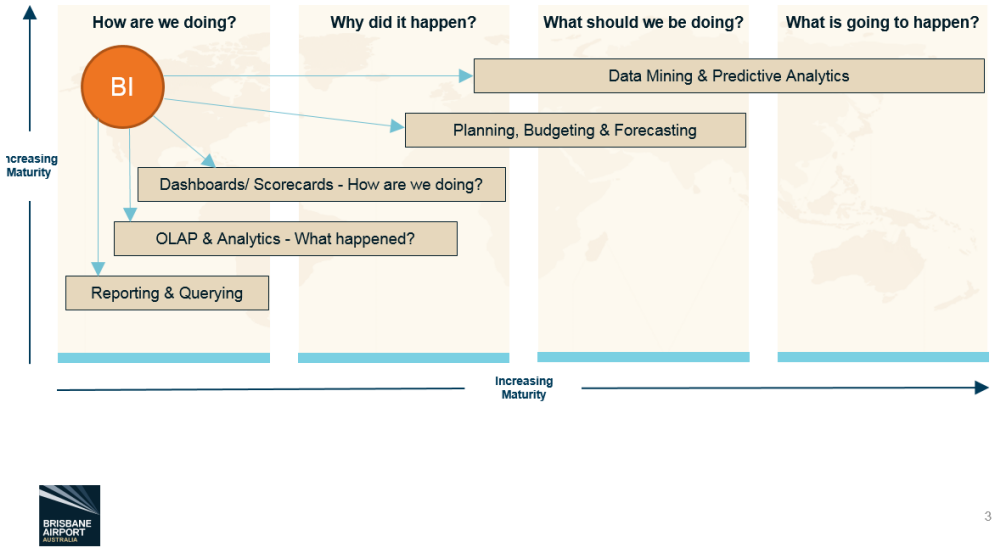
The airport also has a yield optimisation initiative concerning the car parking business underway. Based on data from the CDW, the initiative aims ait providing what-if scenario analysis concerning parking pricing.

Moreover, at Brisbane airport has launched an initiative about BI systems feeding the planning system as these could be theoretically linked. However, operationally this is

currently not possible due to the different intervals of information used in both systems. BI systems generate data on a daily or weekly basis, while the planning cycle requires a quarterly feed. Furthermore, the data is checked before loaded into the planning cycle for which different tools are used in a process that is not automated. Therefore, short-term planning (3-12 months horizon) is conducted using Beontra software, which provides infrastructure companies an integrated corporate planning system.

These initiatives aim at moving towards the predictive dimension that BI can provide when a company gains in BI maturity as illustrated below.

Figure 9: Brisbane airport - How we use our corporate BI data



Source: McDonnell, David, 2017, Brisbane Airport Corporation

4.3.2.4 Outsourcing vs internal production

BAC outsources BI infrastructure, but keeps the functional part in-house. The infrastructure and IT components are hosted internally, but an external provider takes care of backup, availability and online as these are core IT tasks that can be easily outsourced. Decision-making tools are produced internally, however, similarly as for infrastructure, the support and maintenance for this software will be assured by a contracting company. The data warehouse is, however, supported internally by the BI team.

They also contract with a local BI consultancy company to assist with backlog and new project initiatives as required when internally capacity is lacking. Currently the pipeline of work is very strong as the airport is embarking on some interesting initiatives such as predictive maintenance (leveraging the data captured within the CDW) and the Utility

forecasting model. For such large projects, external consultants are brought in to cover the extra effort needed.

4.3.2.5 Outsourcing factors

- **Specialization:** Once upon a time BAC supported BI internally, but the focus of the IT team has moved from activities such as hands-on server hosting, etc. to more functional activities. As BAC did not want to be an IT company, the decision was made to outsource to a specialist that would be better able to fulfil these activities
- **Cost & Risk:** The BI manager was not sure if outsourcing is really less expensive, but it removes the need for support people and also reduces risk.
- **Security:** Data security is a big focus area at the airport and there are a lot of firewalls in place and security is heavily scrutinized across the board, not only in the data space. When data is outsourced there is a security risk, but by choosing a trustworthy partner and with good controls in place this risk can be mitigated.
- **Focus on internal knowledge:** In a pure outsourcing scenario, the risk is that the internal knowledge needed to make sense of data gets lost.

4.3.2.6 BI Budget

No information received to date

4.4 Philadelphia International Airport

Interviewee: Lindajoy Harris, Strategy and BI Manager at Philadelphia International Airport

Date and time: 11th October 2017, 18.45 – 19.45

4.4.1 Airport general environment

4.4.1.1 General airport description

Philadelphia International Airport (PHL) is a public airport, owned by the City of Philadelphia, and operated by Philadelphia Department of Commerce. It is the 19th largest airport by passenger in the United States with over 30.7 million of passengers in 2014 (Philadelphia International Airport, 2015:18). PHL is located in the southwestern section of the City and north-eastern section of Delaware County. PHL covers both domestic and international markets that include the United States, Canada, Europe, Latin America, Middle East and the Caribbean. PHL is both a hub and a point-to-point airport. PHL is a large air

traffic hub for American Airlines and a regional cargo hub for UPS Airline. PHL is also defined as a point-to-point airport as PHL passengers are going to Philadelphia as a final destination for leisure and business.

The airport is composed of seven terminal units totalizing 3.3 million square feet with facilities including ticketing areas, baggage claims area, passengers hold rooms and 185 retail, food and service establishments. PHL has six active cargo facilities. PHL also benefits from two parallel, one crossing, and one commuter runways as well as interconnecting taxiways. Since 2006, PHL aircraft operations have declined due to mergers and consolidations of airlines, the increase in load factors, and the decrease of take-offs and landings. But despite the decrease in aircraft operations, passengers level at PHL remains stable (Philadelphia International Airport, 2015:87).

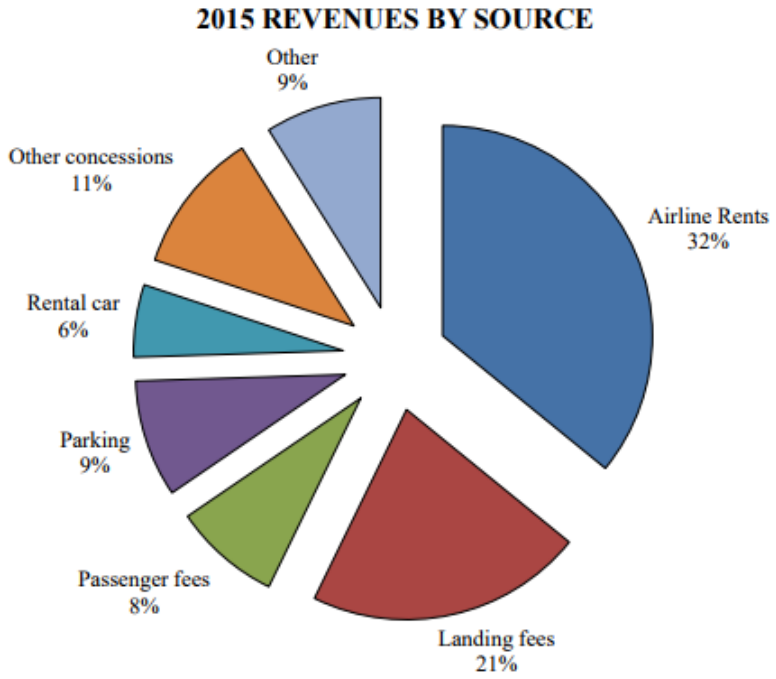
4.4.1.2 Revenue structure

In 2015, PHL has generated total revenues of 322 million $, which come from different areas of the airport's business as illustrated in Figure 2.

Operating revenues increased by $6.9 million (2.2 percent) in 2015 due to an increase in rent, and passengers higher than the decrease of concession revenue and landing fees. The airport's non-operating revenues decreased by $1.3 million (36.8 percent) in 2015 due to the decrease in government grants. Last years recent increase in passenger volume generated additional revenue to invest in infrastructure despite the small percentage of the price ticket that goes into infrastructure maintenance. As PHL is one of the most aging airports in the United States, the airport is highly dependent on funding decisions. However, the funding outlook for the airport is hopeful in terms of improving airport infrastructure since the recent Trump election.

Due to industry growth overall, the airport has projected growth in passengers but decline in operations. The decline in operations is projected to be due to airline companies aiming for minimization of their operating costs by reducing operations to optimize capacity and to be more cost efficient. Nevertheless, PHL remains an attractive location for airlines to establish new routes and adapt to their customers' demand. PHL uses an integrated business model and provides services that are either run by the airport or by the airports' tenants or paid by the airline.

Figure 10: Philadelphia airport – Revenue structure



Source: Annual Financial Information, 2015, Philadelphia International Airport

4.4.1.3 Competitive environment

PHL's passengers are well divided between leisure and business. PHL benefits from its localization with no major airport facilities within a one-hour drive. Baltimore/Washington International Airport and Newark Liberty International Airports are PHL's main competitors. Since the 2004 Southwest Arline partnership, PHL has improved its competitive positioning and is able to offer lower airfares and stimulate air travel demand. Since 2009, the number of originating passengers at PHL has exceeded Baltimore/Washington International Airport (Pezzimenti and Pancholy, 2010:4). PHL's competitive positioning is however highly dependent on its airlines partnership.

4.4.2 Business Intelligence

4.4.2.1 Definition, historical development and place within the company

Philadelphia International Airport is in the early phase of its BI development. It is currently in the process of gaining data awareness, data cleaning, and some data is integrated. The BI function is located under the Strategy Department. However, PHL's efforts on BI are increasing, which is illustrated by the opening of a Chief Technology Officer position aiming

at trying to understand the sense of existing data. The BI team consist of 3 people including the future Chief Technology Officer, a Strategy BI Manager and a Business Analyst.

The airport's BI manager defines BI as a strategic partner in challenging existing assumptions, better understanding the business and its environment, as well as the passengers and employers to generate additional revenue and reaching operational excellence while reducing its costs.

The core expectations of BI at the Philadelphia International Airport are:

1. Providing passenger driven data to the various businesses and commercial units to growth passenger revenue
2. Use process driven data to provide excellent customer service at reduced cost

The BI team relies on the future Chief Technology Officer to develop the technology needed for the existing infrastructure.

4.4.2.2 BI systems used

PHL does not have a fully integrated BI system at the time of the interview. The airport uses an airport management system built by the IT team in-house. This system allows PHL to analyse passengers and employees' satisfaction through surveys.

4.4.2.3 Outsourcing vs internal production

PHL is internally developing the BI infrastructure through the IT staff and the future Chief Technology Officer. However, the IT tasks are outsourced to an on-site team from Venice Consultant since at least ten years. The IT team is developing in-house IT system. PHL also uses external contractors to support their consultants to develop the IT system. Contractors choice depends on the IT team's needs e.g. out-of-the-box versus tailored system for coding part. PHL occasionally contracts external providers for specific IT systems.

4.4.2.4 Outsourcing factors

- **Time & Capacity:** Time represents how urgently the product/service is needed. Based on the required deadline, as well as internal man power capacity, time and internal capacity become a factor for deciding to outsource or develop the product/service in-house.
- **Cost**: Cost helps to decide also if the product/service must be outsourced.

4.4.2.5 BI Budget

No information received to date

4.5 Case study findings

4.5.1 BI definition

Nice airport defines their BI as a system allowing to find correlations between the different types of data collected at the airport. Brisbane airport defines their BI as a tool that assist the business users with informational needs to make fact-based decisions and improve the overall business performance. Philadelphia airport defines their BI as a strategic and operational partner to challenge assumptions and make more informed decisions based on data. Frankfurt airport defines their BI as a tool primarily used for consolidating, enriching, capturing, analysing, categorizing and visualizing data through many different tools/systems. They identified 2 types of BI: administrative BI which covers the predictive, maintaining, and planning analysis and the operational BI which covers the take off and landings, gate information, passenger processing and flow management.

Bernard Raoux's definition (portfolio strategy manager at Amadeus Travel) of BI sums up the different definitions encountered in the case studies and divides them in 3 distinct groups.

1. **Analytics around market dynamics** including competition landscape, competitor performance, etc. An airport cannot do this type of analysis alone because they need industry data, e.g. GDS data sold by Amadeus, Sabre, IATA, etc. Market dynamics are especially important for new routes development for an airport to decide which airlines to attract to add profitable routes to its network. Airports can try to build their own estimates, but as externally much more data is available, it is much simpler to buy this insight.
2. **Understanding airport operational performance** including gate management, delays, service quality, etc. Airports need to bring together data from various systems on a platform to be analysed. This is mostly done internally using infrastructure from IBM, HP, Microsoft, Oracle, Terradata etc. to save costs. As performance/operations are driven by the same parameters in all airports, this can be outsourced.
3. **Understanding the traveller** including who he/she is, nationality, needs, profile, leisure vs. business, family vs. single, age, etc. This helps to improve personalized merchandizing to them (upsell parking space, lounge access, shop discounts, fast track, etc) and improves negotiations between airport and shop owners by giving them intelligence about their potential clients. Today, airports only have one way to

understand travellers, which is by doing surveys in the airport. This, however, is costly and represents a very limited sample of travellers.

It can be observed that the BI definition as defined by interviewees embrace the definition as cited in the literature but is more specific for airports with concrete example of what their BI system does. In addition, as highlighted by Bernard Raoux, three types of BI can be observed, in the airport industry whereas in the literature review there is no differentiation between different types of BI.

4.5.2 Hypothesis regarding BI differences between airports

4.5.2.1 1st Hypothesis: Small airports are more inclined to outsource BI than large airports

- Nice airport is considered as a small airport (handling 0-20 million passengers) and its BI infrastructure is 100% outsourced
- Brisbane airport is considered as a medium airport (handling 20-40 million passengers) and its BI infrastructure is partially outsourced and in-house developed
- Philadelphia airport is considered a medium airport (handling 20-40 million passengers) and its BI infrastructure is both outsourced and in-house developed
- Frankfurt airport is considered as a large airport (handling 40+ million passengers) and its BI infrastructure is 100% produced in-house

Based on the case studies findings, it appears that the hypothesis can be accepted. However, findings from the interview conducted with Bernard Raoux reject this hypothesis. He argues that the size of an airport is not a valid criterion to explain the outsourcing vs in-house decision because there are small airports and airlines that are highly innovative and develop BI in-house to achieve an improved speed to market. It rather depends on the maturity of BI development in the airport as well as the innovativeness and flexibility of the airport. He argues that the phenomenon applies equally to airports as well as airlines and cites Ryanair and Munich airports as examples for comparatively small, but highly innovative companies producing their bi in-house.

We are not able to confirm or refute this hypothesis at this stage, additional research needs to be conducted to further investigate the hypothesis.

4.5.2.2 *2nd Hypothesis: Constrained airports (in terms of geographical expansion potential) focus more on BI than unconstrained ones due to their only option to grow revenues through efficiency rather than a major traffic increase.*

- Nice airport has a constrained geographical expansion potential due to its location at the shore and the densely populated area around the airport and had a medium focus on BI until 2016 and a higher focus since 2017.
- Brisbane airport does not have a constrained expansion potential and is strongly growing currently, but has a strong BI focus only since 2012.
- Philadelphia airport faces a constrained expansion potential and had a low focus on BI until 2017.
- Frankfurt airport has a constrained expansion potential due to its geographical location being surrounded by many villages and has a strong BI focus since 2004.

Based on the case study findings, we do not find a correlation between the geographical expansion potential and the BI focus of the airports in the study. The constrained expansion potential appears to not be an influencing factor for implementing BI in the airport industry. It seems that the innovativeness of airports much more defines the mode for BI development, than location constraints. However, for strongly constrained airports such as Nice, outsourcing seems to be the only option as BI infrastructure requires large spaces for hosting servers that are at the heart of any BI initiative.

4.5.2.3 *3rd Hypothesis: Airports facing high competition focus more on BI than those having a lower competitive environment*

- Nice airport faces medium competition due to its attractive location and low airport competition in the area. Nice airport had a medium focus on BI until 2016 and a higher focus since 2017.
- Brisbane airport faces strong competition from Gold coast airport and has a strong BI focus since 2012.
- Philadelphia airport faces medium competition because other airports in the area are quite far away. Philadelphia airport had a low focus on BI until 2017.
- Frankfurt airport faces strong competition especially from Munich airport, which is easily reachable from Frankfurt by intercity train, and other hub airports internationally providing a better customer experience to travellers. Frankfurt airport has a strong BI focus since 2004.

Based on the case studies findings, the hypothesis can be accepted. The competitive environment appears to be the strongest influence factor for implementing BI in the airport industry and also to produce it in-house when it constitutes a strong competitive advantage.

4.5.2.4 *4th Hypothesis: Airports focusing on non-aeronautical revenue have stronger focus on BI than those focusing on aeronautical revenues*

- Nice airport derives 60% of its revenues from aeronautical revenues related to the turnaround of aircraft versus 40% of revenues related to shops, parking, etc. This focus on aeronautical revenues is explicable by the fact that Nice airport is a point-to-point airport, meaning that travellers only pass through, but do not stay there for layovers during which they could potentially spend a lot of money.
- Brisbane airport derives only 39% of its revenues form purely aeronautical revenues as indicated in the annual report. However, the BI manger indicated a ratio of about 60% aeronautical versus 10% from retail and 25% from parking businesses. Due to its location in a tourist destination and despite the airport offering flight connections to the pacific region, it is much more of a point-to-point airport than a hub airport. However, the airport is strongly growing and expected to double passenger numbers by 2034, which indicates a possible change in focus towards becoming more of at least a regional hub. This would correlate with the strong emphasis on BI since 2012.
- Philadelphia airport generates 61 % of its revenues from fees related to aeronautical activities including passenger fees, landing fees and airline rent. Philadelphia airport had a low focus on BI until 2017.
- 35% of Frankfurt airport's revenues stem from aviation and 24% from ground handling as the airport itself provides this service. Retail and real estate account for 19% of its revenues. The retail revenues amount to more than 50% of aeronautical revenues indicating a strong retail focus. It is one of the largest hub airports in Europe and increasingly feels the burden of competition within Germany from Munich airport and from hub airports internationally. Frankfurt airport had a strong BI focus since 2004 reflecting the changing environment it finds itself in and the need to improve competitiveness.

Based on the case studies findings, the hypothesis can be accepted. A high percentage of revenue related to retail activities indicates a strong focus on BI as data giving insights into what passengers want to buy are key for boosting the retail business. It can also be said that hub airports have a stronger retail focus compared to point-to-point airports because

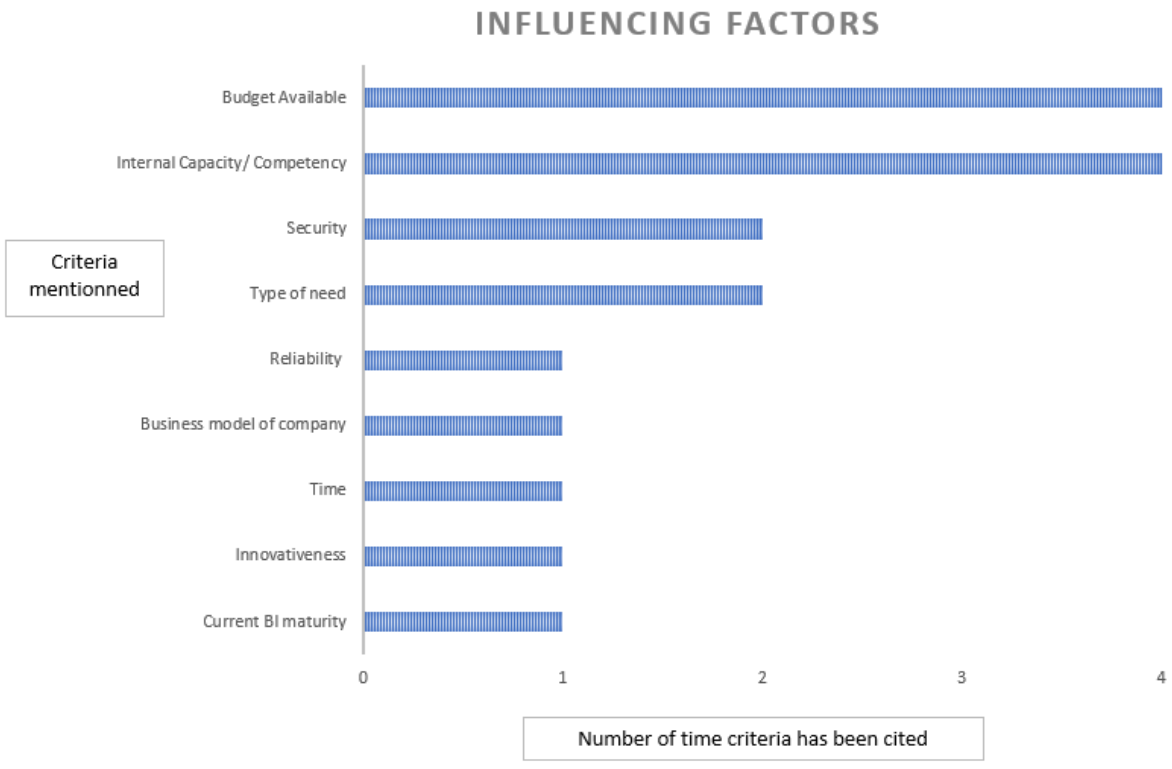
passengers stay longer at these airports during layovers, offering an exceptional opportunity for retail businesses to sell to these passengers during their waiting time.

Following the discussion of the hypothesis above, it can be found that the competitive environment and the need for being innovative as compared to the competition seems to be the strongest influencing factor for whether airports outsource or produce their BI in-house. Furthermore, hub airports are more likely to produce BI in house as the retail business is a major part of their revenues and as offering the right products and services to customers presents a strong profit opportunity. On the contrary, the location constraints and airport size seem to have a limited impact.

4.5.3 Make vs Buy decision factors of BI activities in airports

4.5.3.1 Framework of influencing factors Make vs Buy decision of BI activities in airports

Figure 11: Influencing factors found in case study cross-analysis



The case studies cross-analysis findings highlight that the budget that airports are willing to devise for BI initiatives is a major criterion to consider when deciding to outsource versus develop internally. Airports with large budgets dedicated to information technology will be more likely to produce BI in-house compared to those that have rather limited resources

available for such causes. Unfortunately, the airports in our sample could not give us detailed numbers regarding their BI budgets as this type of information is strictly confidential. However, each of them mentioned that with little budget, an airport cannot possibly produce BI in-house due to the large infrastructure costs that are associated with such initiatives.

Airports are also considering other factors such as the internal capacity/competency available, security, assessing the type of need, the reliability of the supplier, the airport's model, the time scope, the level of innovativeness, and the current BI maturity when thinking about outsourcing BI activities.

The same reasoning as for the IT budget available applies to internal capacity and competencies. Airports will outsource BI if they have limited IT resources or resources that lack the specific capabilities for producing BI themselves.

Integrated airports providing most of the services at the airport themselves would rather focus on BI than airports following the renting model where airlines themselves operate the airport functions and the airport only renting the terminal buildings to them. The integrated airport model is mostly applied in Europe and requires much more coordination and benefits therefore from cost optimization through data. In the other airport business model, mostly used in the US, BI is not considered as important as it would generate large costs for the airport that it could not necessarily pass on in the form of rents to airlines.

On the contrary, airports will be forced to produce BI in-house in cases where there are no reliable outsourcing partners available for addressing the specific need of an airport.

Likewise, when data security and protection is a big concern, producing BI in-house seems to be a way to avoid costly lawsuits in case that sensitive data would get into the hands of unauthorized people or countries through sub-contracting structures and outsourcing agreements in the outsourcing partner's business.

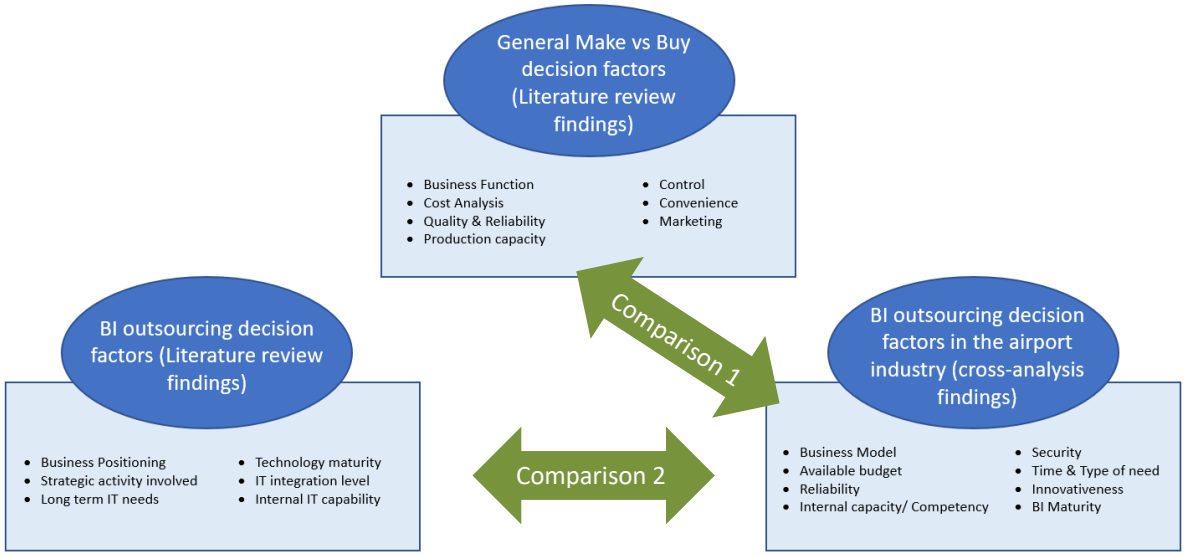
As mentioned earlier, innovative airports that consider data as a strategic asset giving them a competitive advantage would prefer to produce and treat this data in-house to avoid the competition getting access to it.

Furthermore, airports that are already rather mature in their usage of BI are more likely to produce it in-house as their needs will be much more specific. Airports that are just starting to explore BI will be able to buy off-the-shelf solutions to achieve a fast and rather cheap access to test what BI can do for them.

4.5.3.2 *Framework of influencing factors Make vs Buy decision of BI activities in the airport industry versus general factors in the literature review*

The literature review covers the make versus buy decision factors as well as the BI decisions factors. In this section, the case study cross-analysis findings are separately compared with the make versus buy decision factors and the BI decisions factors as illustrated in Figure 12 below. Thereby, we want to establish the similarities and differences between general decision factors found in the literature and those that have been found to be specific to the airport industry.

Figure 12: Framework of different influencing factors per industry



Comparison 1

There is no significant difference between the general make versus buy decision factors highlighted in the literature review and the decision factors found in the cross-case analyses. However, the marketing strategy factor, as discussed by Gartenstein (n.a.) in the literature, has not been mentioned as a significant influence factor in the four case studies. However, this might be due either to the small sample size or to the relatively low importance of this specific decision factor to the 4 airports interviewed. In addition, two influencing factors that have been cited repeatedly in the case studies that have not been mentioned in the literature are innovativeness and BI maturity. These decision factors seem to be specific to BI decision-making in the airport industry.

Comparison 2

There is a difference between the BI outsourcing influencing decision factors as highlighted in the literature review and the decision factors found in the cross-case analyses. The BI outsourcing factors in the literature do not consider the budget dedicated to BI, security and innovativeness as major outsourcing factors, however, these seem to be highly relevant in the airport industry. The level of IT integration, however, has not been mentioned as a major BI outsourcing decision factor in the airport industry, while it has been mentioned as significantly impacting the decision by the literature. This omission of the importance of the level of IT integration could be due to the commercial rather than technical focus of the interviews.

4.5.3.3 BI in-house advantages/ disadvantages in the airport industry

Advantages

The main advantages that companies derive from producing and hosting BI in house are the following.

- Keeping BI in-house allows to keep full control of data, which is especially important in Europe, where strict data protection laws prevent companies from outsourcing sensitive data. Furthermore, the only way to guarantee that strategic data cannot be available to other industry players is to treat it in-house.
- Moreover, BI production in-house allows for the accommodation of specific needs that are unique to the airport's environment because software can be personalization to answer specific questions.
- Producing BI in-house can also be a simple necessity and the only choice when companies face a lack of off-the-shelf solutions e.g. for combining data, forecasting, searching for correlations and understanding traveler characteristics that might not apply in the same way to different airports.

Disadvantages

- However, the production and hosting of BI in-house is costly.

- Moreover, keeping BI infrastructure at the latest state of the art is complex due to the fast-changing technology environment. By the time, a company has produced and implemented a BI system, the technology used is already outdated.

5 Recommendations for BI vendors

Following the interviews with airport BI professionals, we believe that BI vendors should consider our framework when selling their system to the airport industry to cover all aspects of the different decision factors (make versus buy decision, BI outsourcing decision and BI outsourcing in the airport industry decision). The level of innovativeness of the airport is an important factor that is not mentioned in the make versus buy decision and the BI decision factor in the literature review and must be considered. On the other hand, our research indicates that the marketing aspect discovered in the general literature is less of an influencing factor when considering the make versus buy decision for BI activities in the airport industry. The findings from our hypothesis testing highlights that the competitive environment is the most critical decision factor for implementing BI in airports.

Therefore, BI vendors should offer highly tailored solutions to sub-segments of the airport industry to address specific needs based on the airport's environment and specific business challenges. Such a tailored approach could consider 3 axes for differentiation of the offer. We propose to design a specific offer to different profiles of airports based on their competitive environment, their existing systems and BI maturity and their future ambition for development.

To achieve such tailored solutions for different types of airports, deploying a modular approach to providing BI could allow to benefit at the same time from the advantages of customization while keeping economies of scale advantages through the limited number of profiles addressed. Thereby, BI vendors can to accompany airports in their development from starting to using BI based on their existing systems to get insights from their data to being mature and performing sophisticated forecasts and scenario planning.

Such an approach would be much more collaborative and extend much further than just to selling infrastructure and software, but towards a consultative approach facilitating a long-term partnership. Thereby, customer can be loyalized much easier and barriers for the customer to change to another provider are increased.

Furthermore, due to their lack of access to data, airports would certainly appreciate BI solutions that already integrate data from third party sources such as GDS, IATA, MIDT, etc. By partnering with such companies and integrating their data into the BI platform, BI vendors could offer high value added to airports.

Future trend

The interviews conducted with people from other functions in the airport industry highlight that the future trend will be to use a hybrid model for sourcing BI. This hybrid model would allow to mix internal BI activities with external provider products and solutions (IT infrastructure providers, GDS, other data providers) providing services at a cost that is much lower than if the airport would itself try to build them. The internal workforce will be needed to personalize standard tools bought from external providers.

Such a hybrid model allows to benefit from the benefits of specialization and reduced cost for standard, off-the-shelf products, while customization of standard tools can help to address airport specific questions.

6 Conclusion and future outlook

Business intelligence in the airport industry is not a strongly researched topic. Furthermore, it seems that airports are far less advanced in terms of BI compared to other industries such as retail or finance. This might be due to the relatively protected place of airports in the economic environment facing an oligopolistic situation with airlines being dependant on airports for servicing their passengers. However, nowadays also airports face an increasingly competitive environment and need to place a stronger focus on cost optimization and increasing competitiveness by being innovative and efficient.

Our research highlights that in the airport industry for BI activities, there is no significant divergence from the decision factors outlined in the literature for the make versus buy decision. When managers are facing a make versus buy decision, they must consider their business function, budget analysis, assess the quality and reliability, the internal capacity and competency, the level of security involved, and the convenience (time and type of need). Other important factor must be considered for the make versus buy decision depending of the

industry such as the level of innovativeness and the BI maturity in the airport industry for BI activities.

Our hypothesis testing reflects that the competitive environment is a decision factor for implementing BI in the airport industry. The airports who had low level of competition do not heavily invest in BI but those that are facing high level of competition have been using BI since several years. Furthermore, a focus on retail revenues indicates that airports invest in BI as retail revenues are strongly linked to airports using the data they have about passengers and their preferences. The findings however cannot be generalized due to the convenience sampling approach used and the small number of airports studied.

Machine learning, the replacement of BI?

Samuel (1960) defines machine learning as the "field of study that gives computers the ability to learn without being explicitly programmed". Machine Learning (ML) is already in place in the airport industry in the retail business at Lagardere Travel Retail. Lagardere Travel Retail had a BI system allowing to generate reporting based on sales, but the system did not include predictive analysis. Management decided to implement ML to stimulate sales in store. While BI provided reporting on past sales, ML can generate instant suggestions of potential products a customer may be interested based on the customer's nationality, his or her destination, and the airline used. While testing the algorithm at Charles de Gaulle airport, results highlighted that 1 time over 5 the customer purchased the suggested product. ML also gives the possibility to include open data that is available online and correlate it with internal data. ML appears to be another level of BI, being able to do exactly what BI systems provide with continuous self-improvement to ensure results that are the closest possible to reality.

Although ML is a powerful technology, it is not implemented everywhere due to the level of resources needed. It requires solid knowledge of coding, data science, data engineers to create a neuronal network, and it is hard to implement. Some sectors have more interest in implementing ML whereas for others only BI is enough. During the interviews we conducted in the airport industry, no one spoke about ML for airport management. But other actors such as retailers are exploring ML for increasing sales turnover. Does BI versus ML depend on the type of needs and the level of innovativeness of the company? We guess that only time will tell.

7 Limitations and recommendations for further research

This study has been limited by time constraints and a lack of access to BI professionals in the airport industry within a rather short time frame. Furthermore, data and information on BI and budget is information that is considered strategic and confidential for many companies, which is why it is difficult to get access to such information.

For exploring this topic more in depth, the study would need to be extended to a larger amount of airports. Additionally, data on each airport's BI budget and IT resources compared to resources working on BI could give a metric that can inform about the effort and importance that airports place on BI as compared to other IT systems.

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9 Appendix

9.1 Interview Summaries

9.1.1 Call with Christophe Imbert, CEO of Milanamos

23rd May 2017, 21.00 – 21.45

BI as defined by Milanamos, Amadeus etc: Business Intelligence = data story telling = data warehousing = reporting, airports do not necessarily define it the same way

Airports sit on a goldmine of data:

- **Commercial data** related to passengers: boarding pass data, security data (how long does it take to go through security, the bottleneck on each airport…), etc – they do not use this data, they have an operational view on it, but not a commercial one. instead they send it to the GDS (global distribution system such as Amadeus, Sabre, etc) to get demand forecasts from them
- **Safety data** unrelated to passengers: compliance issues regarding aircraft safety, runway security, etc

Only ~1/3 of airports have a strategy around big data, but often they use consultants to make use of the data

Milanamos delivers a BI platform to airports to use their own data and get real-time and on demand consultancy in-house.

Airports challenges:

- They do not own the whole experience: they have a very limited view of passengers as they do not even know where they come from due to lack of data ownership. Airports only know where passengers go if the passengers have luggage to check in. This lack of visibility on the entire passenger journey makes it difficult for them to offer additional services
- Cultural challenge: Airports traditionally are not innovators. People in airports, especially big and well-working ones are often reluctant to change and want to stick to the rigid process culture that has served them well, they use data from eg Amadeus,

which does not capture any LLC traffic for example, even though it is accounting for ~80% of traffic

- Airports use airline data, but the relationship between them is difficult due to opposing interests. Airlines want to increase efficiency and they want people to be at the gate on time to avoid high charges for staying on ground for too long, while airports want passengers to spend as much time as possible at the airport, so they can spend money there.

Airports objectives:

- Better understand the passenger
- Moving from a business model as a public services provider to one of a shopping mall
- Developing inter-modality to increase the catchment area and attract more passengers by connecting them better to the airport (Frankfurt airport has a catchment area of 38 Mio people due to the ICE train connection to the airport)

Airport BI activities:

Airports often use external companies to conduct demand surveys for them and IT consulting companies for helping them with BI software.

- 50% of airports use in-house solutions (supervised mode, not on a data science level)
- 25% of airports move to external software
- 25% of airports use consultancy firms

The airport IT market is highly fragmented/atomized (Sabre as market leader with ~ 12 % market share as per McKinsey study commissioned by Sabre)

Big data/data science allows for operating in an unsupervised mode as opposed to a supervised mode where correlations are tested based on hypothesis formulated by people. Unsupervised mode allows for identifying correlations in the data not thought of before. Airports still work based on what they think/know, rather than what they could learn.

Remark regarding Nice Airport as an example:

Nice airport (Milanamos customer) is not a good example for innovation as it serves very touristic places, is limited in growth and is operating at capacity during all year, so there is no need to innovate as enough passengers come to the airport. Small airports in less central places, however, need to innovate to attract passengers

General impression of the call:

Christophe Imbert was very enthusiastic and willing to support us in our thesis. As he is extremely well connected in the industry, he offered to connect us with people that can be of interest for our topic. There is no conflict of interest with Amadeus as he is working closely with people in Amadeus on shared projects.

9.1.2 Meeting with Jean-Pierre TORRES, Head of IT systems department at Nice Airport

29th May 2017, 17.00 – 18.15

Definition of BI: At Nice Airport BI is used only for internal data in order to find correlations between the different types of data collected at the airport

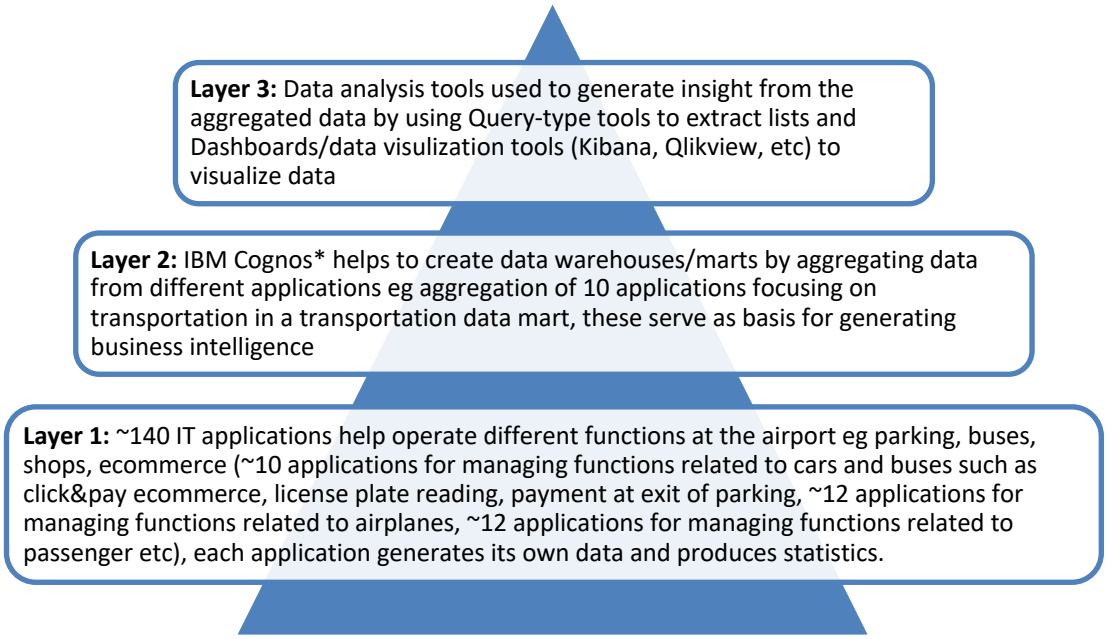
Objectives:

- Make people buy as much as possible by knowing them and their shopping behaviour well
- Use data and BI to
    - use limited space and resources most efficiently
    - know which product/service offerings work
    - reduce costs by optimal resource allocation e.g. allocation of security personnel by forecasting demand for specific times of the day

Nice airport specificities

- Nice is a "point-to-point" airport, meaning that passengers come to Nice as destination and not for connecting to other flights as in hub airports
- Space constraints due to geographic location
- Competition especially for long-haul flights and incoming passengers from long-haul flights from airports such as Marseilles, Milan, Lyon
- Attractive tourist area as catchment area
- Aeronautical revenue related to planes, airport activities (~60%) vs non-aeronautical revenue related to shopping, commercial development (~40%)
- Data governance established each year by a steering committee deciding about how to use which of the data that the airport collects

IT infrastructure



Nice airport has 4 different types of data

- **Exploitation data** related to plane management eg plane parking, departure times, delays, etc
- **Luggage data** consists of technical data (time used to treat luggage, lost items, when entered into the system) and baggage routing data (where do bags go)
- **Passenger data** on all movements passengers make at the airport, their shopping, consumption in restaurants, etc as tracked through the unique sequence number** on the boarding pass, in combination with a subscription to airport services such as eg parking the airport can attach also personal information such as gender, age, preferences etc to a certain passenger, on passengers checking in luggage the airport also has data about where they go and which connecting airports they use, all passenger data is treated impersonally

  Even if a passenger has no luggage and is dropped off at the airport by someone, the airport has information on the passenger regarding the security check process, his/her departure time and shopping expenses
- **Commercial data** related to commercial functions such as parking, retail stores, restaurants, etc

Application development

Nice airport itself does very little development in-house due to limited IT resources. It's 140 applications are either purchased as off-the-shelf solutions where systems meeting the requirements exist or otherwise are developed by external companies such as Sopra Steria, Cap Gemini, Avisto, Keyrus according to the airport's specifications and needs. They are also maintained by these external companies, but are internally managed (for 90% of them). Furthermore, data analysis is conducted internally because it is essential to understand the business well to arrive at the right conclusions and it would take much time to explain the business background to an external person. Also, control over data is important.

For companies that do not possess a unique capability, they negotiate a one-year contract, renewable each year for 3 years. At the end of this 4 years period, a call for tender is issued to challenge the price by bringing companies into competition. For companies that possess a unique capability, they establish long-term partnership.

Nice airport also buys external data sets such as the MIDT database***

Other interesting points

- Jean-Pierre mentioned the most efficient airport in Europe is Vienne airport, it could be very interesting to study this airport in our research
- He will visit a fair at Vienna Airport where airports come together to discuss about data management
- Nice airport presents itself at fairs e.g. in South Africa soon to attract airlines and to develop its business. Airports are in competition with each other based on security waiting times, availability of shops, facilities for receiving planes and passengers

Next steps

In-depth meeting with IT manager, Meetings with business development manager and BI manager of Nice airport before end of June

*IBM Cognos Business Intelligence is a web-based, integrated business intelligence suite by IBM. It provides a toolset for reporting, analysis, scorecarding, and monitoring of events and metrics. The software consists of several components to meet the different information requirements in a company (Wikipedia).

**When passenger data/lists are sent from the Global distribution system (Sabre, Amadeus, etc) to the Departure control system, a unique sequence number identifying each passenger is attributed.

*** The MIDT (Marketing Information Data Transfer) database gives detailed information about the worldwide booking activities of travel agencies and airline carriers. The MIDT database is specifically designed to provide airline companies with valuable competitive information so that they are able to make well-informed decisions in their business strategies (Airlines Magazine, 2006) https://aerlinesmagazine.files.wordpress.com/2013/01/32_witlox_et_al_midt1.pdf).

9.1.3 Meeting with Anne-Marie TRAN, Business Intelligence Manager at Nice Airport

23th June 2017, 16.00 – 17.00

As the functional manager for BI at the airport, Anne-Marie is responsible for constructing a BI system based on the users' needs. She also supervises the infrastructure and supports it internally. For that, she is convinced, that a strong technical as well as functional expertise is needed. She is the interface between the internal users of BI and the external partner Keyrus who provides the BI infrastructure and develops functionalities according to her specifications. She then configures the tool and delivers to the users and trains them on how to use it as a self-service tool. The users themselves then can extract the information needed and generate tables

For her, data quality, reliability, coherence and codification are key for doing BI as they constitute the base for building on top

2 domains of BI at Nice airport:

1. Airport related applications: flights, finance, etc
2. Commercial applications: shops, billing, fees, etc

Reason for choice of BI outsourcing partner: company must be stable and not go out of business suddenly as there is a great dependence. Keyrus has been chosen through a tendering process in 2008.

Internally, there is 1 software developer who develops minor applications, etc, but everything else is outsourced to Keyrus (buys licenses for Cognos from IBM and sells those as well as software development services to the airport)
For her, her daily job would be much easier if BI were produced in-house due to the geographical proximity of an interlocutor, even though she uses a web portal to communicate with Keyrus where she enters her specifications and communicates any problems.

She believes that the data itself is the most important for taking decisions, not the way how it is presented, which is why she does not think that nice presentation of data in interactive dashboards is important.

For making BI useful and worth the investment, it must be widely supported by people within the company

Nice airport started to implement a BI infrastructure in 2008, starting with a marketing application for reporting purposes followed by a resource exploitation application for managing flights, fees, etc. Today, Anne-Marie is working on an application for baggage handling.
BI at the airport has developed very slowly as the airport manages to attract airlines and passengers due to its favourable location in a tourist region. Only since 2017, the company has established a data committee.

The BI infrastructure is built by adding up different modules that allow for exchanging part of the infrastructure without breaking the whole system.

Definition of BI: BI is used on the one hand for operations e.g. reporting and on the other hand for decision support and simulations. It helps to compare how well shops do, in which locations they do better than in others and which products work best with passengers

9.1.4 Meeting with Delphine LE SEC'H, Head of Airline Marketing at Nice Airport

23th June 2017, 17.00 – 18.15

Definition of BI: BI makes a lot of data available that is not interesting for her specific objective. For deciding which routes to open in the future, she mixes internal and external data to plan ahead and build forecasts.

Nice airport has 61 airline partners that come to the airport at a regular basis. 600 people are employed by the airport, while in total about 5000 people work there when considering the sub-contracting partners. The current airport operator has a concession agreement with the French state until 2044. The runways, buildings, etc all belong to the state. The airport operator only manages the business.
The airport is a point-to-point airport, meaning that passengers do not stay long usually as they do not wait for connecting flights as is the case for hub airports.

Competitive positioning

- Nice airport is promoted as a destination for incoming visitors due to the attractiveness of the Cote d'Azur as a tourist destination
- Nice airport has a considerable catchment area from Marseille to Geneva that is densely populated with people who can afford air travel. In this context, the visiting friends and family segment of travel is important as the catchment area concerns mostly people living around the airport and taking the plane for travelling.
- Nice airport competes with other European airports with a similar setup meaning an attractive tourist destination and catchment area et Barcelona, Geneva, Venice
- The airport offers incentive programs to attract airlines and to consequently develop traffic. The longest routes from Nice are to Singapore, China, Canada and the USA.

Revenue sources

- Parking (non-aeronautical)
- Shops (non-aeronautical)
- Fees from airlines (aeronautical)

Aeronautical fees are regulated by the law and are justified by the cost of investment needed at the airport. The fees concern all airlines equally and independent of the terminal that is used. As the airport does not make any profit from aeronautical fees, the company places a strong focus on non-aeronautical revenue.

Business intelligence is strongly used for development and resource allocation. Since 2014, cost reduction is top priority in order for the airport to remain competitive.

In terms of innovation, the airport is experimenting with beacons, security screening techniques and special welcome services for Chinese passengers. Innovation is considered as important if it helps to reduce costs.

Airline marketing department teams

- **Studies**: The aim is to defend Nice airport's competitiveness for adding new destinations as airports compete with each other
- **Statistics and forecasting**: all data connected to planes landing and taking off at the airport is transferred to the BI System Cognos to generate forecasts for the year, the following one as well as long-term forecasts
- **Airline promotion**: the aim is to make airlines known to the people living and working in the airport catchment area to increase traffic and airport attractiveness

BI data sources

- Cognos (internal BI infrastructure)
- External data about the origin of passengers bought from GDS and IATA
- The MIDT (Marketing Information Data Transfer) database
- Surveys conducted by a third-party partner at the airport to better understand passenger behaviour and to size volumes (18000 surveys per year)

These data sources are crossed internally to detect trends and project traffic volumes in the future. The most important objective is to identify evolutions.

9.1.5 Call with David McDonnell, BI Manager at Brisbane Airport Corporation

6th July 2017, 23.00 – 00.30

David had a partial BI role in operations where he was dedicated to BI at 40%. After the restructuring in 2011 with a new CIO, he was brought into a corporate full-time BI role in the strategic planning and development department composed of the Airport planning division and the Business development division, where BI is located. The company has a very corporate/business approach to data as the BI function is located in strategic planning and not in IT. If they were in IT, the purpose would be very different.

As the CIO will leave next year, changes and restructuring of positions are again possible.

David's team carries out the internal technical support and links user requirements to infrastructure. They coordinate efforts and provide reporting and programming.

Core functions of BI

3. Providing information to the various business and commercial units to improve business performance and support data requirements for the corporate planning department
4. Insuring that his department as planning function across the airport has data that supports the planning process across lots of metrics such as runway performance, passenger busy hour, corporate planning cycle

There is a theoretical link between BI and planning, but not an operational one at the moment. There are initiatives on outcomes of BI Systems feeding downstream systems, but currently due to the nature of long-term planning, the key metrics that are fed into the planning cycle do not feed in at this point of time because the planning cycle is not daily or weekly, but quarterly. Furthermore, some of the data is checked before loaded into the planning cycle. Different tools are used for that and this process is not automated.

More tactical planning (short-term planning 3-12 months) is done using Beontra software (fed by a data warehouse, often low-level data, needs to be checked before). Long-term planning is conducted for up to 20 years.

How would you describe the economic environment that airports in general and your airport in specific are in?

Generally, airports play an integral role in the economic activity and growth of a region by providing a gateway to travellers and other ancillary services.

At Brisbane airport we have a diversified business including:

- Airport Operations – who manage flight operations including runway operations and terminal infrastructure allocations
- Airline Business Development – manages Airline relationships and attracts new Airlines and flight routes to the airport.

- Parking & Transport Services – manages the car parking operations, Ground transport operators (taxi, buses, limo operators and ride-share), car rental companies
- Retail Management – manages retail businesses within the Terminals
- Property – manages leases and land bank within airport precinct including Skywalk (retail shopping precinct separate from the Terminal areas) as well as industrial properties.

Brisbane airport faces a fair bit of competition from Gold Coast airport 100 km south of Brisbane (both in Queensland state), who is a high-growth airport with a strategy to target low-cost carriers and from Sydney airport (1 airport state) and Melbourne (also 1 airport state). Queensland is a tourist destination and therefore, the value of the AUD is a big influence factor. Sydney and Melbourne face less competition as they have many business passengers.

Car parking is a strong focus area and a lot of work is done in that one because off-airport car parking businesses are growing, they are situated in industrial areas and can offer cheap products and have customers take a bus to the airport.

Smaller airport focusses on being cheap, which is a different business model. Gold Coast airport offers cheap landing fees and closely cooperates with local tourism bodies and the regional council to benefit from the region being a major tourist destination. The airport has limited landmass, small car parking business and retail.

There is no big focus on BI, the focus is on bringing as many passengers as possible into the region cheaply. David is not sure what they do with BI, but after speaking to guys there, it does not seem to be a focus.

Larger airports are more likely to focus on BI than smaller ones because smaller ones focus on being cheap.

Revenue structure

Brisbane airport's of 400 – 500 mio total revenue per year (see exact number in annual report) comes from aeronautical business 60%, 25% from parking, retail 10%, remainder property.

The Australian competition body ACCC reviews all airport fees (highly scrutinized), but it is up to airports how they charge airlines who pass on airport taxes to passengers. A lot of them are negotiated every 5 years, airports have to publish their landing fees. Sydney is the most

expensive airport, then Brisbane, then Melbourne because they are building of new infrastructure, which must be financed by higher charges.

Brisbane airport‘s focus is on growing aeronautical revenue – attracting new airlines to the airport – however, having a slot at Brisbane airport is not easy as new airlines want to come in at peak times, which is not possible.

Hypothesis: growing airports focus on aeronautical revenue while constrained ones focus on commercial revenues.

What are the challenges and objectives?

As an infrastructure company, airports are very capital intensive. Expanding a terminal, building a new car park or building a new runway are very large projects. On the commercial side there are steps being taken to attract more airlines to our region, improve customer experience and increase passenger spend rates across our retail business and attracting more patronage from car parkers. As with any business project justification and return of assets are very important.

How would you define business intelligence?

Traditional BI is all about assisting business users with informational needs – providing good quality business information to the right people at the right time. If we do our job correctly business managers can make fact-based decisions and ultimately improve business performance.

At our airport we take a corporate approach to data and information and use a number of different tools to provide access to the information which is captured.

My team is responsible for the CDW (corporate data warehouse) which is key to ensuring that data is captured and stored consistently in a central repository – effectively the single source of truth. We then use different tools to analyse and to deliver information to end-users. Our main BI tool is COGNOS (provided by IBM), however we also use excel and more recently Qliksense.

The BI team’s goals and objectives are:

- Treat corporate data as a valuable strategic asset

» Provide a consistent view of corporate data and improve information accessibility

» Link and integrate data sets to uncover new insights to improve fact –based decision making

» Deliver competitive advantage through data insights

The data captured serves 2 important purposes:

» For Business Unit performance monitoring and to assist operational and tactical decision-making

» To improve BAC's medium / long-term planning capability

Also see below some slides for your reference of how we use data plus some of the varying datasets captured within our CDW.

Which systems do you use to optimize revenues?

We have a yield optimisation initiative underway at the moment with our parking business to use data drawn from the CDW to provide the ability to forecast and provide what-if scenario analysis around parking pricing.

Brisbane airport corporation uses different complimentary tools for BI:

- COGNOS on top of data warehouses allows for dashboarding, analysis studio (self-service analytics tool), traditional reporting (self-service also)
- Scorecard in a tool for senior management prepared every month. For it to be effective, it needs to be controlled centrally
- Microsoft Power BI („Excel on steroids") rolled out to everyone

Cognos is one of the latest systems in its space, lately Tableau, Qlik etc have come up with good offers.

There is an appetite for more configurable self-service tools and improved access to data within the organization. However, wider access could potentially lead to a challenge of source of truth.

Objective: improving access to data through Qliksense blending internal data with external data (Objective for end of July 2017), 20 power users have been identified, will not be rolled out to everyone

BI high priority and focus as situated high up in the organizational hierarchy, more data-related roles coming into the organization, same as in many businesses

Do you use external providers to develop IT systems?

There are many different and disparate IT systems on airport including flight operations, car park ticketing systems, taxi & ridesharing systems, property management, online booking systems and operational systems to name a few. All of these systems are COTS (custom off the shelf) systems and typically provide line of business functions – many of these contain transactional datasets which are very valuable for post-analysis and to understand past performance.

Where the BI team ultimately assists the business is with integrating the various data sources captured from within these IT systems to improve data insights and to improve decision making across the organisation. For example, passenger numbers and flight movements are key pieces of information which can be joined with retail point-of-sale data sets and car parking transactions to determine metrics such as PSR (passenger spend rates) and ATV (average transaction value).

Which factors influence the decision for outsourcing BI or producing it in-house?

We have a small internal team including a Business Analyst, Analytics Lead, Data warehouse Developer and myself. We also outsource to a local BI consultancy company to assist with backlog and new project initiatives as required. Currently our pipeline of work is very strong as we are embarking on some interesting initiatives such as predictive maintenance (leveraging the data captured within the CDW) and the Utility forecasting model.

BI architecture outsourcing

Internal data warehouse supported by his team, 1 maintenance and 1 backup person – aim is to capture data, ensure it is up to date, it is captured.

Infrastructure/IT components are hosted internally, but David's team does not look after it, an external provider takes care of backup, availability and online. Those core IT tasks are done

by external IT company. The CDW and support is provided by his team. External consultants come on site to do some of the extra work, extra resources for large projects.

In a purely outsourced model for BI the focus around data would be much less and it would entail a loss of internal knowledge of data which is really important.

Decision making tools are done internally – data exposed to Qliksense comes from DW and allows end user to pull out data of varying data quality – support for that software will be an arrangement with an external company – technical issues will be fixed by an outside company. To sum up, it can be said that infrastructure is outsourced, while the functional part is kept in-house.

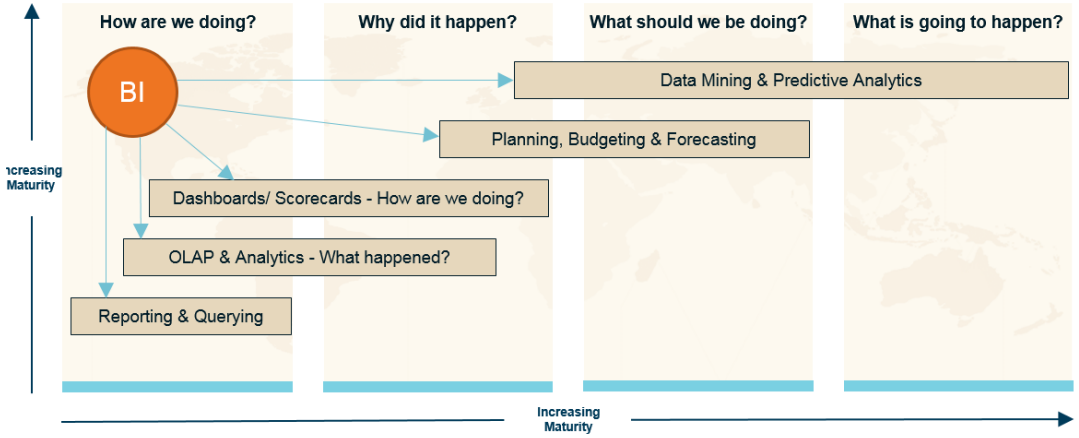
Reasons for outsourcing

- Once upon a time, BI has been internally supported, but then the focus of IT team has moved from hands-on server hosting etc to more functional activities as BAC did not want to be an IT company. It was found that this could be better done by a specialist company.
- David is not sure if outsourcing is cheaper on paper, but it certainly removes the need for support people and reduces risk.

Data security is big focus area at the airport. There are a lot of firewalls in place, all systems are heavily scrutinized across the board, not only in the data space tight controls are deployed.

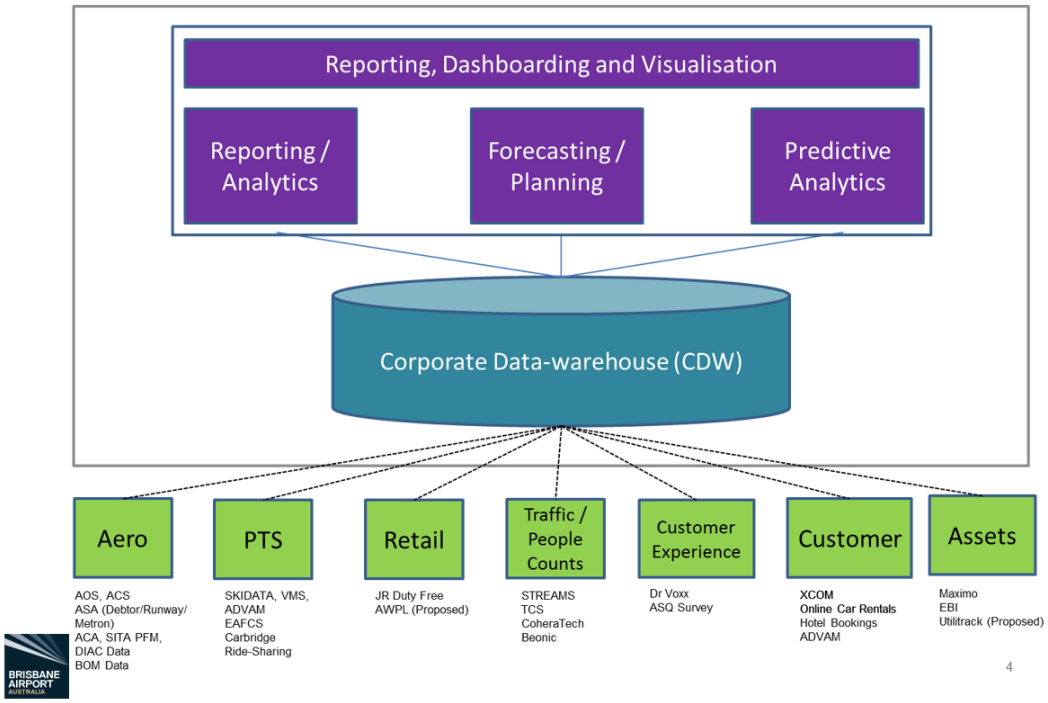
If an organization outsourced data there would be a security risk Therefore it is vital to ensure to work with a partner that is trustworthy with good controls in place.

HOW WE USE OUR CORPORATE BI DATA



3

BI ENVIRONMENT



4

9.1.6 Meeting with Xavier Callens, Department Manager at Amadeus IT Group - Head of Hotel BI & Personalization R&D at Amadeus SAS

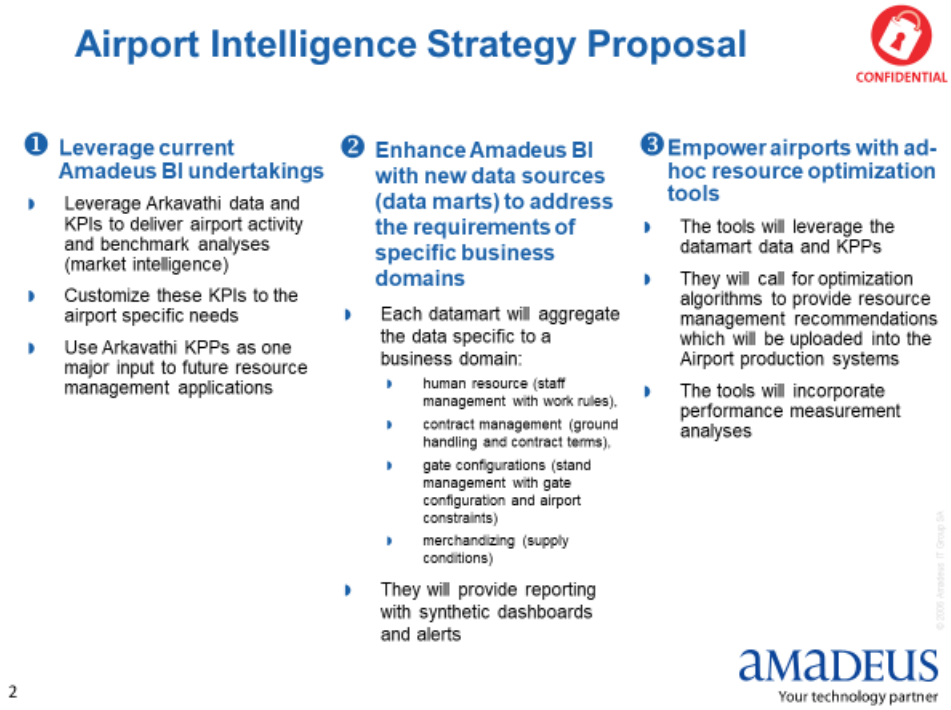
11th July 2017, 11.00 – 12.45

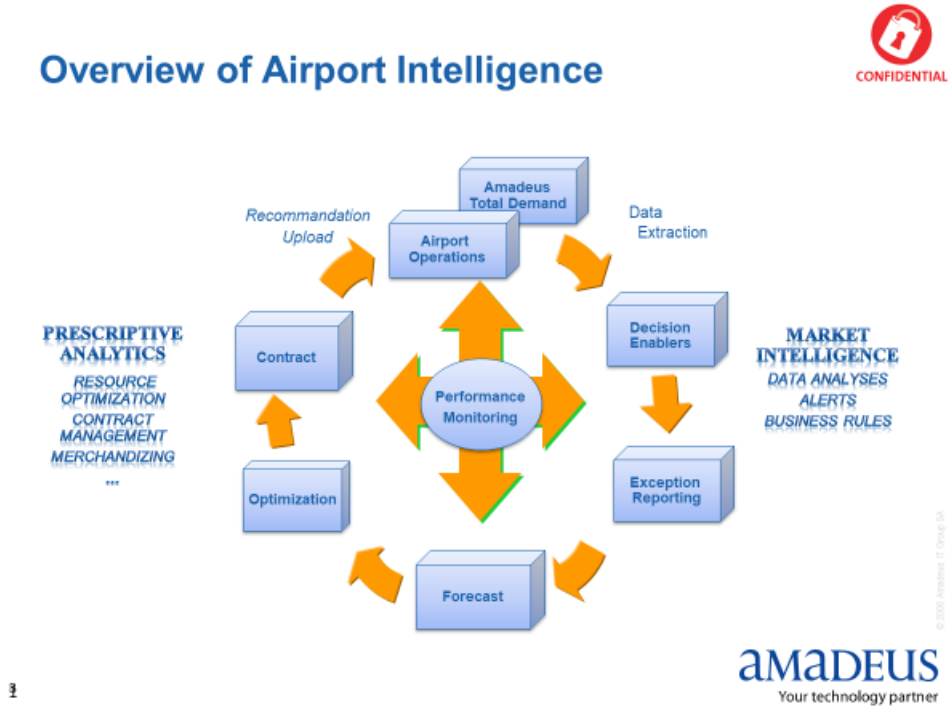
This meeting with Xavier Callens has enhanced our understanding on how an IT company that has customers related to the airline/airport industry has tackled BI tools. Xavier Callens is a former Product Strategy manager in the R&D department at Amadeus. In 2011, he developed a BI strategy venture together with Corporate strategy to look at how to position R&D products in a strategic way and to look at market potential. They searched to establish a common vision on BI strategy starting from the R&D viewpoint of looking at a product and what it can bring to a customer. Then he started working with colleagues from airport team on what could be the use cases.

1. Airport operational database (AODB): the idea was to provide reporting and BI around airport operations on top of this master database
2. Innovation: create a Passenger forecast for airports to estimate how many passengers will arrive at a given airport.

3 steps process:

1. collect data
2. add more data
3. provide reporting to optimize resources (aircraft movements, frequency share, seat capacity, schedule structure, ground handling efficiency, hub efficiency, origin and destination analysis for city pairs)





Amadeus wanted to provide a tool similar to Cognos leveraging its access to travel data from its function as a GDS and airport IT provider.

Airport Market Intelligence

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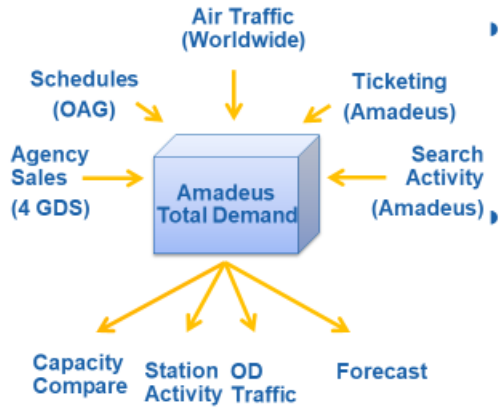

- **Main Data sources**
  - 4-GDS MIDT
  - Airconomy traffic estimates
  - Schedule and ticketing data
- **Main KPIs and KPPs**
  - Activity analyses/benchmarks by airport and airline
    - Passenger volumes, seats offered, aircraft movements,
    - Peak analyses
    - Aircraft types, slack time
    - Hub analyses, schedule regularity

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4

Airport Activity Forecast

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- **Predictive analytics is key to the decision making process**
- **Forecast is relying on BI data (history data, future activity indicators) and user inputs**
- **Data are modelled by day of week, event period, seasonality**
- **Forecast is an essential input into the Resource Management optimization processes**

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16

Predictive Analytics Principles

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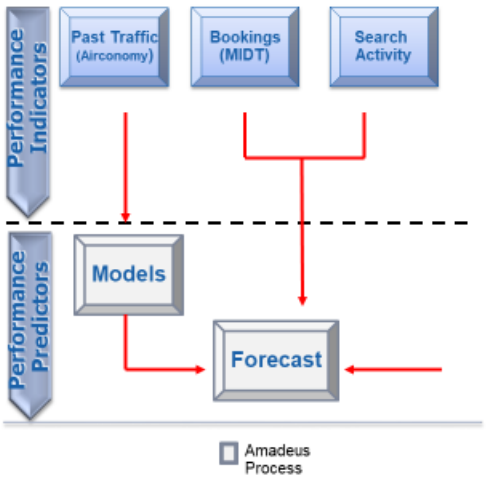

Activity Forecast

of bookings

- By Day, Week, Month
- By O&D
- By Carrier
- By Flight #
- By Cabin Class

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Resource Management

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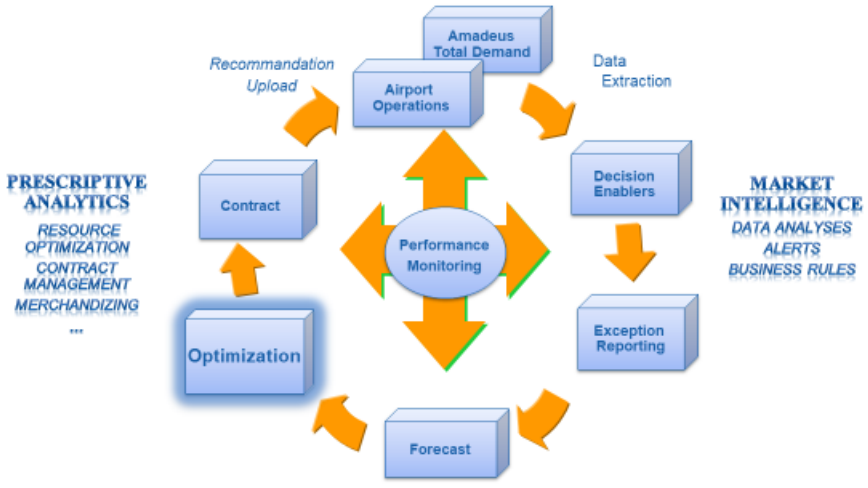

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Optimization Levers

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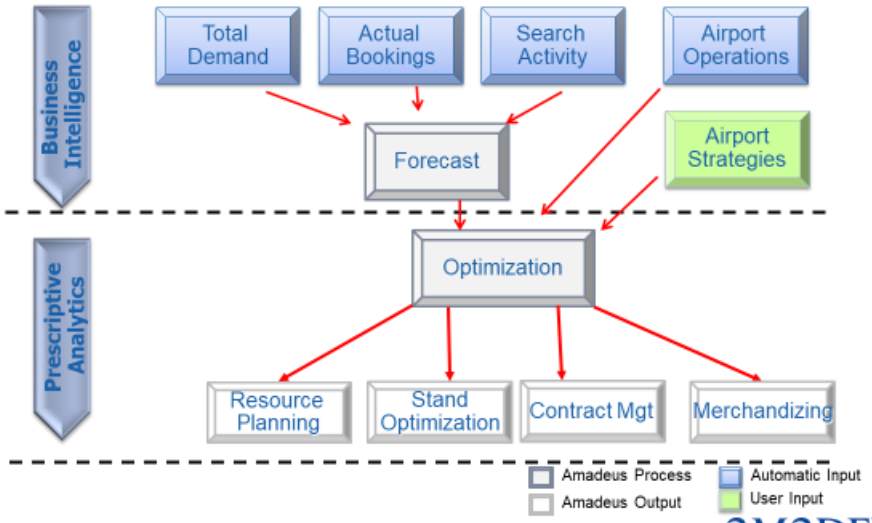

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Resource Planning

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Activity short term forecasts by time slots and HR input parameters (shift working times, breaks) will allow to build optimal resource plans

- **Check in counters**
- **Security agents**
- **Ground operations**
- **Baggage handling**

Applications can go from resource volume estimation to more precise shift planning and rostering. The application will account for varying work rules depending on staff categories.

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Aircraft Stand Optimization

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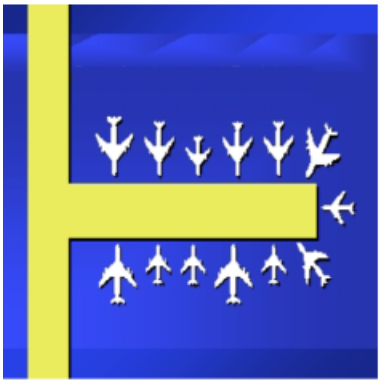

- Main data sources
  - Flight schedules
  - Passenger short term forecast by flight #
  - Connection forecast
  - Airport gate configuration & constraints
- Gate assignment will be done to minimize transfer connecting times. Passenger flows will be optimized in the terminal buildings

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Contract Management

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- Long term forecast allow to determine & negotiate global ground handling activity and conditions with airlines
  - Lower prices for slack periods
  - Preferable conditions to large volume contracts
- This involves developing simulation tools for the Airport, with a possibility to evaluate the impact of changing some contract terms

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Merchandizing

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- Airport boutiques, lounges, restaurants and hotels will benefit from the provision of early business indicators
  - Boarding and Connecting passengers
  - Passenger types (business, economy)
- Corresponding forecast data will be sent to respective users who will use the forecast to fine-tune their purchase / supply order
- Ultimately, Airport Analytics can also recommend the supply quantity to purchase based on a history of consumption/consumer habits

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Performance Measurement

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- Performance measurement allows assessing how efficient the recommendations have been
- This is best done by simulating what would have happened without the recommendations and comparing the simulation outcome with the actual performance
  - How are the resources allocated when one does not anticipate intra-day passenger traffic variations?
  - How are aircraft stationed based on first-in first-serve at the various standpoints?
  - etc

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Airports need BI tools to:

- Manage Human resources management (Allocation security gate, Personnel for baggage handling)
- Manage Suppliers (customs agents, ground handlers - control the quality, measure the quantity, and enhance relationships)
- Optimization of operations (gates – related to commercial retail, which consist of large part of negotiations between airlines and retail outlets)

BI benefits

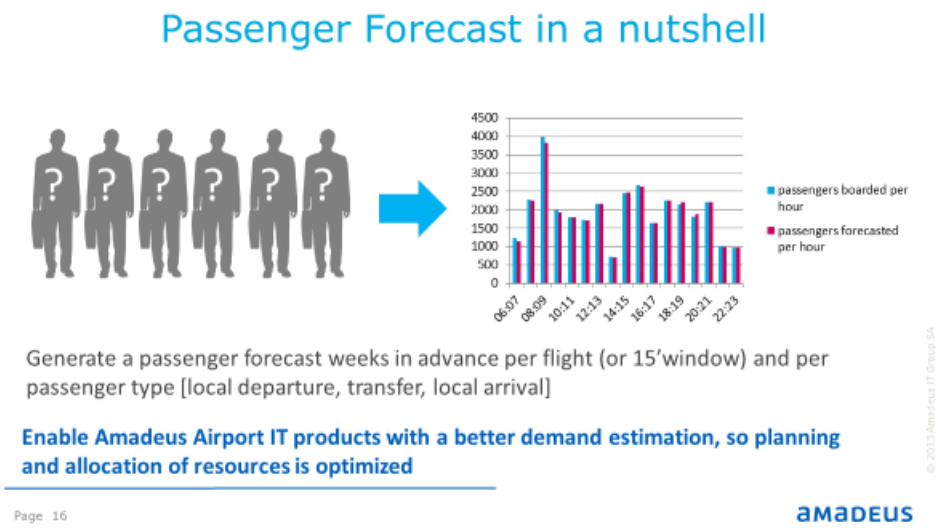
The benefits sought through BI depend on an airport‘s current vision and its environment, so tools are different.

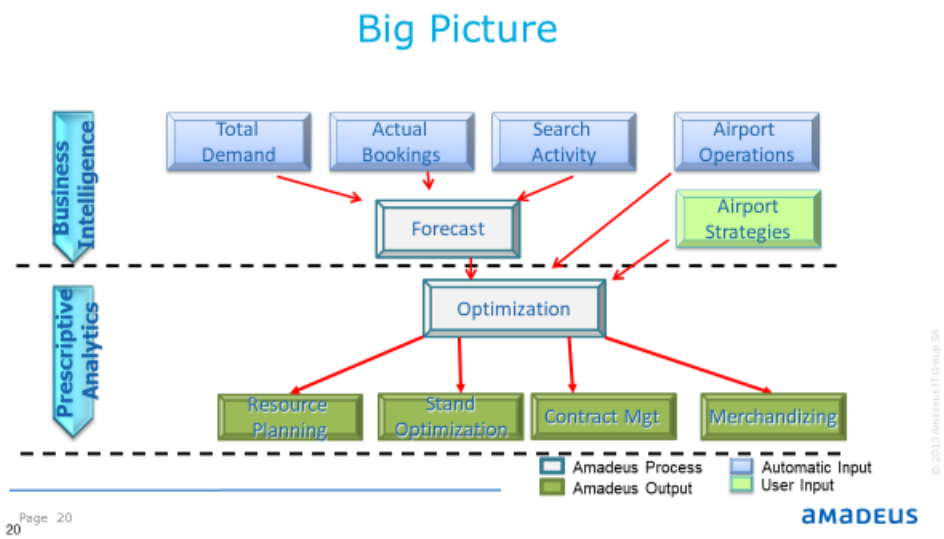
BI tools allow airports to be efficient and win market share by being efficient.

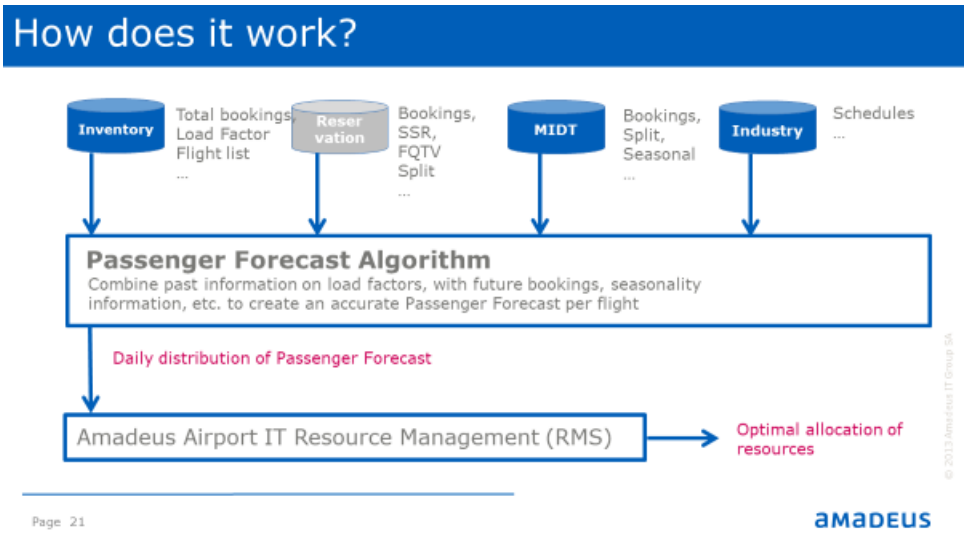
Hypothesis: Hubs would focus a lot on efficiency and retailing and services, so the goal is to attract as many people as possible (hubs are especially well placed for focus on retailing because passengers stay there usually for some time during layovers)

Point to point airports/constrained airports would focus on selling more parking, efficient baggage handling etc, as they cannot increase capacity a lot

Passenger forecast





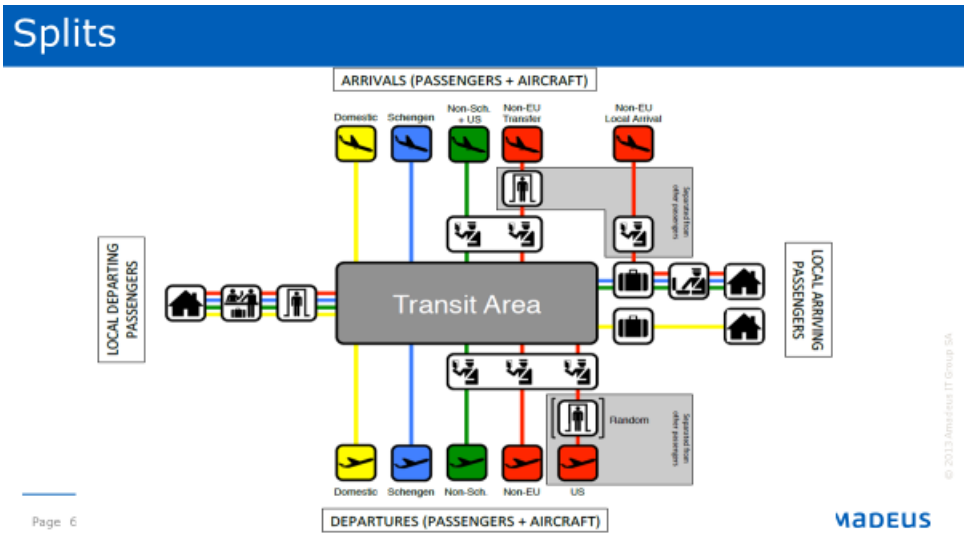


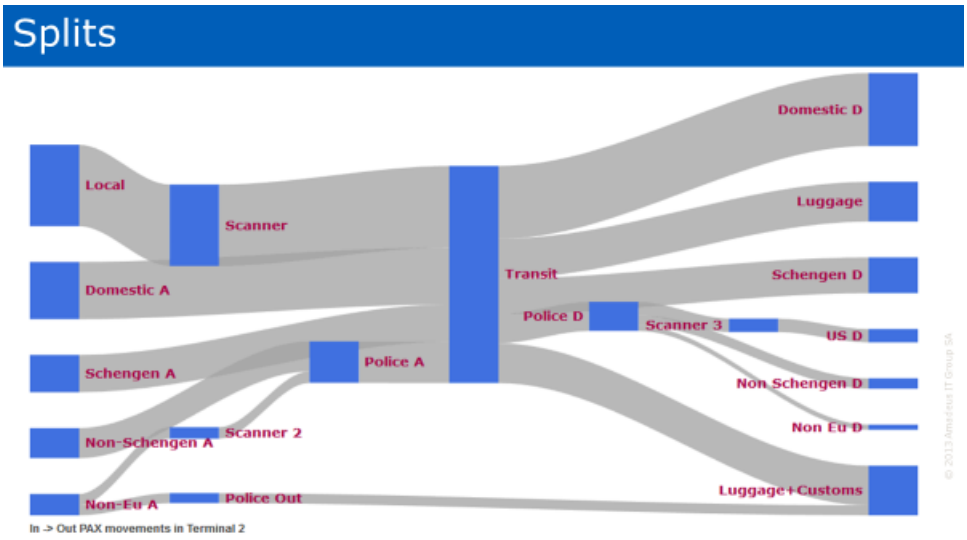
Amadeus was working on passenger forecasting in cooperation with Copenhagen airport because it is essential for airports for resource handling. Passenger forecast is key and specific to each airport, so they might keep it internal or in partner mode (mathematicians are doing forecasts).

Frankfurt airport is using cameras, Bluetooth connection to anticipate passenger traffic (see their whitepaper).

Forecast is the basis for optimization as illustrated above (luggage handling is a big pain point for airports)

Furthermore, the passenger split by nationality, destination, etc is key to analyze and optimize the passenger flow within the airport because not all passengers follow the same steps in their journey.





Furthermore, it is vital for merchandizing (where to place shops to reach a certain target audience, brand level information might be interesting – airports could sell data about passenger origin etc to brands to orient their merchandizing strategies)

75% airlines are coming into Copenhagen airport using the ALTEA inventory (Amadeus system for seat allocation).

They used to have 10% of error before using airport only data. When using the Amadeus algorithm including much more and diverse data (Crossing GDS data (MIDT*), aircraft capacity, schedules - airline info about given route, updated every 6 months, IATA schedule update, OAG, Infineta – aggregators of schedule data, Altea inventory - managing seat management of planes)) they could bring down the error to 2,8%. (For making a model more accurate there are 2 options: including more data or creating a more complex model)

Business intelligence definition

BI is a process to take smart decisions. (Big data is a way or context to address BI, with data accuracy being a big IT challenge)

Current situation

The product roadmap for creating a sophisticated BI infrastructure similar to COGNOS did not gain enough momentum within Amadeus and therefore is still in the incubation phase (passenger forecast piloted with Copenhagen airport). Up to date, the Amadeus systems still provide reporting only. The company objective is to sell big parts of IT infrastructure for airports such as departure control systems, etc first, before selling sophisticated add-ons such as BI because there is a large up-front investment needed for BI to make sense.

Next steps

Xavier Callens advised us to read White Paper (Resource Guide to Airports Performance Indicators) to understand the KPI for airports operations.

We asked him to give us contact to BI manager at Copenhagen airport, to study this airport as case study.

*MIDT data is about distribution, inventory, DCS also represents online sold tickets, LCC data missing (LCCs have high load factor 98% and only few schedules, so easy to forecast)

9.1.7 Interview with Oliver Weber, Manager Business Intelligence administrative at Fraport AG

16th August 2017, 13.00 – 14.30

Oliver has been a consultant for the SAP suite of software since beginning of the 90s. He has introduced SAP BI to Frankfurt airport as a consultant and in 2010 has been asked to work for Fraport AG full-time and head a department. Since then he is the head of the administrative

BI team dealing with SAP. He has a team of 15 people dealing with SAP BI software. Half of the team have been corporate consultants for SAP before joining his team (wanted to stop travelling and therefore became “in-house consultants”). People mostly come from business administration studies who grew into the IT environment without having studied it. It is most important to know internal as well as general business management processes. There are also technicians, but only few as SAP software is easy to use, reporting is easy. There is a separate department for technical questions concerning databases, support, etc with which Oliver’s team is in contact. Oliver’s team deals with controlling, software maintenance, real estate, reporting cost and revenue optimization.

The team supports projects for Fraport AG (15 000 employees). Fraport AG is an airport operator, of which there are not many anymore today as airlines often take responsibility for processing, aircraft cleaning etc (especially important in the US)

General environment:

- FRA is mainly a transit/ hub airport as centrally located in Europe, more business than leisure travellers, many transit passengers, Lufthansa is the main client
- Direct competition with other big airports internationally (luxury airports in Asia, Arab peninsula – new and modern facilities, passengers prefer airports with a better offer) and nationally (Intercity train enables fast connection between German cities), airports seem to move together closer and closer
- Increasing passenger numbers as more and more passengers travel and flying is increasingly cheap, aircrafts getting bigger, less starts and landings
- Aim to become a 5 star/luxury airport with star restaurants (Asian airports already focus on that): focus on passenger well-being, free wifi
- Strong international expansion into Greece, Brazil, Russia: Fraport AG acts either as a consultant helping to build terminals as in several Greek airports or has participations in airports and manages them e.g. Antalya airport Fraport has offices locally to manage the operative business at these airport (need for being present locally), information collected is sent to headquarters to be consolidated.

  Since 7 to 8 years expansions is focus, strong expansion led to a strong increase in revenue

- Airport operating at capacity since already some time, long waiting times at gates and for picking up luggage, passenger processing takes long time compared to other airports
- Limited possibility for expansion in Frankfurt as surrounded by villages (new runway built a few years ago, Airbus A 380 cannot land on this runway as too short due to environmental limits, new terminal 3 for better and more luxurious passenger processing planned for 2022), Munich airport can expand much easier as it is built in the "green field", land available around for construction
- Frankfurt airport's main business is real estate (not only airline management, facilities cleaning, etc) including all the shops as some people even come to the airport to shop

Challenges

- Environmental issues (noise, emissions, etc especially important in urban area), start and landing fees based on aircraft "environmental-friendliness" (emissions, etc)
- Passenger well-being and comfort to become a 5 star airport
- Limited possibility for expansion in Frankfurt
- Low cost carriers - until summer no low-cost carriers in Frankfurt so far, but tendency for LCC carriers growing, more small airlines represented

Business Intelligence

How would you define business intelligence?

Primarily used for consolidating, enriching, capturing, analysing, categorising visualizing data through many different tools/systems.

2 BI teams at Fraport AG:

- **Administrative BI** - predicting, planning, maintaining – near to strategy, controlling
- **Operational BI** dealing with starts and landings, gate information, passenger processing and flow management.

Strict separation of tasks between administrative and operative BI teams, same size of teams, different BI tools.

Administrative BI

Production of reports concerning process optimisation related with real estate, airport fees (analysis of passengers and what products they buy e.g. German business men in transit at Frankfurt airport is likely to buy a coffee, while Russian tourists would be more likely to buy luxury articles)

Accompaniment of projects from A to Z from the business point of view from the definition of the needs and specifications to the implementation and end reporting (people are no technicians, but it is crucial to know internal and business management processes)

Which systems do you use to optimize revenues?

SAP is used for administrative BI at 98%, SAS used for operative BI (information about starts and landings, delays, gate information, how long does it take a passenger to go from A to B)

Also, some "historic" software tools, partly developed internally, especially for analysing, not visualization

Oliver's team defines which software should be used, whole portfolio from SAP (98%) because since 3 – 4 years SAP has included business planning and consolidation into its BI suite (NetWeaver*) allowing to plan, consolidate and therefore to prepare the annual reporting, 2-3% smart notes software as digitalisation of annual reports not possible with SAP

All airports in Fraport AG have to use same system and insert their information into the central information system in Frankfurt to be analysed and consolidated by Oliver's team.

* SAP NetWeaver is the primary technology computing platform of the software company SAP SE, and the technical foundation for many SAP applications. It is a solution stack of SAP's technology products. The SAP NetWeaver Application Server (sometimes referred to as WebAS) is the runtime environment for the SAP applications, and all of the mySAP Business Suite solutions (SRM, CRM, SCM, PLM, ERP, TM) run on SAP WebAS (https://en.wikipedia.org/wiki/SAP_NetWeaver,25.08.2017)

How have the BI efforts evolved over time at your airport?

In the past, only passenger flow was important, today other information is vital e.g. Terminal 1 (1970s) and terminal 2 (1980s) have long hallways without any shops, today this is not anymore adapted, it is important to position shops and incite passengers to go there to shop.

BI has evolved strongly since the 2000s, more possibilities today, hardware is cheaper, so large amounts of data can be stored cheaply, fast information loads possible, data warehouse used in a more modern way, steady increase in acceptance of data warehouse during the last 20 years, all managed internally, less technical know-how needed today

Could topic is important nowadays, Fraport has a few things in the cloud, mainly topics that need little consulting.

Can you give examples of what questions BI helps you to address?

Passenger processing is currently the biggest theme, real estate is the second biggest one.

BI helps to plan which airlines will be coming to the airport generating which revenue, long-term comparison with historic data in comparison to today.

BI allows for flexible ad-hoc reporting for answering business questions (especially interesting when looking at large amounts of data).

Do you use external providers to develop IT systems?

Outsourcing is useful for simple things, dependant on order of magnitude and audience e.g. support und system maintenance. Fraport outsources first level support for IT problems to a hotline, administer tickets. Second level support for software problems provided by Oliver's team e.g. for a report provided by Oliver's team that gives wrong numbers, questions come back to him.

They rarely use external consultants, only when internally skills are missing, only specialists needed (broad expertise inside the team already)

Which factors influence the decision whether to outsource or produce BI internally?

- Order of magnitude of the business
- Type of business (how demanding is the BI topic at the airport, focus on real estate revenues necessitates large BI efforts)

- Consulting effort needed (Close internal customer contact needed, so outsourcing difficult)

Does Fraport AG offer Business Intelligence Consulting for other airports?

Within the Fraport group yes, but not for unrelated companies, Fraport offers consulting and terminal building for airports within the group and those have to pay for the services provided via an internal cost calculation process

What is the order of magnitude of investments related to BI at Fraport AG?

Different year on year, depends if there is for example a new database theme or other big projects, then big investments are necessary, Investments amount to millions of euros per year

Hypothesis: The more focus on non-aeronautical revenue, the more important is BI

9.1.8 Interview with Bernard Raoux, Portfolio Strategy Manager Amadeus Travel Intelligence

8th September 2017, 14.00-15.00

Airlines and airports behave similarly in terms of BI. Some are very mature, they do all internally (in cooperation with a provider, but they will control their BI), they use big data, etc., but some are very immature.

There are 3 types of BI according to Bernard:

4. **Analytics around market dynamics** (competition landscape, competitor performance, etc) → airport cannot do alone because based on industry data (e.g. GDS data sold by Amadeus, Sabre, IATA, etc
   Airports can try to build own estimate, but external is much easier and more data available externally. Market dynamics highly important for new routes development (strong competition between hub airports in Europe, which airline to attract, which routes would be profitable)
5. **Understanding own business, airport operational performance** (gate management, delays, service quality, etc) → done in-house (various systems, need to be put on a platform to be analysed) using IBM, HP, Microsoft, Oracle, Terradata etc

infrastructure

When offering airport BI to airports, Amadeus also uses the above providers and builds a common platform that it then sells to airports
Airports use external providers for infrastructure to save costs
Performance/operations driven by same parameters in all airports → can be outsourced

6. **Understanding the traveller himself/herself** (who is he/she, nationality, needs, profile, leisure vs. business, family vs. single, age) to improve personalized merchandizing to them (upsell parking space, lounge access, shop discounts, fast track, etc) and improve negotiation with shop owners by giving them intelligence about their potential clients

   Today, airports only way to understand travellers is to do surveys in the airport (Copenhagen airport 22 Mio pax received max 200 000 responses for surveys → not representative)

BI 1 types and 3 difficult to do in house, better to outsource, BI type 2 can be outsourced, Combination of 3 types of BI could be done internally

Bernard is convinced that in the long/run, a **hybrid model** will be adopted by airports having people doing BI internally in combination with external providers. Internal people needed to personalize standard tools

Amadeus system based on airline data, available in advance (airports may get data too late), Amadeus forecasting tool can give information about 80% of travellers

Airports can buy data e.g. from Amadeus, they can receive a clean data feed to integrate into their own data warehouse

BI outsourcing influence factors:

- BI maturity
- Budget available
- Type or need

  Recurring/strategic need → better to be built in-house, personalization possible
  One off need → cheaper to outsource
- Capacity of space – space for data centre
- Innovativeness, element of differentiation

E.g. Munich airport does BI internally because strong innovation focus

Size is not a criterion because there are some big airports that are rather immature and some airports are very small, but highly innovative, highly flexible. Airport size depends on location (do people want to go there and for what reason?)

BI in-house advantages:

- Control of data – avoid strategic data to be available to other industry players
- Personalization possible
- Necessary when lack of off the shelf solutions (data combination, forecasting, look for correlations, understanding traveler characteristics might not apply in the same way to different airports, airport specific needs → necessary to build analysis tool yourself)

BI in-house disadvantages:

- Costly
- Often have old technology used when created in-house, while today you need new BI technology (fast-changing technology)

Ryanair is very advanced in BI and sees it as strategic differentiator (uses external providers, investing a lot, opening new centre in Madrid, building new BI team, 80% in-house), **Swedavia** - Scandinavian airports (reviewing their BI, internal department creating own platform), **Copenhagen airport** has nearly nothing in terms of BI and expects Amadeus to deliver this piece of software

Air France and **Munich airport** have invested a lot in doing BI internally because they consider BI as a key differentiator

9.1.9 Interview with Jaqueline Dechamps, Manager Business Intelligence operative at Fraport AG

4th October 2017, 8.30 – 9.30

Airport environment - challenges

Airports need to optimize their existing processes due changes in the passenger structure and behaviour and the competitive environment. Passengers are more and more price sensitive and even though Frankfurt airport is still competitive as an international hub airport, it faces competitive pressure especially from the development in the low-cost segment. Since 2 to 3

years, Frankfurt airport loses passengers to Cologne Bonn, Düsseldorf Frankfurt Hahn and other regional airports because low-cost carriers land there and manage more and more to also attract business passengers. As low-cost companies are flexible, move fast and can easily offer new targeted programs for different passenger groups, they create a rapidly changing market environment also for airports. Therefore, Frankfurt airport wants to open up to low-cost carriers to not get overtaken by other smaller airports welcoming them. For speeding up this process, Frankfurt airport is accelerating the timeline for the expansion of a part of Terminal 3 to process low-cost carriers there.

When such decisions are taken, also the impact on distances for passengers to change planes and the impact on the airport infrastructure need to be considered, which is where the analysis of operative data is invaluable.

The analysis of operative data (passenger structures, quantities, historical development etc.) is important for understanding which levers there are for influencing the challenges mentioned above.

Frankfurt airport has grown organically, meaning that passengers may need to walk long distances for getting to their connecting flight. Frankfurt operates an integrated operating model, landside, airside, ground transport responsibility

If transit distances for passengers would be completely optimized, maybe ground handling would not be able to follow and move baggage as fast as passengers. Therefore, a general process picture is needed when talking about optimization.

BI definition and team

BI is a data-driven approach that allows to gain insights for the company that are then translated into concrete recommendations, decisions and actions.

The operative BI team consists of about 14-15 people.

All people are specialized in certain IT/programming languages, etc. but also are in direct customer contact to support and accompany the customer from the definition of their question and BI needs to the implementation. Half of the team consists of programmers and

developers, while others focus mostly on process consulting supporting the internal customers in their BI project.

Depending on the customer's maturity in terms of BI, sometimes, the team has to start by helping the clients define the exact need based on what is currently used (e.g. Excel) because they do not know exactly what they want in terms of BI, they just have an operative problem. Then the BI team also goes out to observe the processes that they are expected to analyse (e.g in the terminal, apron area, etc) to understand them better before building reports suggesting improvements.

Operative BI system

To date, Frankfurt airport cannot directly monetize operative BI yet. Based on BI, processes change and following these changes, the data changes proving that there was an impact. However, there is no direct correlation between BI and revenue or cost savings changes so far.

Operative BI at Frankfurt airport is based on a SAS data warehouse that has been developed together with SAS since the 1990s. SAS offers a portfolio of different small software products (used by users on their computers) and Fraport uses them based on a corporate license. BI is developed using the programming language SAS base, which is why technical people are necessary.

Within Fraport, 40 IT systems are connected to the data warehouse and operative BI system, including the airport operational database (AODB), ground handling services, passenger information, aircraft handling information, luggage, etc. There is also some external data that comes into the data warehouse e.g weather data, some data from SAP about settled/charged flights, baggage, cargo and sometimes airline data, but only in project mode for a limited time as airlines in general do not want to share their proprietary data. There is a working group called Airport open API working on improving data exchange between airports and airlines to be able to optimize processes for both parties.

Operative BI activities

- Data processing control (ETL – extract, transform, load) represents 80% of BI efforts. As raw data never comes in a perfect form, the BI team needs to harmonize and adapt the data to fit a common structure and naming. Example: incoming and outgoing

aircrafts appear as one character in a certain column, but in different systems, they are called A and D for arrival and departure, in another I and O for inbound and outbound and in another one 1 and 0 mean the same. Here, the data needs to be adapted to fit the common A and O naming when bringing together different data sources.

- Processing, report production and graphs, automated decision recommendations represent 20% of BI efforts.

There is no integrated approach to connecting the administrative and operative data warehouses until now. They run parallel and only on demand they are joint on a project basis for a limited time.

Historical development of operative BI at Frankfurt airport

The operative BI team has strongly grown in an organic way since 2004 when it was introduced and has strongly changed its focus point. The team started with 3 people and today counts 14-15 people. Due to the BI systems being developed internally, the team could react fast to demand from internal clients and add high value.

The team started by doing “classical” BI, processing and analysing data from the day before, comparing different time horizons in the past.

However, only 3 months later, the focus had already changed and people wanted to know what happens today, so Frankfurt airport was one of the first airports to move to real-time processing (data processed within max 5 min) and away from classical BI.

Until today, the operative BI team is being strongly solicited with demands from internal clients.

Today, they demand BI to predict what will happen in the future based on past data.

The next step then is simulation, where statistical models help to simulate scenarios.

BI outsourcing vs production in house

Frankfurt airport uses solutions from SAS institute for 90% of its operative BI needs (servers, computing power, interfaces)

The rest is developed using R, which is a programming language used for statistical computing and allows for a rather mathematical statistical approach to BI. It is used at the airport because many of the internal customer groups are familiar with this language.

The operative BI team has also developed 2 specific interfaces themselves as they did not find the right tool in the market.

- API in Java for visualizing an interactive airport map with real-time aircraft movements for operative employees (based on data from data warehouse)
- Interface for an application aiming at predicting passenger flows at critical process points e.g. security check to improve passenger well-being and reduce stress in the terminal. The application can predict with 98% certainty how many people will be at a certain point of time in a certain place within the airport. Employees then use this information to tell people how they can get through the checkpoints faster.

Today, all BI infrastructure is held internally within server centres at Frankfurt airport for several reasons.

- Organic development since 2004 when the operative BI team has been created, fast reaction to client demands, fast decision taking possible
- High security risk due to confidentiality of data (European and German data security regulations)
- Specialization - Frankfurt airport's operative BI is strongly tied to SAS as data processing has been developed base on its technology, so a significant effort would have to be made on migration and a transition would entail high costs
- Internal know-how – employees can accumulate knowledge and transmit it to their colleagues, while external consultants often leave after their mission without transmitting their knowledge. They can take it with them and potentially even sell it to other companies.
  Many large companies work with lots of external consultants, but there are none in the operative BI team at Frankfurt airport because they want to keep internal knowledge inside.

However, producing BI in house entails high cost because BI technology changes fast and updating servers is slow and costly.

The BI market is moving towards standardization and the cycle of technological innovation in the BI space is shortening, which could benefit outsourcing.

Jacqueline Dechamps believes that a good mix between total outsourcing and total in-house production needs to be found in the future. Infrastructure that is standardized can be

outsourced, while BI content and development should remain in house. It might even be possible to outsource/near shore (within the EU) the data processing and harmonization part (80% of BI effort) if this could be done by specialist companies at a lower cost. By buying this software as a service from a specialist company, the airport could significantly save on personnel cost and gain flexibility. Today this is not yet possible and its future feasibility will depend on how the new European regulation on data security will play out regarding which information can be exchanged (There are high fines up to 4% of global annual revenue for violating this regulation) The challenge is to ensure data protection in a fully digitalized world.

The options to go to the cloud or use software as a service is being observed and might get interesting in the future when significant cost savings would justify a migration.

BI budget

The largest part of cost related to operative BI is manpower and licenses. There is not so much infrastructure investment. Jacqueline Dechamps gives an estimate of 0.5% of revenue as investment into operative BI and an order of magnitude between 1 000 000 and 10 000 000 EUR per year. This cost is only related to the cost of the business intelligence competence centre, so only IT related to BI, but additionally there are people in the business areas that are also dedicated to work on BI (data scientists, etc)

General outsourcing influence factors

- Cost-benefit can be dependent on size of airport (small airports with only few flights per day do not need an AODB and sophisticated IT if movements can be tracked with an Excel or even only on paper)
- Airport business model: passenger number and type – transit hub airport vs. regional airport, annual revenue, service level – is the airport providing ground handling services, etc. or only airport operator* → integrated airports would need to do more BI than only airport operators as they need to optimize their processes to save costs
- Human Resources: Ratio of total empolyees : people in IT : people working on BI (at Frankfurt airport 20 000 : 400 : 25)

Operative BI for other airports within Fraport AG

Today, the operative BI team does very little BI for other airports within Fraport AG. For some of these airports, Fraport is only an airport operator, so it has consulting contracts to optimize costs, but is not responsible for all processes.

For others, such as the 14 regional Greek airports, Fraport has a full concession and is responsible for everything, but they are too small to need deep BI insights on their processes.

They simply send their results on a quarterly basis to be consolidated by the administrative BI team.

*The airport operator model is especially common in America and Asia. The airport provides only the building to the airline and then it is up to the airline how to equip and operate the buildings.

Hypothesis: Companies are strong in BI where there are pain points that they need to address.

9.1.10 Interview with Jeremy Hamon, Business Analyst, Lagardere Travel Retail

5th November 2017, 19.00 – 20.00

There are several actors in airports that derive revenues for the airport: airline companies, retailers, car rental companies…

The major problem that we see is that the different actors do not exchange data. The airline companies work with external data providers such as Amadeus for instance, but refuse to give its collected data to retailers. They do not share passengers' information with retailers as the data is too sensitive. Otherwise, retailers would be able to know their aircraft load factor when airlines make money, when they lose money, etc. They might share it with airports, but not with retailers. So, when you are a retailer you have to estimate passenger flows. The data information for retailers is based on sales revenue in store, and tickets data (travel destination, airline company used, and citizenship. Cashiers are not allowed to note down personal information as shown on passports). With this data we use BI to create reports based on a combination of sales revenue and tickets data, but some data is to be carefully considered as it is manually entered thus possibly containing errors. The problem we have with our BI system is that it did not include predictive analysis so at Lagardere retail we decided to launch a "poke" of Big data (volume, variety, velocity, and veracity). A "poke" is a proof of concept, is something that is designed and implemented really quickly. It is designed to be tested to see of it works. People tend to confound Big Data and Machine Learning. Big data is a pool of

data, being meaningful if not analysed. Machine Learning (ML) is an algorithm that learns and self-improves by its own. Although BI can be used for predictive data, we did not use it and tried to use ML for predictive analysis at Lagardere Travel Retail.

What is the advantage of ML over BI?

BI is about reporting providing excel sheets to vendors. The ML used at Lagardere retails had 2 algorithms: one was used to help vendors for generating additional sales. After scanning articles for a Chinese customer that has just bought a specific cognac brand, the algorithm allows for the vendor to see a list of other potential articles the customer might be interested to buy. We implemented it into our retail stores at Charles De Gaulle airport for testing. What we found is that 1 time over 5, the algorithm was right, and the customer was purchasing one of the recommended articles. Our "poke" was right 20% of the time which is great for a first model!

Our second algorithm highlights statistical correlation between all products, and can derive strong correlation on small individual quantities, which is something that cannot be analysed in BI. In BI you mostly see the chunky knit, but with this ML, we are able to reduce it to a smaller group of persons but that are 250% more willing to purchase a product with another product. For instance, we found that only French people buying olive oil are extremely likely to purchase vinegar as well. ML also gives the possibility to include open source data (available online such as the weather) and correlate it with internal data such as the sales of a specific product according to weather and temperature.

Our BI was allowing us to highlight the trends, but the ML allowed us to be more flexible, with continuous analysis. The analysis allows to target a specific person which is not possible with BI. ML is much more powerful in predictive analysis as it continuously adds variables, tests them and if relevant implements changes right away in the predictive model. By combining Big Data and Machine Learning, correlations to derive additional sales related to one individual can be found rapidly.

Why using BI when ML is more powerful and available?

The terms BI, Big Data and Machine learning are often confused as these are quite recent themes. In terms of formation, BI is easier for everyone as Machine learning requires solid knowledge of coding, data science, data engineering, etc. to create a neuronal network. Most of people can be data analysts, but data scientists are not the same and demand programming,

mathematical, and statistical skills. It is also really hard to implement in a business. We had some IT issues when developing it as data access was really hard to obtain across IT department. We were supported by the CEO so everything went through fortunately. Also it depends on the sector of activities, some sectors have more interest in implementing ML whereas for others only BI is enough (digital sector is preferred for ML for instance).

9.1.11 Interview with Lindajoy Harris, Strategy and Business Manager at Philadelphia Airport

11th October 2017, 18.45 – 19.45

Economic environment

There is a belief with the new administration in the USA, the new president Trump, that he will fund aging infrastructure. The economic outlook is hopeful in terms of improving airport infrastructure. Philadelphia airport is one of the most aging airports so additional funding would be great if the president keeps his promise. In general, there are a lot of things that airports are doing in order to build and make the most of construction they have so in general it is hopeful.

We saw an increase in passenger volume last year, which generated more money to reinvest in build more infrastructure. There is a small percentage of the price ticket that goes to maintaining our infrastructure. Having passenger growth is good but it needs to be correlated with revenue that you get. What is passenger growth or decline and what is the non-airline revenue growth or decline? Our passengers are split into 50% leisure and 50% business. We projected growth in passengers and decline in operations because we have seen an industry growth overall over the last few years. We also projected a decline in operation due to Airline Companies trying to minimize their operating costs. Basically airline companies no longer want to fly with empty aircraft so they are reducing their operations to minimize their operating costs and be more efficient. Operation will decline because of what I explained but they might growth because we are being added as additional destination by some airlines. As the economy continues to growth, Philadelphia airport continues to attract airlines and manages to bring airlines in. We have flights to Ireland, so there might be other airlines that want to fly to Ireland as well, but choose to not operate this flight. It will depend on their customers' demand and what they need to do to keep them loyal. So there was a decrease but it will level up and may increase over time.

What is challenging is our ability to move in a very fast-paced environment where a lot of airports are bureaucratic. They could be owned by the city so the challenge is to operate as a business and work efficiently as any other business would, but still work within a bureaucratic environment.

Business Intelligence

Definition

Multiple definitions of business intelligence as focus on the technology, integrating data, trending data, what are the systems that we need to use to make sure the data is integrated and that's vital but that's more an IT function. IT would be our strategic partner, so I look at data in a sense of exactly what is says. How can we run our business in a more informed and intelligent way? What do we think and where do we think we want to go in the organization and is it what the data tells us? For instance, we may feel that most business travellers are male. Is that what data tells us? Business Intelligence means that we challenge our assumptions. We start looking not just at our business but also at our environment. Airports have a lot of data, tons of data. The other piece of business intelligence is how we prioritize this data? As we continue to have more data available to us, the "Big Data", what should we use and what should we use it for? It is related to what is our vision, what are our supporting role and objective and what kind of metrics would let us know what we are doing well or not. What kind of metrics, data do we need to look at to make informed decisions that help us to figure out a way to achieve our objectives. So we are not looking at every piece of data that we have but focus and prioritize what data are we going to look at, and how we can leverage that in order to help us understand our passengers, employees. Example: one of our goals is to transform our employee's experience so we are in the middle of doing an employee survey so with the HR department I asked them what kind of data do you need, we can collect everything from satisfaction to engagement, this could be 200 questions or more. So what is really going to make an impact, what information do you need to know in order to build the program that is going to transform the employee experience. We have some data, but we need some more data, so we would go out and get it. If we gather data, it needs to be prioritized and focus on what is going to help our strategic plan. Other people are more operational so they will look at data in a more operational way in terms of if we have many large

international flights coming then I want to make sure that we have more staff in this terminal in this area during this certain time. So I think it is related to strategic and operational aspects.

Systems to optimize revenues

I don't know. There are different ways we optimize revenue but if you are looking at particular systems, I am not sure. I would say, it is a mixture of proper work, internal governance system, and I think the software that we use is not a commercial software, it is something that the IT staff built. It is a software that has been developed in house over many years as an airport management system.

Business intelligence efforts evolution over time

We are right in the middle of hiring a chief technology officer so a lot of things will be developed in that way. At this point what we are doing is trying to gain data awareness so for people to understand what data do we have, who owns it, how are we keeping it, and then data cleaning before integrating the data. We are at the point where we integrate data so we have to make some decisions about who gets the priority. Everybody has data so the question is where do we start and who gets the priority. We have to figure it out with the strategy and operational sense. We are still in the process of building data awareness, data cleaning and some of our data is to be integrated. We do not have fully integrated data at the moment. There has been a larger focus on BI but the IT department itself has not grown. We have also a business analyst, so that is growth. But it will growth more once we have the chief technology officer in the next months, he will work on the technology that is needed for our infrastructure. I imagine there would be a lot of initiative and focus on Business Intelligence but I am not sure what it might be. I hope our organization will use Business Intelligence to make money through passenger driven data and saving money though process driven data. Our role is to make data driven decision making possible so that we try after to partner with strategic people either people who have contract with us or people in-house and say here is how we believe it can help. We hope that our executives will have a look at that and say what strategic initiative can I plan based on the information provided that will grow our airport.

Examples how BI help to address issues

Improve the employee experience, and giving the right data to programming, understanding where passengers are, how they feel (through survey analysis), a lot of demographic information, how old people are, international vs domestic travellers, how many are male vs

female, and how we break things down to terminal, how people rate the experience depending of the terminal, what type of checking methods are used to different terminals, gender tendency regarding satisfaction. We pulled out data to base our recommendation to figure out a way to maximize our revenue. So our recommendation on our last passenger survey was to focus on the household spending and look at who spends the most money and tailor it to the type of purchase we want to make (impulse, gift…). So you take the market research and then figure out a way to maximize revenue based on the information provided.

External providers of IT systems

We are unique in a sense that most of our IT staff for as long as I can remember are Venice consultants and are being here since at least ten years. They are not technically part of the company but they are part of the culture. The IT consultants outsourced from Venice Consulting Group are working on developing the IT systems in-house. We also use external contractors to help our consultants to develop the IT system. We use external contractors for smaller systems that are doing very specific things that we might buy.

Factors influencing the outsourcing decision

Urgency – how fast does it need to be built and do we have the manpower needed available internally

Cost – looking at cost to develop it in house versus outsourcing it. Maybe we have the capacity in house but it is more expensive than outsourcing it.

Capacity – if we need a particular skill and no one in house has it, we need to outsource

Other questions

Recommend analyst report

ACI Research "ACRP BI" reports but not sure if what we are looking for is available online

Amount of Investment BI

I don't know. To me BI is not just part of the IT department but also in our office in strategy, operations. I am looking at it as an organizational initiative and not as a BI initiative. There are people doing BI in their department, they are not doing it in a full-time position.

Integrated Business Model

Philadelphia airport has an integrated model for everything. We do not just rent space and take care of facilities. Most of the systems are either run by us or run by our tenants.

Data Security Concern

I am not the person to answer that.

9.2 Cross Case Analysis – Data reduction

Airport size classification:

- 0 – 20 Mio passengers = Small
- 20 - 40 Mio passengers = Medium
- 40+ Mio passengers = Large

Criteria	Nice	Brisbane	Philadelphia	Frankfurt
General Environment				
Annual Passengers	12.4 Mio	22.3 Mio	30.7 Mio	60.8 Mio
Airport Size	Small	Medium	Medium	Large
Location	Constrained	Not Constrained – string infrastructure investment planned (parallel runway, regional satellite facility, upgraded domestic and international facilities, and improvements to transport networks*)	Constrained	Constrained
Competitive environment	Medium competition (competition from Geneva, Barcelona airports but limited as Cote d'Azur tourist come to Nice)	Strong competition (Gold coast airport – much cheaper than Brisbane to attract more tourists)	Medium competition (competition Baltimore/Washington, and Newark airport) PHL has a competitive positioning with lower airfares and good air travel demand. Large traffic hub and regional cargo hub.	Strong competition (especially from Munich airport, large hub, reachable easily from Frankfurt with Intercity train)
Destination	Tourist destination	Tourist destination	Hub airport for tourism and business	Hub airport for transit passengers
Revenue structure	60% Aeronautical 40% non-aeronautical revenues	50% Aeronautical 50% non-aeronautical revenues	61% Aeronautical 49% non-aeronautical revenues	60% Aeronautical 40% non-aeronautical revenues

Business Intelligence				
BI definition	BI is used only for internal data in order to find correlations between the different types of data collected at the airport	Traditional BI is all about assisting business users with informational needs – providing good quality business information to the right people at the right time. If we do our job correctly business managers can make fact-based decisions and ultimately improve business performance.	BI is used as a strategic and operational partner to challenge assumptions and make more informed decision based on data	Primarily used for consolidating, enriching, capturing, analysing, categorizing visualizing data through many different tools/systems. • Administrative BI - predicting, planning, maintaining – near to strategy, controlling • Operational BI dealing with starts and landings, gate information, passenger processing and flow management.
BI status	Medium focus until 2016 Since 2017 higher focus	Low focus until 2011 Since 2012 higher focus	Low focus until 2017 Stronger focus in 2018 with future chief technology officer	Strong focus on BI since 2004
BI location within company	IT department	Strategic planning and development department	Strategy department	IT department
Size BI team	1	4 business development department + 2 IT people	2 (1 strategy BI manager and 1 business analyst) but 1 chief technology officer in the future	30 (15 administrative BI team, 15 operative BI team)
BI team scope	Functional link between outsourcing company and internal users of BI – translation of business needs into functional requirements	Consolidate data from different applications into the corporate data warehouse The BI team's goals and objectives are: » Treat corporate data as a valuable strategic asset » Provide a consistent view of corporate data and improve information accessibility » Link and integrate data sets to	Data awareness, data cleaning and beginning of data integration	Administrative BI team: Production of financial reporting and reports concerning process optimisation related with real estate and airport fees. Operational BI team: Operational data analysis to understand the internal client's paint point and gives recommendations for improvement based on data

		uncover new insights to improve fact –based decision making » Deliver competitive advantage through data insights		
BI usage	BI is used in one hand for operations eg reporting and on the other hand for decision support and simulations. For route development, purchasing external data is vital.	1. Providing information to the various business and commercial units to improve business performance and support data requirements for the corporate planning department 2. Insuring that his department as planning function across the airport has data that supports the planning process across lots of metrics such as runway performance, passenger busy hour, corporate planning cycle	BI is at its early stage of development. The core expectations of BI are: 1. Provide passenger driven data to the various business and commercial units to growth passenger revenue 2. Use process driven data to provide excellent customer service at reduced cost	Administrative: BI helps to plan which airlines will be coming to the airport generating which revenue, long-term comparison with historic data in comparison to today Operational: BI helps to optimize internal resource for customer service improvement
BI tool used	IBM Cognos, Kibana, Qlikview	Cognos, Scorecard, Microsoft Power BI, Qliksense, Excel	Airport management system	SAP (98%), smart notes, (2%), SAS
Make versus Buy				
BI Infrastructure	External only	Internal data warehouse but supported externally	Internal infrastructure built by external consultant but not operational at the moment	Internal only
Outsourced Activities	Keyrus (BI provider) provides infrastructure and support for all BI in Nice airport	Local BI consultancy for helping with backlog and new project initiatives	IT staff is outsourced, use external contractors to support their consultants to level the IT system. Contract external	Some first level IT support and system maintenance, consultants brought in only rarely when specific skills not available internally

			providers for specific IT systems	
Outsourcing factors	• Off-the shelf availability of applications satisfying the BI needs • Reliability of potential outsourcing partner due to the strong dependence of the airport on the outsourcing partner • Control over data	• Specialization • Cost & Risk • Security • Focus on internal knowledge	• Time • Capacity • Cost	• Order of magnitude (size) and cost/benefit definition • Business model (passenger type and volume, turnover, level of service offer, integrated business model, real estate oriented) • Consulting effort needed • Human resources

*http://www.abc.net.au/news/2015-02-03/brisbane-airport-expansion-plan-gains-federal-approval/6066786

9.3 Cross Case Analysis – Testing Hypothesis

Research question: Which airport specificities are influencing the choice of outsourcing vs in-house BI development?

9.3.1 1st Hypothesis: Small airports are more inclined to outsource BI than large airports

Criteria	Nice	Brisbane	Philadelphia	Frankfurt
Airport Size	Small	Medium	Medium	Large
BI Infrastructure	External only **Outsource**	Internal data warehouse but supported externally **Mix of outsource and in-house**	Internal infrastructure built by external consultant but not operational at the moment **Mix of outsource and in-house**	Internal only **In - house**

9.3.2 2nd Hypothesis: Constrained airports (in terms of expansion potential) focus more on BI than unconstrained ones

Criteria	Nice	Brisbane	Philadelphia	Frankfurt
Location	Constrained	Unconstrained – string infrastructure investment planned (parallel runway, regional satellite facility, upgraded domestic and international facilities, and improvements to transport networks*)	Constrained	Constrained
BI status	Medium focus until 2016 Since 2017 higher focus **Medium**	Low focus until 2011 Since 2012 higher focus **Strong**	Low focus until 2017 Stronger focus in 2018 with future chief technology officer **Low**	Strong focus on BI since 2004 **Strong**

9.3.3 3rd Hypothesis: Airports facing high competition focus more on BI than those having a lower competitive environment

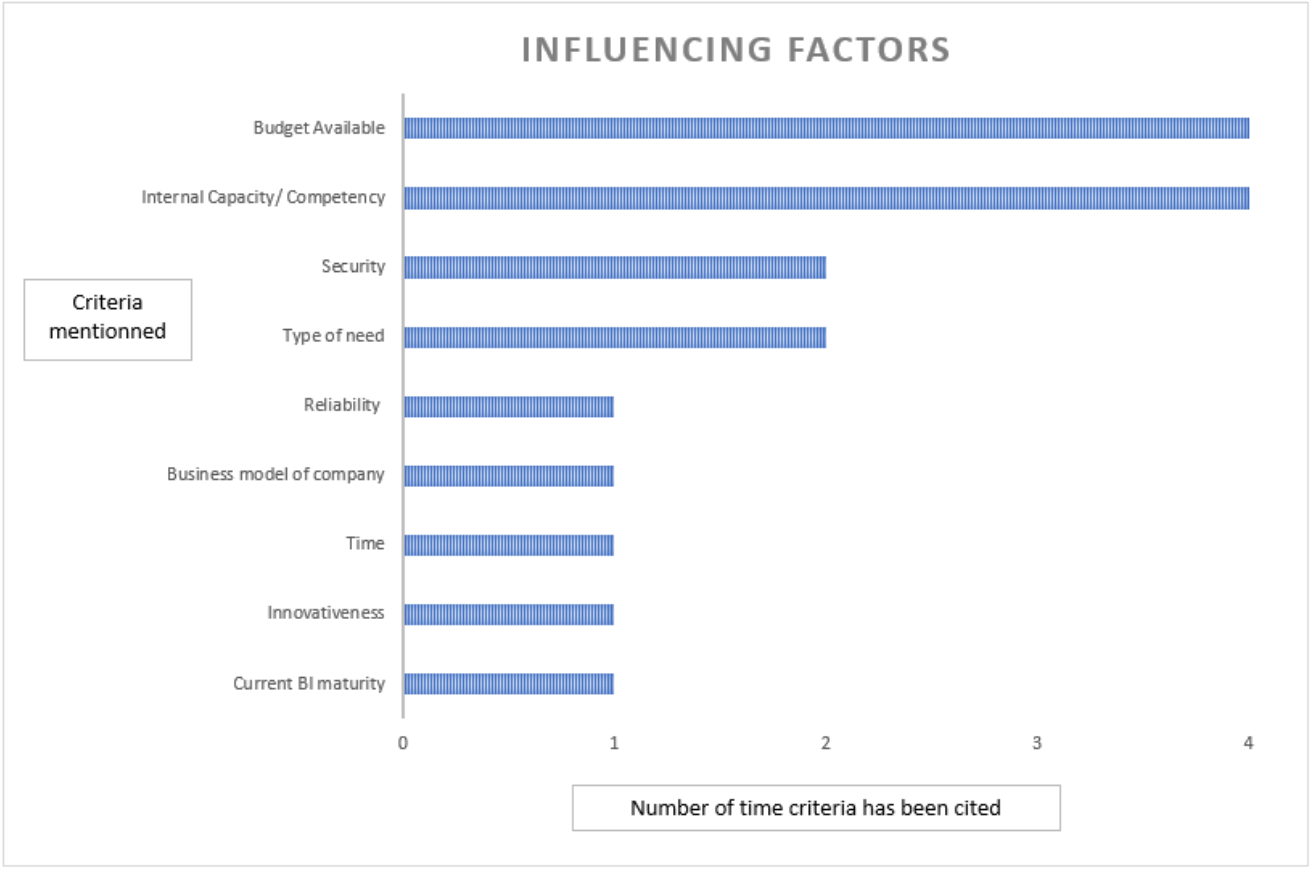
Criteria	Nice	Brisbane	Philadelphia	Frankfurt
Competitive environment	Medium competition (competition from Geneva, Barcelona airports but limited as Cote d'Azur tourist come to Nice)	Strong competition (Gold coast airport – much cheaper than Brisbane to attract more tourists)	Medium competition (competition Baltimore/Washington, and Newark airport) PHL has a competitive positioning with lower airfares and good air travel demand. Large traffic hub and regional cargo hub.	Strong competition (especially from Munich airport, large hub, reachable easily from Frankfurt with Intercity train)
BI status	Medium focus until 2016 Since 2017 higher focus **Medium**	Low focus until 2011 Since 2012 higher focus **Strong**	Low focus until 2017 Stronger focus in 2018 with future chief technology officer **Low**	Strong focus on BI since 2004 **Strong**

9.3.4 4th Hypothesis: Airports focusing on non-aeronautical revenue have stronger focus on BI than those focusing on aeronautical revenues

Criteria	Nice	Brisbane	Philadelphia	Frankfurt
Revenue structure	60% Aeronautical 40% non-aeronautical revenues	50% Aeronautical 50% non-aeronautical revenues	61% Aeronautical 49% non-aeronautical revenues	60% Aeronautical 40% non-aeronautical revenues
BI status	Medium focus until 2016 Since 2017 higher focus **Medium**	Low focus until 2011 Since 2012 higher focus **Strong**	Low focus until 2017 Stronger focus in 2018 with future chief technology officer **Low**	Strong focus on BI since 2004 **Strong**

9.4 Cross Case Analysis – Make vs Buy decision factors of BI activities in airports

Influencing factors	
Criteria	**Cited**
Current BI maturity	1
Innovativeness	1
Time	1
Business model of company	1
Reliability	1
Type of need	2
Security	2
Internal Capacity/ Competency	4
Budget Available	4



9.5 Framework of influencing factors Make vs Buy decision of BI activities in the airport industry versus general factors in the literature review