PIRAEUS UNIVERSITY of APPLIED SCIENCES

MASTER THESIS

Athens International Airport: the impact of the economic crisis on traffic and the way to recovery - a data analytics study.

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A thesis submitted in fulfillment of the requirements
for the degree of ***Master in Business Administration***

in the

SCHOOL of BUSINESS and ECONOMICS
DEPARTMENT of BUSINESS ADMINISTRATION

September 2017

ACKNOWLEGEMENTS

The completion of this thesis could not have been possible without the kind assistance of some experts of the field. I wish to express my gratitude to:

My supervisor, Professor Yannis Theodoridis, Director Data Science Lab, Department of Informatics, University of Piraeus, for his guidance and encouragement
Mr. Ziomas Alexandros, Manager, IT&T Business Transformation and Support services, AIA, for his targeted directions
Mr. Nektarios Psycharis, PhD, Team Leader IT&T Business Analysis & Project Management, AIA, whose contribution to this project has been vital
Miss Anastasia Christodoulou, Software Engineer, IT&T Business Unit, AIA, for her time and support

I would also like to thank the TARGIT BI suite Team for their technical support.

Date: September 13, 2017

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TABLE OF CONTENTS

ABSTRACT

2008's global recession provoked harsh stagnation or declination on the operation and traffic of European airports as a result of the crisis in the airlines industry. This thesis discusses the impact of the economic crisis on the traffic of Greece's main hub airport, Athens International Airport (AIA). A data analysis of AIA's data warehouse is conducted via a business intelligence platform namely *TARGIT DECISION SUITE 2017* for the period from year 2010 to year 2016. The analysis compares information of the crisis period (2010-2013) to this of the after-crisis period (2014-2016). The analysis gives insights of the remarkable increase in airport's traffic after indicative year 2013 that lead to discussions about how AIA managed to recover from recession. The contract with a strong national airline as well as with a solid low-cost carrier seems to have contributed most to this recovery.

Keywords: *business intelligence, data mining, global economic crisis, recession recovery, airports, Athens International Airport, airlines*

Chapter 1: Introduction

The airlines industry produces a vast volume of data in an everyday basis including information about passengers, flights, aircraft moves, baggage handling, maintenance activities, retail services etc. This data is very useful to the airports' management as well, since it provides statistics of past and present deliveries of airport customers that can be translated to revenues for the airport hub; or it can provide knowledge of the expenses occurred for developing necessary infrastructures. The intelligence gained can make useful predictions for future airport traffic and for wise use of budgetary issues.

AIA maintains a large data repository in its SAP Management Information System (MIS), empowered by ORACLE's Enterprise Resource Planning (ERP).

Undoubtedly, the global economic crisis of 2008 and its results in the industry is of great interest.

The present Thesis provides analytics and editing of airlines data concerning passengers, flights and carriers for the period 2010-2016 on behalf of the Athens International Airport. The main objective is to mine information and make useful correlations regarding the traffic at the airport before and after the airport's economic crisis. For this purpose, a Business Intelligence (BI) platform namely "TARGIT Decision Suite 2017" is utilized to generate charts and Key Performance Indicators (KPI).

Business Intelligence (BI) is the process of analyzing and editing critical information to produce knowledge that will be used at the decision-making of an organization. Through the Data Analytics techniques, its target is to mine very important information (data mining) and lead to useful predictions. Data input in an organization delivers very little value to the organization unless the users have access to this data. Only after this information has been involved in the decision-making its usefulness becomes comprehensive.

The steps of the BI process can be summarized in the following:

Data Sources and Data Warehouses: The base of the pyramid is the beginning and most important element of the process: the data sources. Without data availability and accessibility there can be no other action. The data source is raw, unstructured data that can be in the form of table, text, image, web page etc. The data warehouse is where the data source is extracted from and structured in order to be exploited. OLAP enables end-users to perform ad hoc analysis of data in multiple dimensions, thereby providing the insight and understanding they need for better decision making. The above processes (data sourcing and data warehousing) are taken over by the Database Analyst of the organization that conducts the analysis project.

Data exploration and Data Mining: The next stage is the exploration of data where statistical analysis, querying and reporting is conducted, supported by the OLAP multidimensional analysis and attributes setting. The data mining follows as a critical

stage of the BI process, since the business information is discovered at this point. There are several technics for the analysis of data the most popular of which are Regression, Clustering, Decision Trees, Visualization. The Data Analyst, who handles these two stages, expects to discover useful insights as a result of the data analytics.

Visualization techniques and Decision Making: visualization is very popular to current enterprise processes, since it provides modern presentation of the analytics results. This is the stage where the Business Analyst should produce understandable dashboards via the system and convey their information to the Management of the organization that is responsible for the decision making.

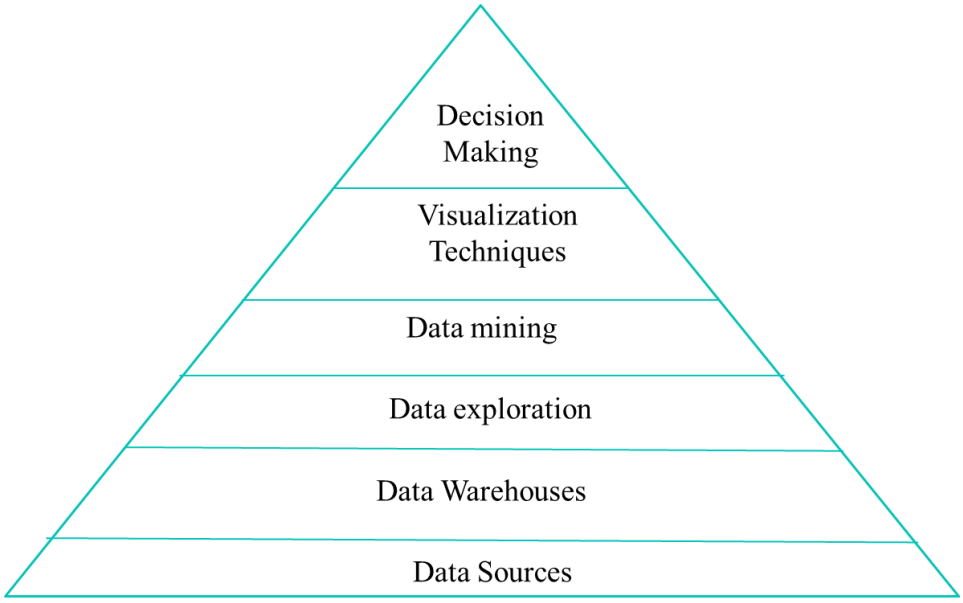


Figure 1.1: the BI Pyramid

The present Thesis, through the literature review, displays the techniques and methodologies that were initialized and evolved through the years to elevate the analysts' project planning competence.

Chapter 2: Thesis Objective

Athens International Airport "Eleftherios Venizelos" was launched in 2001 and currently employs 13.000 people in around 300 side-businesses. These numbers make it a very critical element of the Greek financial productivity. The global economic crisis of 2008 had a negative rebound to Athens airport's traffic similar to many other European airports. The analysis in this thesis attempts to enlighten the crisis period as far as the airlines and passengers traffic is concerned.

Athens International Airport (AIA) maintains data warehouses in their Management Information System, where information concerning (among other) flights and passengers are inserted. For the present work two relational model tables are given, under the file names FLIGHTS_PAX.xls and PER MONTH.xls, containing data about: Airlines Names, Number of Flights, Number of Passengers, Year and Month of flight and Destination of flight.

In this crosstabulation there are 958 registrations from year 2010 to year 2016. Considering year 2010 as the second year of declining traffic for AIA, this thesis will attempt to explain why there was a critical turning point (bend) in 2013 after which there has been an increase in traffic.

Consequently, the following chapters will be focused in the analysis of the obtained data for the time period 2010-2016. The period 2010-2013 is considered the crisis period, while the 2014-2016 the after-crisis period.

The analysis to be developed will seek answers to the below-mentioned critical questions:

Q1) What are the percentages of passengers traffic before and after the crisis?

Q2) What are the percentages of flights number before and after the crisis?

Q3) Which is the predominant destination?

Q4) Is the number of airlines related to the passengers traffic?

Q5) How are the carriers classified and what is their flight portion to AIA?

Q6) Which carriers' traffic was increased/decreased?

2.1 Thesis Organization

The thesis is articulated as follows:

Chapter 3: The relevant scientific literature is transcribed, starting from the used technologies and methodologies of Business Intelligence industry. A comparison of the state-of-the art BI suites is investigated to strengthen the election of the suite that is utilized for the present analysis. Hereupon, the airlines and airports industry is reviewed in terms of the alterations occurred due to the global economic crisis. Finally, a snapshot of the Greek situation is presented.

Chapter 4: Our approach of answering the queries Q1-Q6 as stated in Chapter 2 is developed. The steps of the applied data mining methodology (CRISP-DM) are documented and the data analytics techniques are visualized via the TARGIT BI Decision Suite 2017.

Chapter 5: The outcome of the analysis is deployed, assessing the applied data mining model and evaluating the results. It is revealed that the results comply with what I expected before starting the analytics process and are in accordance with relevant scientific literature.

Chapter 6: I make conclusions and propose future steps regarding the continuance of the present work in favor of the analyzed system.

Chapter 3: Literature Review

The relevant scientific literature is transcribed, starting from the used technologies and methodologies of Business Intelligence industry. A comparison of the state-of-the art BI suites is investigated to strengthen the election of the suite that is utilized for the present analysis. Hereupon, the airlines and airports industry is reviewed in terms of the alterations occurred due to the global economic crisis. Finally, a snapshot of the Greek situation is presented.

3.1 Business Intelligence

Business Intelligence (BI) systems combine data gathering, data storage, and knowledge management with analytical tools to present complex internal and competitive information to planners and decision makers. (S. Negash, 2004). While the term Business Intelligence is relatively new, computer-based business intelligence systems appeared, close to forty years ago.

BI as a term replaced decision support, executive information systems, and management information systems. With each new iteration, capabilities increased as enterprises grew ever-more sophisticated and as computer hardware and software matured.

According to Shaudhuri et al, 2011, BI is a collection of decision support technologies for the enterprise aimed at enabling knowledge workers such as executives, managers, and analysts to make better and faster decisions.

BI technology is used in manufacturing for order shipment and customer support, in retail for user profiling to target grocery coupons during checkout, in financial services for claims analysis and fraud detection, in transportation for fleet management, in telecommunications for identifying reasons for customer churn, in utilities for power usage analysis, and health care for outcomes analysis.

Business Intelligence finds its roots in the 1990s. Since then, it has evolved in parallel with the technology changes that force enterprises to new models for decision making. Big data and Big Data Analytics are new terms that are nowadays used to define massive and complex amount of data, requiring new techniques and methodologies.

The evolution of the Business Intelligence & Analytics (BI&A) is described by Chen et al., 2012, who categorize business intelligence according to its advances that relies mainly on the data quality: i) the database management system structured content (DBMS), ii) the web based unstructured content and iii) the mobile and sensor based content. These processes apply to several new industries like e-commerce, e-government, smart health and security and public safety.

Demand for business intelligence (BI) applications continues to grow at a rapid pace. Business intelligence via mobile devices is the latest frontier to drive demand among organizations interested in BI applications. However, mobile BI is still in its infancy. There are many opportunities to advance the way users use and interact with BI applications using mobile BI.

While e-commerce, credit card registrations and telecommunications produce inconceivable amount of raw data, data modeling becomes even more critical for the analysis conduction. A popular conceptual model is the multidimensional view of data, where measures and dimensions are identified. The measures provide the numerical data for the model and the dimensions provide the context of the measures.

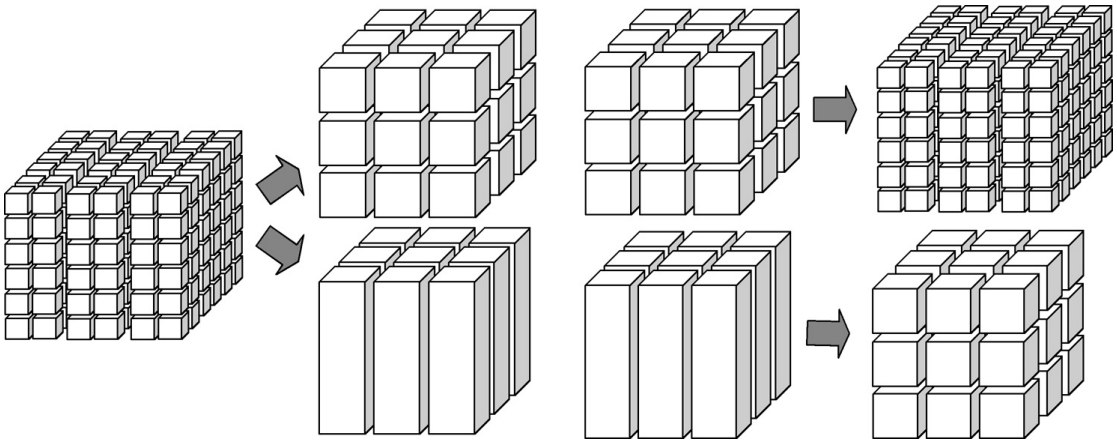


Figure 3.1.1 OLAP multidimensional views of data

Online Analytical Process (OLAP) performs multidimensional analysis of business data and provides the capability for complex calculations and data modeling. It is implemented by using MOLAP engines - that provide multidimensional view of data and usually have rapid deployment – and ROLAP engines that provide a relational data model view of various tables containing relational information. These tables are represented in Star or Snowflake schemas depending on the dimensions attributes hierarchy.

3.1.1 Data Mining Methodologies

According to Theodoridis et al., 2003, Data Mining is a process that utilizes methodologies for extracting patterns from large data warehouses. Patterns are compact and rich in semantics representation of raw data. There are several data mining algorithms (or techniques) that produce patterns for a dataset, namely some of which clustering, classification, association rules.

In order to conduct Data Mining for a system or organization, certain methodology must be followed as a procedure of transforming data into knowledge. The standard processes utilized are the Cross-Industry Standard Process (CRISP) and the Sample Explore Modify Model Assess (SEMMA). They both have the bone structure of the Knowledge Discovery in Databases (KDD) as presented by Fayyad et al., 1996.

The steps of each methodology are stated below:

Knowledge Discovery in Databases (KDD)

Fayyad et al., 1996, consider DM as a step in the process loop and the whole process is deployed in 5 steps: Selection, Pre-processing, Transformation, Data mining, Interpretation/Evaluation.

After the understanding of the application goals, the target data to be analyzed is selected, it is pre-processed in order to produce clean and consistent data, transformation methods are used for defining useful data elements, formulation of the data modeling derived from data mining techniques, use these techniques to reveal patterns, interpret the discovered patterns and evaluate them returning to any previous step. The knowledge discovered is then used to the performance of the system or is being compared to previous knowledge.

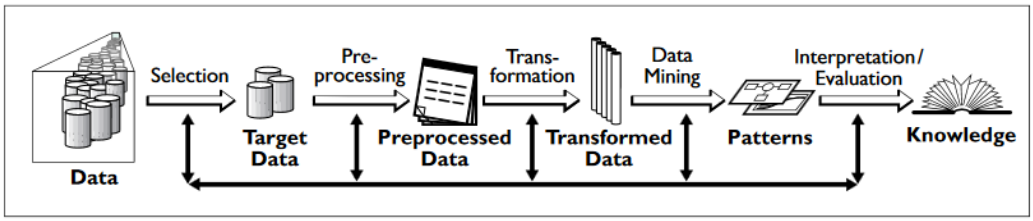


Figure 3.1.2: The Knowledge Discovery in Databases, Source Fayyad et al, Communications of the ACM, V39/11, 1996, p29

Cross-Industry Standard Process (CRISP)

This model is widely used and it comprises of six steps in a cyclical form:

- Business Understanding is the determination of business objectives and the establishment of data mining goals.
- Data Understanding can include collection, description, exploration and verification of initial data.
- Data preparation involves the selection, cleaning and formulation of the data source.
- Modeling: Selection of appropriate modeling technique. Splitting of the dataset into training and testing subsets for evaluation purposes. Development and examination of alternative modeling algorithms and parameter settings.

Fine tuning of the model settings according to an initial assessment of the model's performance

- Evaluation of the models in conjuction with the business/organization/system objectives. The evaluation may lead to the recodnition of headen needs of the system as the business understanding is an infinite process.
- Deployment: The discovered knowledge from models and patterns can be applied to the business operations for several purposes such as key situation and prediction. The outcome of the analysis can be used for future comparisons with other CRISP processes carried out by the business or organization.

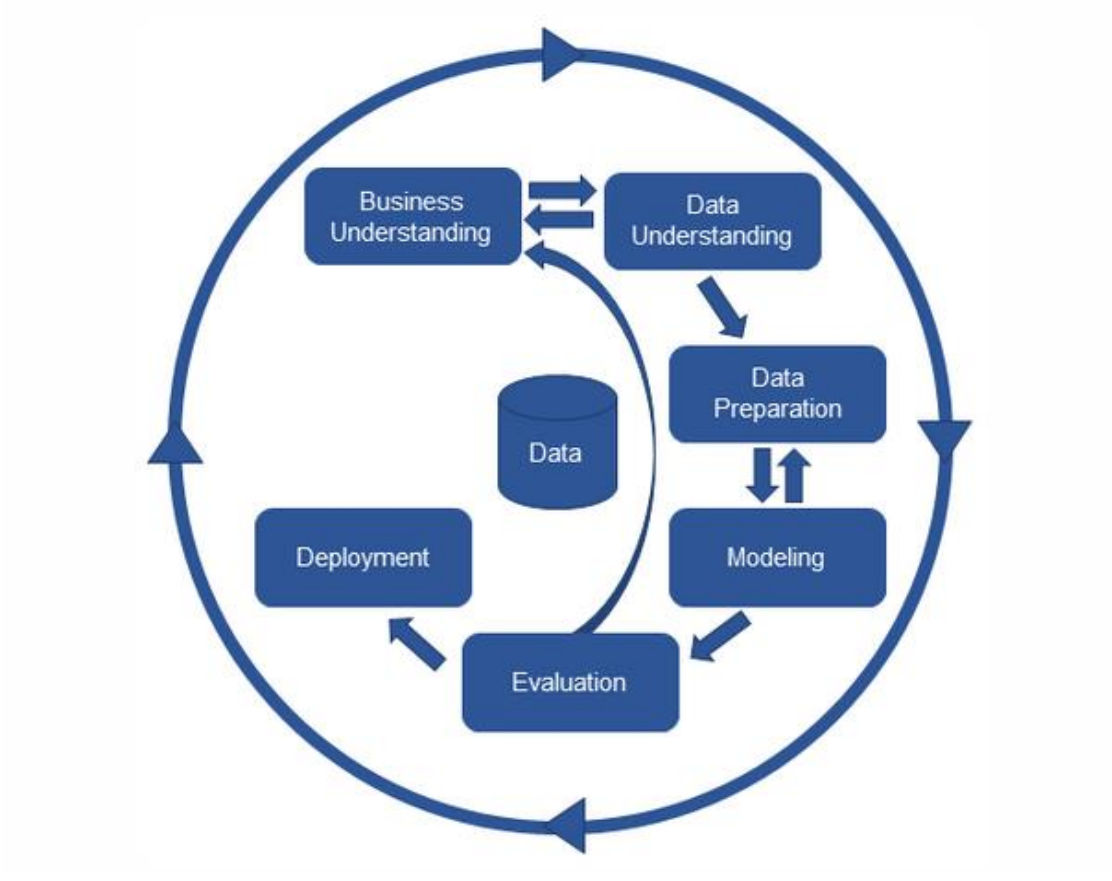


Figure 3.1.3 The CRISP cycle

Sample Explore Modify Model Assess (SEMMA)

This methodology was developed by the SAS Institute and it comprises of five steps:

- Sample: This is the first step of the methodology where the sample of data is extracted. The sample must be large enough to be exploited but also small enough to be manipulated quickly.
- Explore: After the sampling of data, exploring it will provide better understanding of the data set. Exploration may include using of visual or statistical techniques.

- Modify: This is the step of data modification by transforming data variables to the desired formula suitable for the selected model.
- Model: the process of allowing the software to automatically search for data combination that predicts the outcome.
- Assess the data by evaluating the outcome of the process and estimating its solid performance.

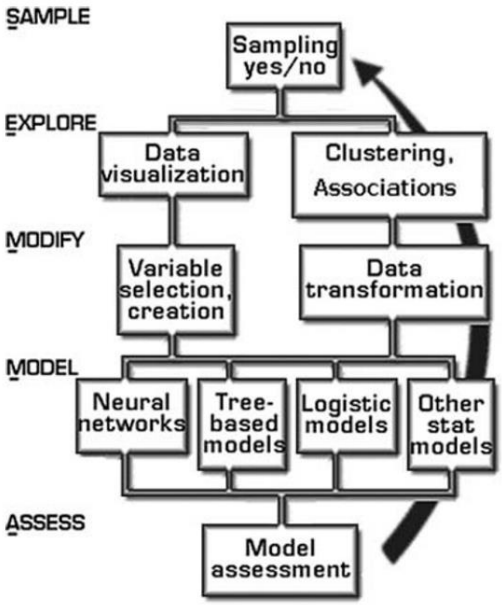


Figure 3.1.4 The SEMMA process

Comparing the two data mining methodologies CRISP and SEMMA, Semma is focused on the model development aspect of data mining and was developed with a specific tool in mind – SAS Enterprise Miner. It places less emphasis on the initial planning phases covered in CRISP-DM and omits entirely its deployment phase (Azevedo and Santos, 2008).

For the present work, the CRISP methodology is being followed.

3.1.2 Software BI Tools

Enterprises are awash in data about their customers, prospects, internal business processes, suppliers, partners and competitors. Often, they can't leverage this flood of data and convert it to actionable information for growing revenue, increasing profitability and efficiently operating the business. Business intelligence (BI) tools are the technology that enables business people to transform data into information that will help their business. Over the years, many BI tool styles have emerged to match the varied ways that business people need to analyze data.

The BI tools include:

- Spreadsheet integration
- BI search
- Dashboards and scorecards
- Corporate performance management
- Ad-hoc reporting and analysis;
- Online analytical processing (OLAP)
- Data discovery
- Data visualization

Many software companies have developed their own Business Intelligence suite, a platform that facilitates BI process manipulation. Gartner Methodology has gathered the "first class" BI suites, depending on the customers' preference, and present them in the following capture:

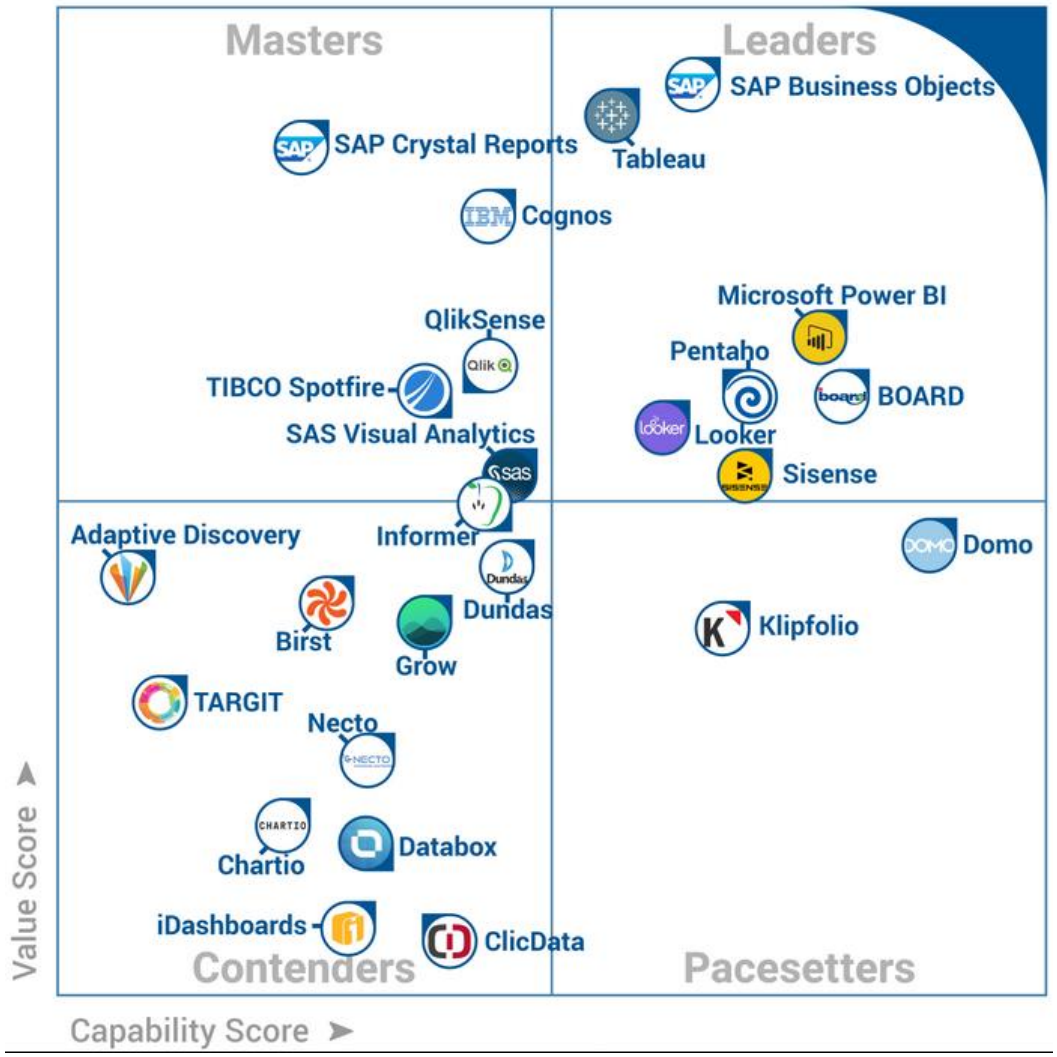


Figure 3.1.5 Front Runners for Business Intelligence, April 2017. Source Gartner Methodology

- **Upper Right = Leaders:** Leaders are all-around strong products. They offer a wide range of functionality to a wide range of customers. These products are considered highly valuable by customers.

- **Upper Left = Masters:** Masters may focus more heavily on certain key features or market segments than Leaders do. If you need a more specialized set of functionalities without bells and whistles, then a product in the Masters quadrant might be right for you.

- **Lower Right = Pacesetters:** Pacesetters may offer a strong set of features, but are not rated as highly on value. For example, a Pacesetter might offer greater functionality, but cost more.

- **Lower Left = Contenders:** Contenders may focus on a more specialized set of capabilities that are priced at a higher point. This makes them ideal for companies willing to pay more for specific features that meet their unique needs.

The data analytics in the present thesis will be conducted via the TARGIT BI Suite, located in the Contenders quadrant.

TARGIT

TARGIT Decision Suite 2017 meets the dual demands of business and IT by combining all data, all people, all BI disciplines in one user interface. Raw power meets self-service analytics. It generates a comprehensive view of the business and experiments with data with the confidence that security and quality are ensured across the organization.

3.2 The Effect of economic crisis on Airlines

Three major factors changed the airline industry and forced carriers to a vivid competitiveness:

1. Deregulation of air traffic
2. Consolidation within the airlines industry provoked by terrorists' attacks and economic crisis (fuel price increase being the first heavy burden)
3. The evolvement of Low Cost Carriers (LCCs)

Undoubtedly, low-cost airlines' intention to enter the industry (and be competitive within it) combined with the recession rules that lessened the passengers' leisure travel paying power, led to disproportional ticket rates compared to those of traditional airlines. Consequently, LCCs provided passengers with product and services prices that were adjusted to relevant economic conditions and thus triggered a market change. *(Stimac et al, 2012)*

LCCs not only introduced a new business model within the airline industry, but significantly altered passengers buying criteria "preferring price and convenience over extensive connectivity and seamless travel". *(Franke, 2007:24)*

3.2.1. LCCs Business Model

The liberalization of air services, high levels of competition and rising fuel costs has forced airlines globally to attract extra revenues from secondary sources such as unbundling the airline product.
The first ancillary products and services idea was captured by the LCCs in Europe which, taking advantage of the technology evolution and the internet, introduced **unbundled** products that lowered the base ticket fare.

Purchasing through internet directly from the airline's website diminished agents' and handling costs. If a customer does not want to pay for a checked baggage the airline will have lower ground handling costs meaning a cost saving that can be extracted from the ticket fare. *(Fageda et al, 2014)*
Klophaus et al, 2012, Table2:55 indicate the following main criteria for the low-cost carrier business model:

1. Fleet homogeneity
2. Secondary airports use
3. Point-to-point only
4. No code sharing
5. One-way fares only
6. No more than one fare per flight at each point
7. Single class cabin
8. No frills

3.2.2. Comparison of LCCs and FSNs

As captured by Stimac et al (2012), low-fares carriers had multiple advantages over the full-service network carriers (FSNs).

Low-Cost Carriers	Ful- Service Carriers	Advantage of LCC
Mostly use secondary regional airports	Use primary airports and HUB airports	Lowewr airport fees, faster aircraft handling, fewer delays due to congestion and traffic control
Fast aircraft handling mainly because of little baggage screening	Slow aircraft handling caused at HUB airports	Better utilization of the fleet
Point-to point flights, short haul routes	Long hauls, medium and short haul routes with transfers	Lower complexity
One model of aircraft	More than one model of aircrafts with more space between seats	Cheaper aircraft finance, lower maintenance and training expenses, higher capacity utilization
Web booking	Most tickets sold via travel agencies	Lower or no distribution costs, easier to purchase ticket
No catering	Many in-flight services, separate treatment of business and forst class customers, VIP lounges, Paper tickets, catering	Lower secondary costs, additional revenue
Commissions to employees for in-flight commercial services	High fixed salaries for employees	Higher employee productivity

3.2.3. Hybrid Model

The business model by which the LCCs had up to 50% lower operating costs compared to FSNs is no longer achievable due to the global economic crisis and higher fuel costs. Additionally, FSNs adjusted their business models to the new market conditions in an effort to maintain share in the medium-haul markets reducing costs and fees. These changes in the air industry dynamics provoked LCCs to alter their business models as well.

Fageda et al (2015, Table1:290) illustrate the most significant differences between archetypical and hybrid LCCs:

- ✓ Code sharing

- ✓ Transfer between flights
- ✓ Long-haul destinations
- ✓ Different fare bundles offering different levels of service
- ✓ Frills depending on fare bundling

On the other hand, according to Nigel Dennis (2007), the FSNs adopted the following approaches:

- ✓ Revise pricing
- ✓ Charge for catering or reduce free provision
- ✓ Reduce aircraft handling time in less than 30 minutes
- ✓ Run-down of secondary hubs
- ✓ Abandon business class on short-haul destinations
- ✓ Reduce commissions to third parties
- ✓ Increase aircraft utilization (direct sales of air tickets)
- ✓ Set-up a low-cost subsidiary

Consequently, the differences among the types of airlines become thinner and as a result there can be no clear distinction of airlines business models as it used to be in the past. Ryanair, WizzAir, BluExpress and BlueAir continue to follow the typical LCC structure.
Many of the rest should now be classified as hybrid. (Vidovic et al, 2013)

3.2 The Effect of economic crisis on Airports

When the world economy grows, the need to travel increases and it results on the increasing number of passengers at airports. When the global economy is in decline, the number of passengers is also falling. The world economy has become dependent on air transport industry and vice versa.

Investigating the impact of the economic crisis on primary hub airports like AIA's, Stimac et al indicate that the crisis seems to have begun in the first part of the year 2008, and the first recovery in passenger traffic can be seen in mid-2009. Stimac et al have observed that the average amount fall in passenger traffic during the impact of the crisis was -7.5%, with the exemption of Istanbul Ataturk Airport which recorded a significant growth in passenger traffic compared to similar airports at the annual level.

Is there a strategy that the airports can adopt in order to recover from severe financial crisis?

As Stimac et al quote "*Airports have focused their business on tracking and negotiations with those airlines that recorded stagnation or growth during the global economic crisis, which is primarily related to the strong network airlines, such as Lufthansa and Turkish Airlines and low-cost airlines such as Ryanair, EasyJet, Wizz Air and Norwegian Air Shuttle. By analyzing the available traffic data of the above-mentioned airlines, mostly those using low-cost model, it can be concluded that their model is recognized as a factor of success at the time of crisis, and their impact on*

airports increased significantly with the result of softening very negative business airport trends related to passenger traffic."

So, the strategy of negotiating with a strong network and low-cost airlines proves to be the financial salvation of a European airport.

The Hellenic case: Aegean and OlympicAir merger and the Low-Cost Carriers

In October 2013, Olympic Air was taken over by Aegean Airlines, unable to turn profit in a climate of severe recession – Greece's economy contracted for a sixth straight year in 2013. The carrier became a subsidiary of Aegean, Greece's largest airline, after the European Commission concluded the merger was the only way of preventing the carrier's collapse and hence it was not a subject of Greek-air monopoly anymore.

As Aegean's vice-president has quoted "*At this time (2013), Greece needs a strong air carrier, in order to be able to respond to domestic demands but even more to demands overseas given that tourism is the lung of the country."*

On the other hand, at the beginning of 2014 there was a contract signing between AIA and Ryanair making "Eleftherios Venizelos" Ryanair's second hub in Greece. In 2015, Blueair's and Volotea's entry confirms AIA's trend to low cost carriers.

3.3 Athens International Airport's History in brief

Committed to operation and service excellence, safety and user-friendliness, the state-of-the-art Athens International Airport "Eleftherios Venizelos" (AIA) has been serving Greece's capital since the opening date March 28th, 2001. A 2.2 billion Euro investment, the new airport was built in a record time of 51 months, replacing its congested predecessor, and offering to all airlines and passengers a modern, spacious and state-of-the-art environment. Athens International Airport has already managed to earn international recognition, holding top positions in the world for the last four years in Overall Passenger Satisfaction - in its airport size category - according to the IATA Global Airport Monitor and AETRA surveys.

Athens' strategic position at the crossroads of three continents offers access to numerous short-haul and medium-haul markets, thus promoting "Eleftherios Venizelos" as the natural connecting point of the region. The new airport is developing into the Southeastern Gateway of Europe providing connecting/feeder traffic from the eastern Mediterranean region, the Middle East, the Balkans, Africa and Greece to European and long-haul destinations.

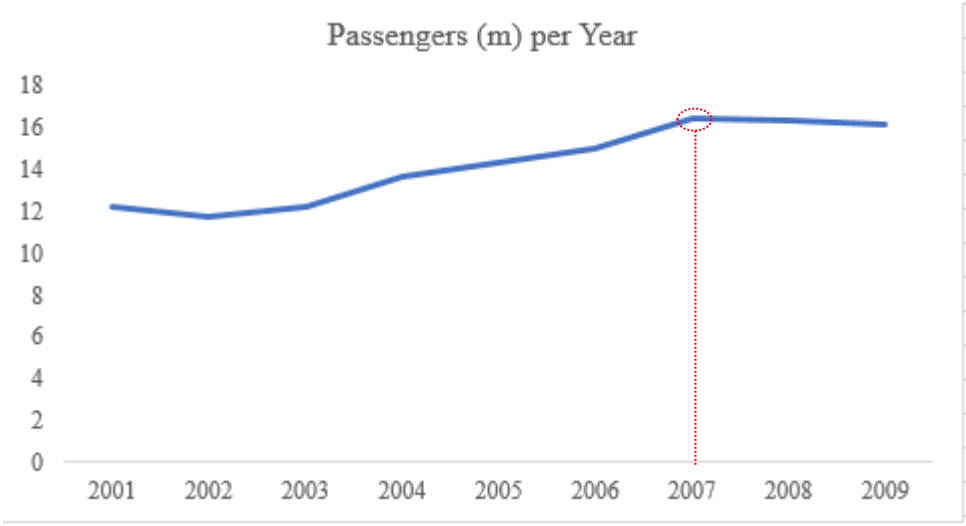
AIA is considered a pioneer international Public-Private Partnership of its type in the world, being the first major greenfield airport constructed with the participation of the private sector. 'Athens International Airport S.A.' is the company responsible for the operation, management and development of the airport for a 30-year concession period

initiated in 1996. 'Athens International Airport S.A.' is a privately managed company, with the Greek State holding 55% of shares, while the private shareholders collectively hold 45%.

Based on the Airport Company's management approach, the new airport acted as a catalyst for long-term business development, by creating a business platform for over 300 enterprises directly related to the airport's operation. More than 14,000 people work at the airport compound, making Athens International Airport one of the biggest employment engines in Greece, which already at its opening generated approximately 3,300 new jobs.

Counting AIA's history in number of passengers, the total number of passengers throughout the airport was 128,3 million from 2001 to 2009. Year 2007 was marked as the best year since then, in terms of passengers traffic, due to the Champions League that was organised at Greece in that year. In 2008 the global economic crisis bursted out and AIA's passenger numbers started showing a slide. In Chapter 4, I am analysing the curve of this slide from 2010 and on and how AIA managed to recover.

Year	Passengers (in millions)
2001	12,2
2002	11,8
2003	12,2
2004	13,7
2005	14,3
2006	15
2007	16,5
2008	16,4
2009	16,2
TOTAL	**128,3**



3.4 Hellenic International Arrivals Statistics

According to Hellenic Ministry of Tourism (EOT) and Hellenic Statistical Authority (ELSTAT), there was an important increase in the arrivals of international travelers through the country borders from 2013 to 2016. Non-residents first choice regarding means of transportation was the airplane constituting the 70% of total passengers' transportation.

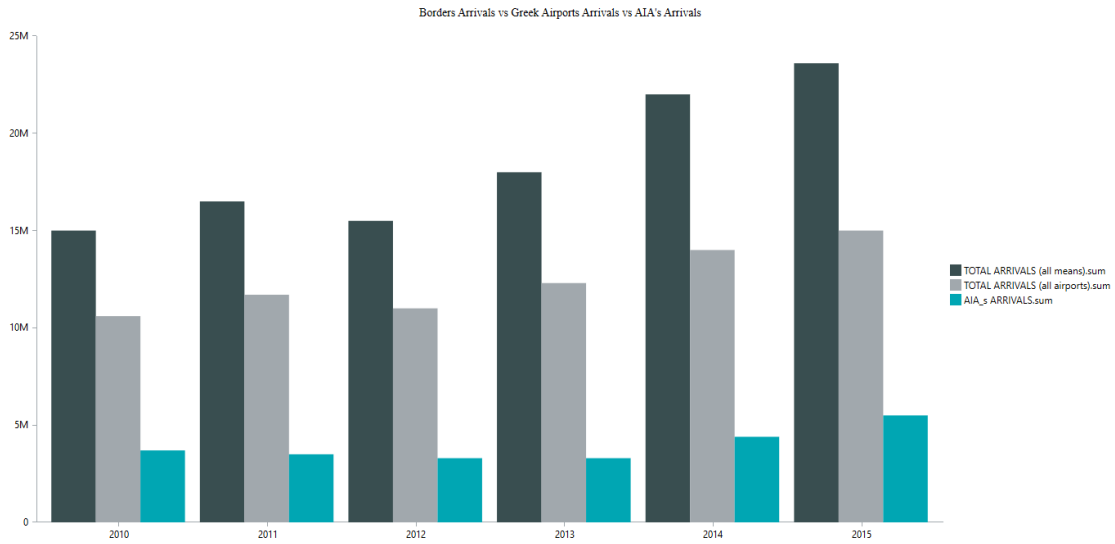
AIA counts an average of 32% of the transportation with airplane and 23% of all means of transport.

*Table 3.3.1. Comparison of Borders and Greek Airports Passengers Arrivals to AIA's**

YEAR	TOTAL ARRIVALS (all means).sum	TOTAL ARRIVALS (all airports).sum	AIA_s ARRIVALS.sum
Total	**110,600,000**	**74,600,000**	**23,700,000**
2010	15,000,000	10,600,000	3,700,000
2011	16,500,000	11,700,000	3,500,000
2012	15,500,000	11,000,000	3,300,000
2013	18,000,000	12,300,000	3,300,000
2014	22,000,000	14,000,000	4,400,000
2015	23,600,000	15,000,000	5,500,000

*Created by the author using sources from ELSTAT and Aerostat Handbook

*Chart 3.3.1. Number of International Arrivals through borders (all means) vs AIA's Arrivals**



*Created by the author using sources from ELSTAT and Aerostat Handbook

Chapter 4: Approach and Methodology

My approach of answering the queries Q1-Q6 as stated in Chapter 2 is developed. The steps of the applied data mining methodology CRISP-DM (as described in Chapter 3) are documented and the data analytics techniques are visualized via the TARGIT BI Decision Suite 2017.

4.1 Understanding and Preparation of Data

The database to be analyzed is given in an excel format under the name FLIGHTS_PAX.xls. It contains 958 registrations as a crosstabulation of airlines, flights number, passengers number, year of flight and destination:

AIRLINE_NAME	YEAR	PASSENGERS	FLIGHTS	DESTINATION
ADRIA AIRWAYS Slovenija	2013	257	3	International
ADRIA AIRWAYS Slovenija	2014	371	10	International
ADRIA AIRWAYS Slovenija	2012	257	4	International
ADRIA AIRWAYS Slovenija	2011	2.830	69	International
ADRIA AIRWAYS Slovenija	2015	487	6	International
ADRIA AIRWAYS Slovenija	2010	6.534	146	International
Aegean Airlines S.A.	2013	2.282.636	18.946	Domestic
Aegean Airlines S.A.	2013	2.507.028	18.438	International
Aegean Airlines S.A.	2015	4.199.457	38.363	Domestic
Aegean Airlines S.A.	2011	2.450.242	24.509	Domestic

An auxiliary crosstabulation containing the per month registration is also given in an excel format named PER MONTH.xls. It consists 13.926 registrations of number of flights and number of passengers clustered in year, month, airline and destination. This file will be used as an extra data source and will be worked in parallel because it contains extra airlines information but not sufficient to be thoroughly analyzed in the present thesis.

YEAR	MONTH	AIRLINE_NAME	FLIGHTS	PASSENGERS	INTERNATIONAL_DOMESTIC
2010	Jan	ADRIA AIRWAYS Slovenija	2	75	International
2010	Jan	AERIEN MILITAIRE FRANCAIS	1	0	Domestic
2010	Jan	AERIEN MILITAIRE FRANCAIS	3	0	International
2010	Jan	AEROFLOT Russian International A	60	5.345	International
2010	Jan	AEROLAND	313	0	Domestic
2010	Jan	AERONAVE MILITAR ESPANOLA	2	0	International
2010	Jan	AEROSVIT AIRLINES Aerosweet Air	24	1.297	International
2010	Jan	AIR ARABIA2 LLC	24	2.095	International
2010	Jan	AIR FINLAND	5	675	International
2010	Jan	AIR FRANCE	172	12.697	International

The data concerns the time period 2010-2016 as this includes the harsh financial crisis period for the airport, according to Anna.Aero AIA's 2015 report.

An attempt to approach the reasons of 2013's recovery will be made. For this cause, I conducted a research regarding the airlines personality approach on customers and I classified the airlines into several categories the most important of which are: Full Network Carriers (FSNs), Low Cost Carriers (LCCs), Hybrid Carriers and Charters.

At this point, the understanding and preparation of data is very critical: a deep understanding of the airlines industry and the airlines companies is imperative for the preparation of data and the adding of the "carriers" extra columns. I had to carefully examine all the parameters of each airline in order to safely categorize them as carriers. Moreover, I had to add headings to the columns of my crosstabulation, to uniform and clean the data and to eliminate any zero values. This procedure is crucial in order to generate a solid OLAP cube because any improperly conveyed data will lead to the cube malfunction.

I performed the classification of carriers after the relevant literature review as presented in Chapter 3, AIA's Aerostat Handbook and a deep research on airlines' official sites. The airlines that ceased their operation at some point during the examined period, are included.

In this work, I will concentrate in the analysis of these four carrier types, which are the prevailing carriers. The definitions of FSN, LCC and Hybrid are profoundly explained in Chapter 3. Charter airlines are the ones that provide scheduled leisure/holidays group trips usually in cooperation with travel agents.
So, an extra column entitled "CARRIER" is added in the original database's crosstabulation where the characterization FSN, LCC, Hybrid, Charter is related accordingly to each airline:

YEAR	AIRLINE_NAME	PASSENGERS	FLIGHTS	DESTINATION	CARRIER
2016	Aegean Airlines S.A.	4.799.907	37.284	International	HYBRID
2016	Aegean Airlines S.A.	2.418.048	17.622	Domestic	HYBRID
2016	AER LINGUS Plc	16.850	126	International	HYBRID
2016	AEROFLOT Russian International A	136.523	1.106	International	FSN
2016	AIR BALTIC Corp. SIA	10.278	104	International	LCC
2016	AIR CANADA	120.391	496	International	FSN
2016	AIR CHINA International Corp.	31.810	202	International	FSN
2016	AIR EUROPA	4.924	32	International	HYBRID
2016	AIR EVEX GmbH	153	1	International	BUSINESS
2016	AIR EXPLORE	708	6	International	CHARTER
2016	AIR FRANCE	327.002	2.443	International	FSN
2016	Air Horizont	3.041	22	International	CHARTER
2016	AIR LEISURE/EGYPT	1.811	18	International	CHARTER
2016	AIR MALTA Plc	4.260	48	International	FSN
2016	AIR MOLDOVA	6.309	102	International	FSN
2016	AIR SERBIA	106.393	1.019	International	FSN
2016	AIR TRANSAT	49.672	180	International	CHARTER
2016	AIR-BERLIN GmbH & Co. Luftverkeh	312	3	International	CHARTER
2016	ALBA STAR	1.378	10	International	CHARTER
2016	ALITALIA	324.001	2.408	International	HYBRID

It should be noted that in the "charter" category, airlines with freight and cargo activity are incorporated. The main mail/freight cargo airlines are not included in the original database and they are not part of this analysis.

4.2 Modeling

For the analysis conduction, a specialized business intelligence platform must be utilized. For the present work i chose to use TARGIT Decision Suite 2017 platform, a BI and analytics solution platform that enables organizations to reach data-driven decisions.

The FLIGHTS_PAX.xls file is inserted into the TARGIT's Data Modeler as a data source file to create the data cube that is to be drilled in (picture 1.1). The same process is followed for the file PER MONTH.xls, in order to create data source for the monthly registrations (figure 1.2).

Next, the attributes of our data are set in the Cube Designer sector of the platform (figure 2). The dimensions of the cube are the AIRLINE_NAME, the YEAR and the MONTH, the DESTINATION and the CARRIER, while the measures are the PASSENGERS and the FLIGHTS.

Following the cube creation and the attributes setting, the drill-in/drill-out process begins resulting in correlations amongst the data. These correlations are visualized in charts that help us answer several queries. But first, they help us see clearly some interesting numbers as stated in the "Number of passengers per Airline and per destination" Table 4.2.1.

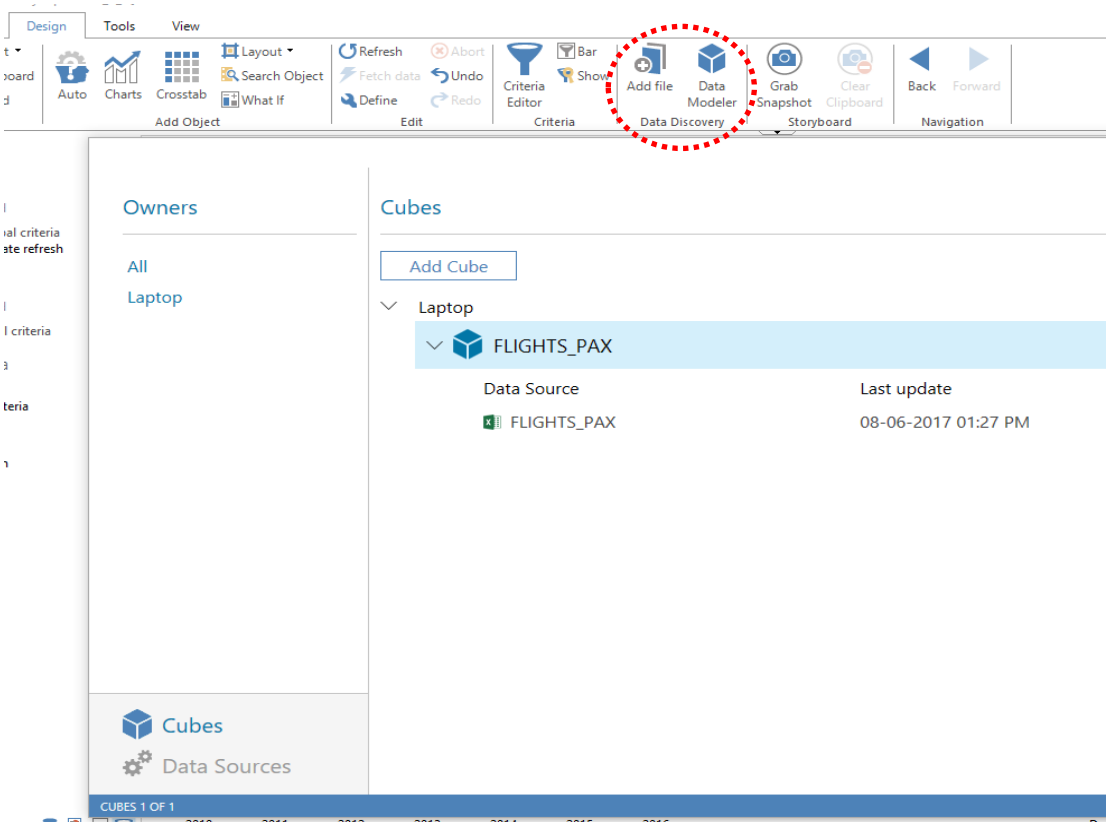


Figure 4.2.1: Data Modeler, cube creation TARGIT DECISION SUITE 2017

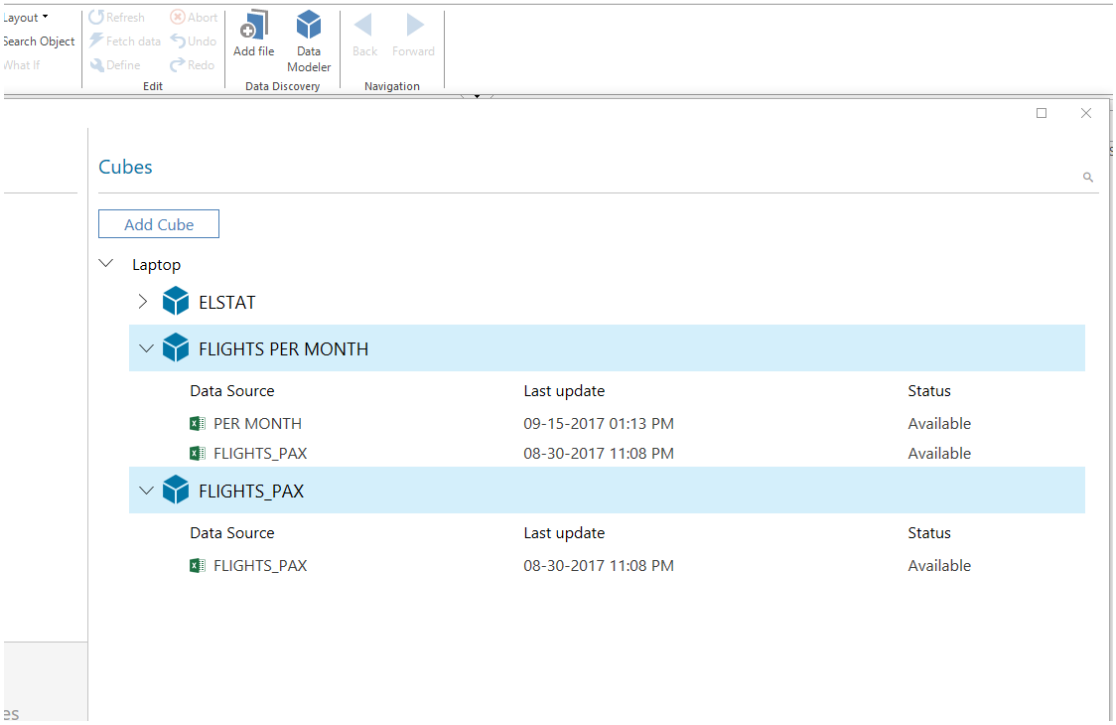


Figure 4.2.2: Data Modeler, cube creation TARGIT DECISION SUITE 2017

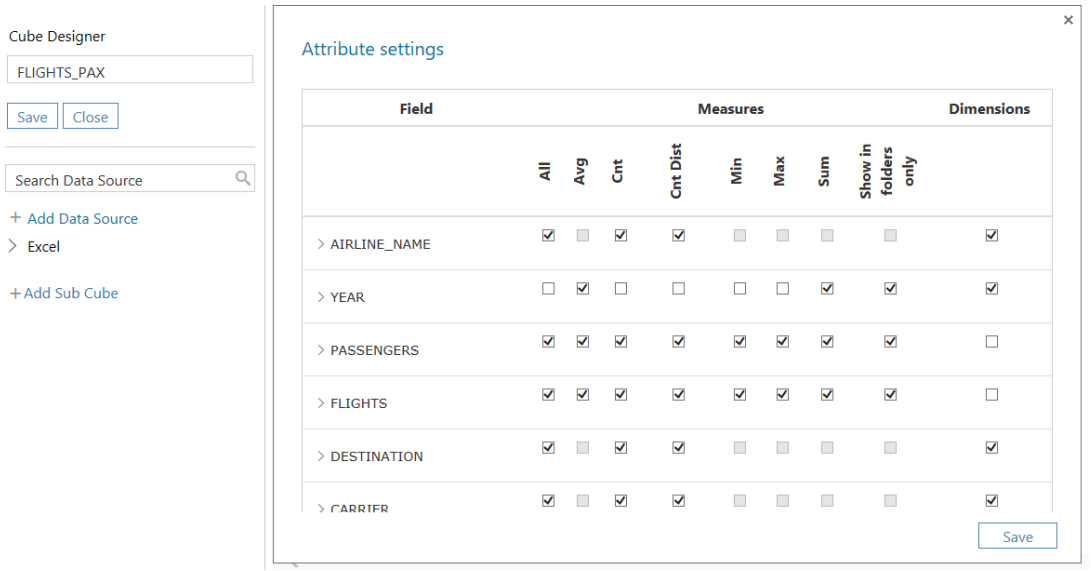
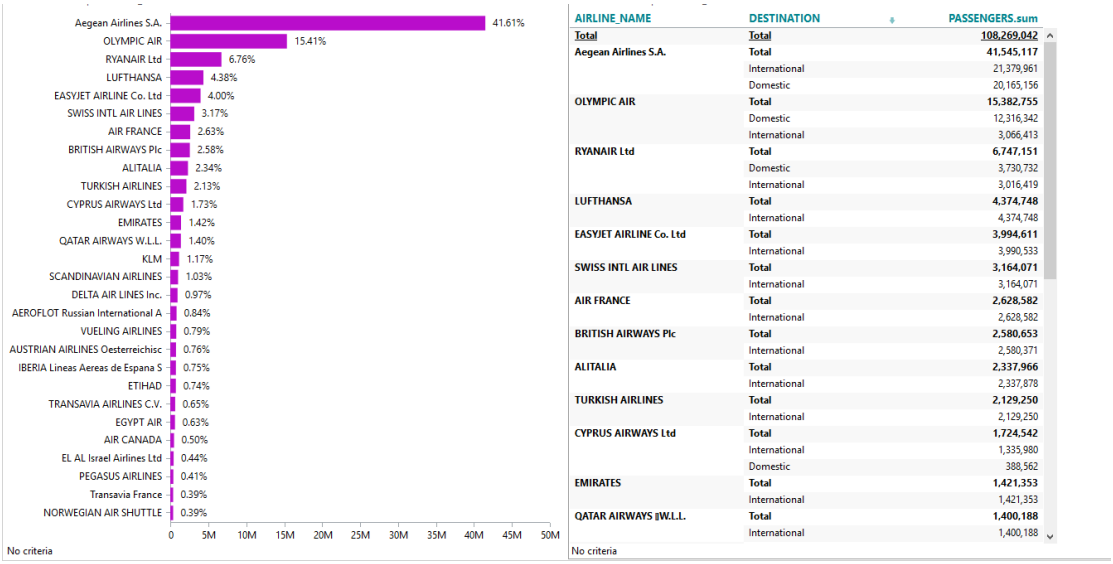


Figure 4.2.3: Cube Designer, attributes setting TARGIT DECISION SUITE 2017

Chart 4.2.1. Number of passengers per Airline and per destination (years 2010-2016)



The total number of passengers arrived to and departed from the airport during 2010-2016 is 108.269.042. Aegean Airlines and Olympic Air, after their merge, hold the 57% of the total passengers traffic. The third airline is Ryanair which carried out the 6.76% of the passengers traffic for the years from 2010 to 2016.

The total number of airlines landed and taken off from the airport during 2010-2016, is 284. This number includes airlines that were merged, changed ownership or ceased during the examined years.

In the following queries, the applied drill-ins will give insights of this database.

Q1. What are the percentages of passengers traffic during and after the crisis?

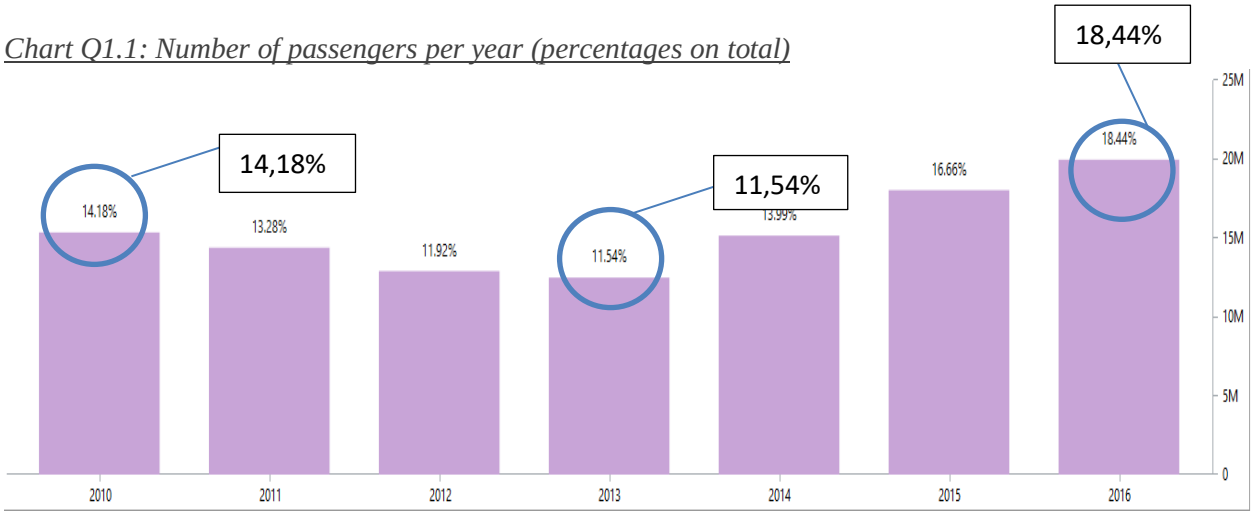
The total number of passengers through the years 2010-2016 is more than 108 million. At the beginning of the airport's crisis the passengers summed the 14,18% of total traffic value, while in 2016 reached the 18,44% with merely 20 million passengers.

As shown in Chart Q1.1, there was a backsliding of 18.6% in the passengers' traffic from 2010 to 2013 when the crisis "bend" is noticed, as expected. After the lowest value of 2013 the passengers' traffic demonstrate 60% increase which gives in 2016 the highest sum of passengers of all years, overcoming even the best record of 16.5 million passengers in 2007.

Table Q1.1: Number of passengers per year

YEAR	PASSENGERS.sum
Total	108,269,042
2010	15,350,493
2011	14,381,348
2012	12,902,458
2013	12,492,312
2014	15,146,031
2015	18,036,051
2016	19,960,349

Chart Q1.1: Number of passengers per year (percentages on total)



In Chapter 5 the reasons of this extraordinary recovery will be discussed.

A more analytical view of the monthly database records demonstrates that the summer quarter Jun-Sept performs nearly 50% of the total yearly passengers' traffic, year 2016 having the highest value in July when 0.5 million more passengers moved through the airport compared to July 2010.

Chart Q1.2: Passengers' traffic per month per year

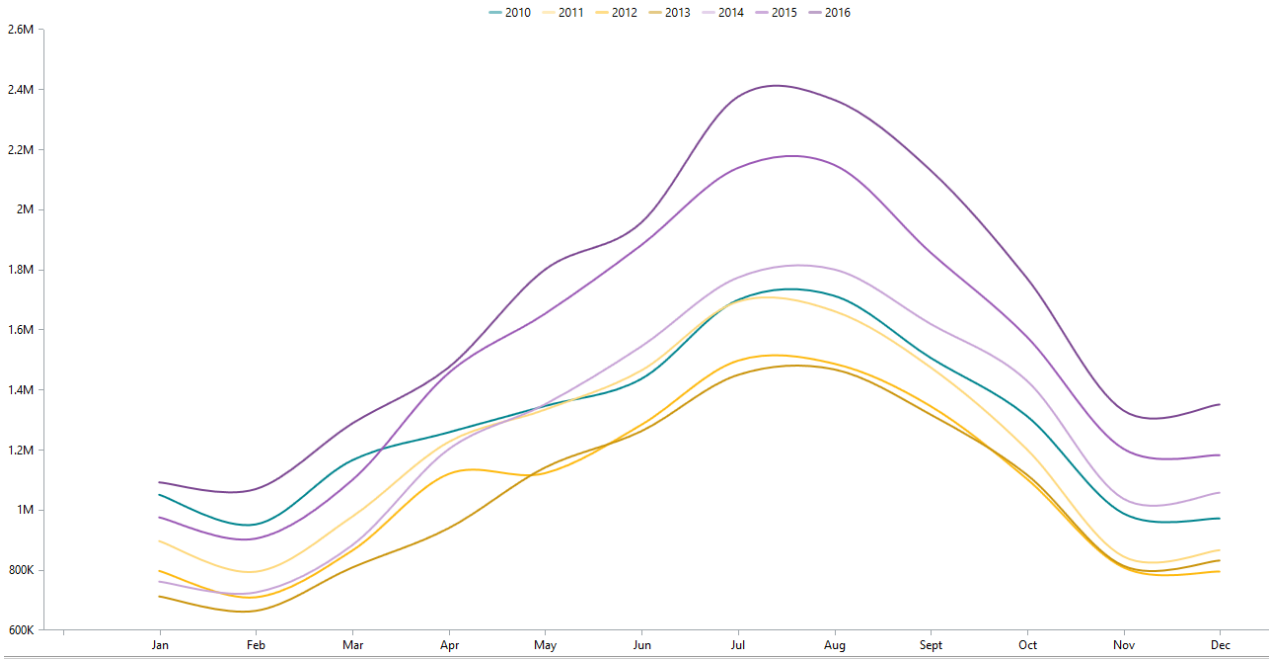
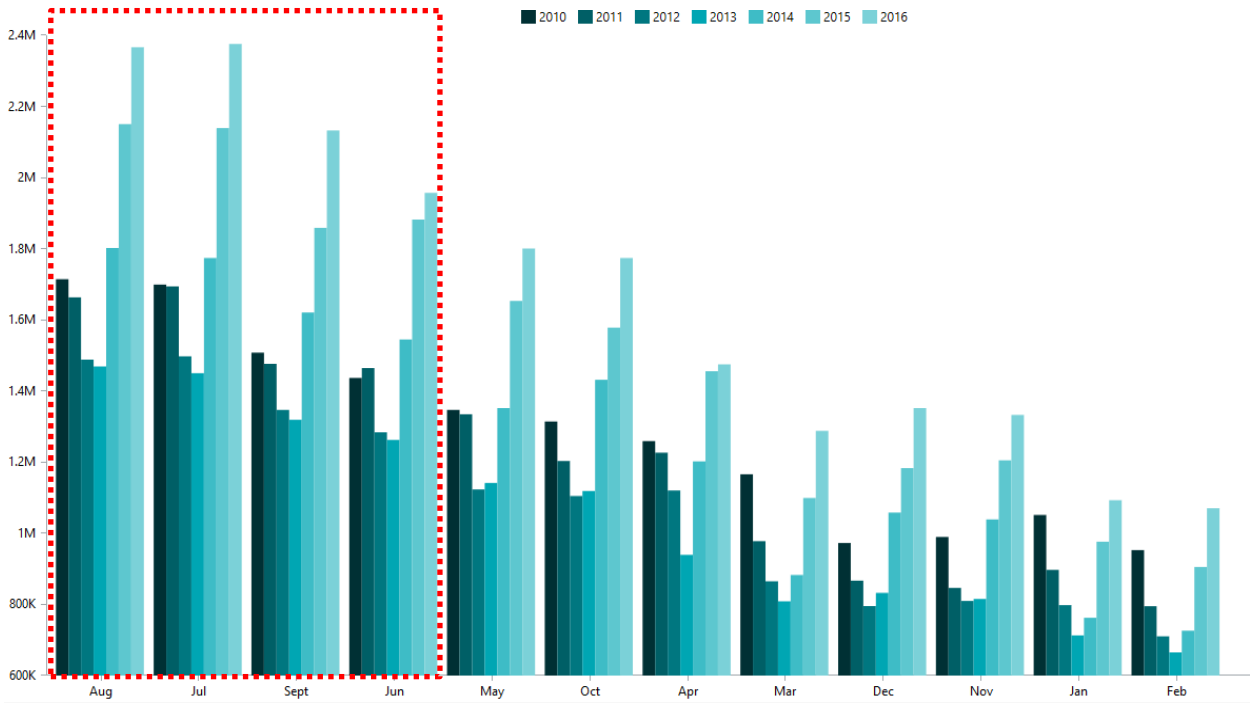


Chart Q1.3: Passengers' traffic per month per year (descending hierarchy)



A closer look at the per-month values (Table Q1.2) shows that from November to March (that is a five-month period) there is registration of low traffic at all examined years (excluding January 2010). In 2013, the worst of all years in traffic, April is added to the very low traffic period.

But there has been a remarkable change in 2014: only three months, January to March, constitute the very low traffic period which is registering higher numbers every year towards 2016.

This is the turning point when Aegean airlines merged Olympic Air and Ryanair was established in AIA, as explained in query Q3.

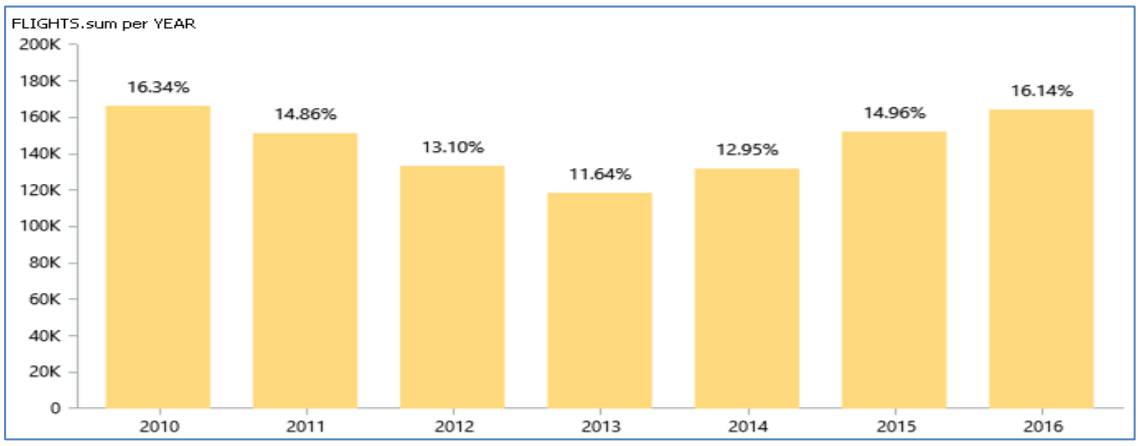
Table Q1.2: Passengers' traffic per month per year

	Total	2010	2011	2012	2013	2014	2015	2016
Total								
Jan		1,051,703	897,309	798,010	713,134	762,436	976,388	1,092,844
Feb		952,745	795,245	710,237	665,083	726,311	905,505	1,070,294
Mar		1,165,970	977,826	864,994	808,954	882,790	1,099,428	1,288,173
Apr		1,259,031	1,226,552	1,120,486	939,593	1,202,197	1,455,786	1,474,752
May		1,346,739	1,334,552	1,123,189	1,141,604	1,351,980	1,653,428	1,800,482
Jun		1,436,857	1,464,750	1,283,887	1,262,676	1,544,794	1,882,093	1,957,064
Jul		1,699,296	1,694,083	1,497,559	1,450,042	1,774,058	2,139,127	2,375,645
Aug		1,714,239	1,663,244	1,488,104	1,469,107	1,801,982	2,150,265	2,366,601
Sept		1,507,947	1,476,414	1,346,981	1,318,996	1,620,794	1,858,739	2,132,546
Oct		1,314,162	1,203,434	1,104,900	1,118,832	1,431,754	1,578,118	1,773,871
Nov		989,825	846,590	810,027	815,454	1,038,889	1,205,089	1,332,726
Dec		972,585	866,972	795,659	832,582	1,058,384	1,183,271	1,351,998

Q2. What are the percentages of flights number during and after the crisis?

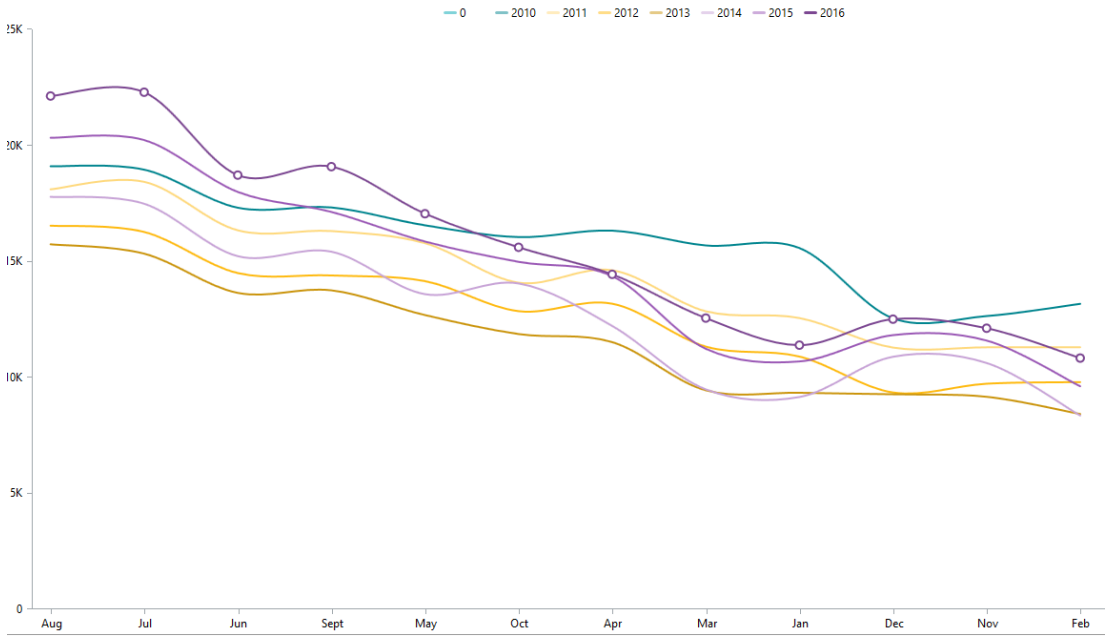
Chart Q2.1 demonstrates that the flights traffic follows the curve of the passengers traffic but with a higher slide of 40% from 2010 to 2013 and a lower recovery percentage of 38% from the 2013 crisis point, but managed to slightly surpass 2010's rates. In the following analysis, it is mined that the international flights are the main reason for this recovery.

Chart Q2.1: Number of flights per year (percentages on total)



The per month analysis shows that during May to September 50% of all year flights were carried out, while year 2016 (marked line) delivered the highest values for the particular period.

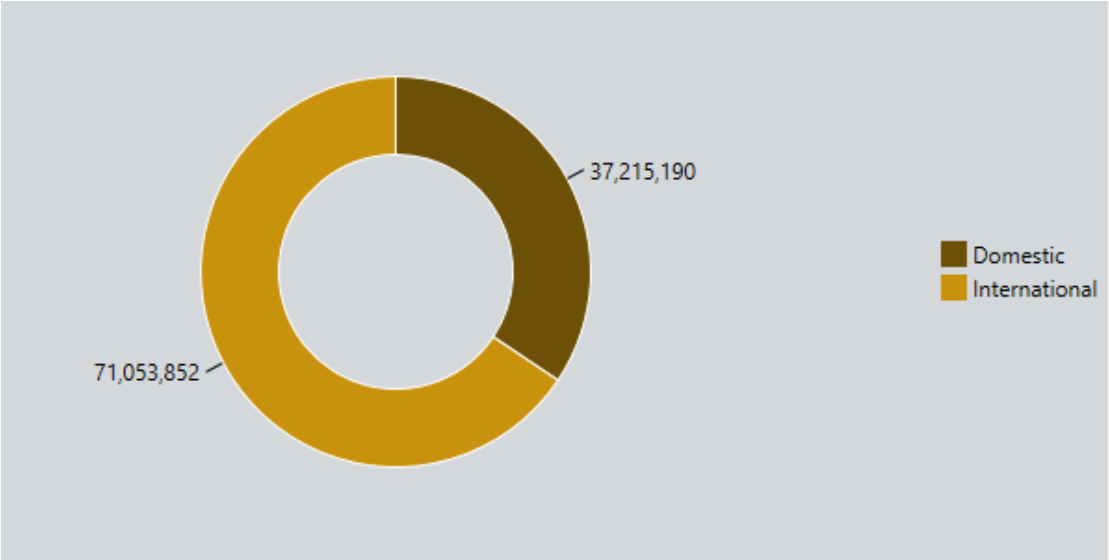
Chart Q2.2: Number of flights per month per year



Q3. Which is the predominant destination?

Chart Q3.1 indicates that the predominant destinations are the international.

Chart Q3.1: Number of passengers per destination



Charts Q3.2 and Q3.3 illustrate the number of flights and passenger per destination. It is clear that the international destination passengers are nearly double of those choosing domestic destinations whereas the flights number follow a lower percentage with a 49% increase of the international and a 15% increase of the domestic flights.

Chart Q3.2: Number of flights per destination per year

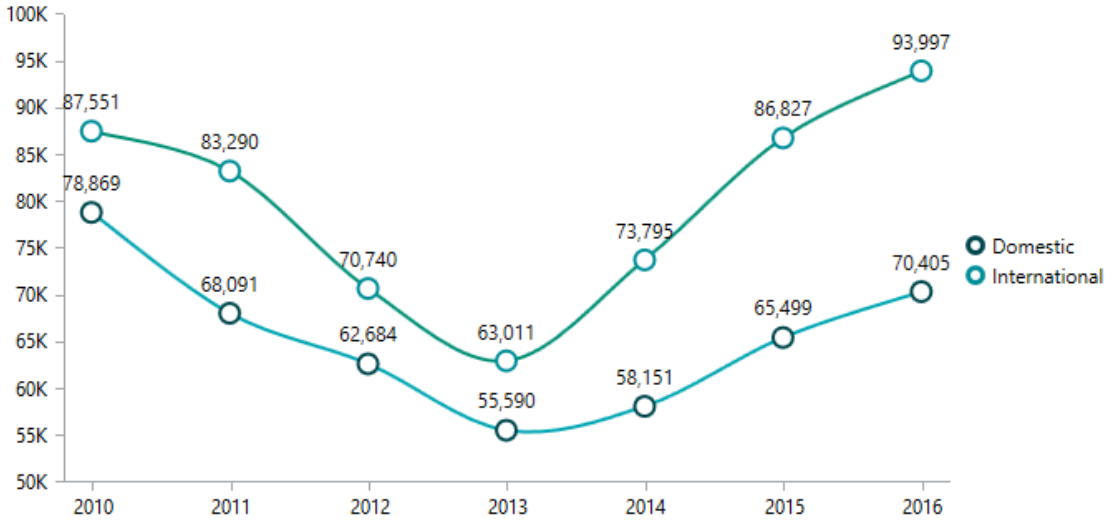
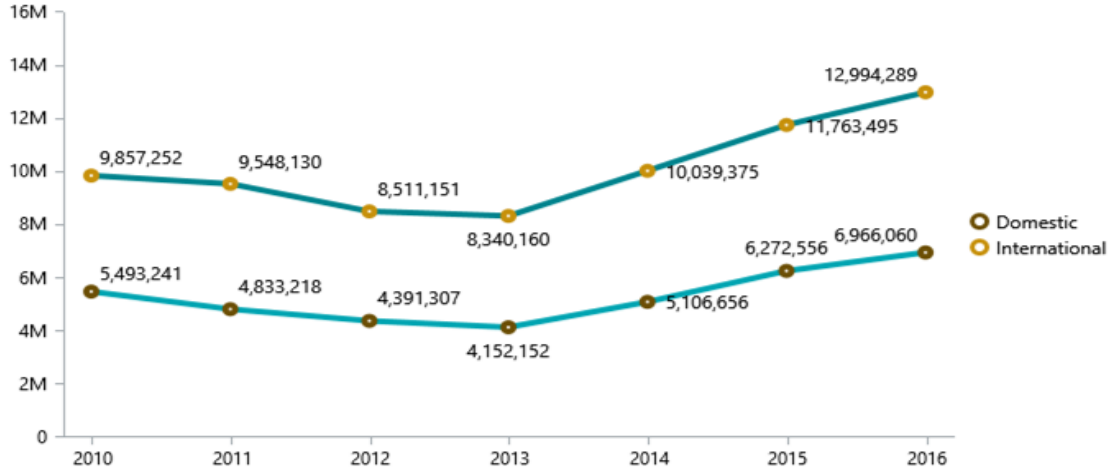


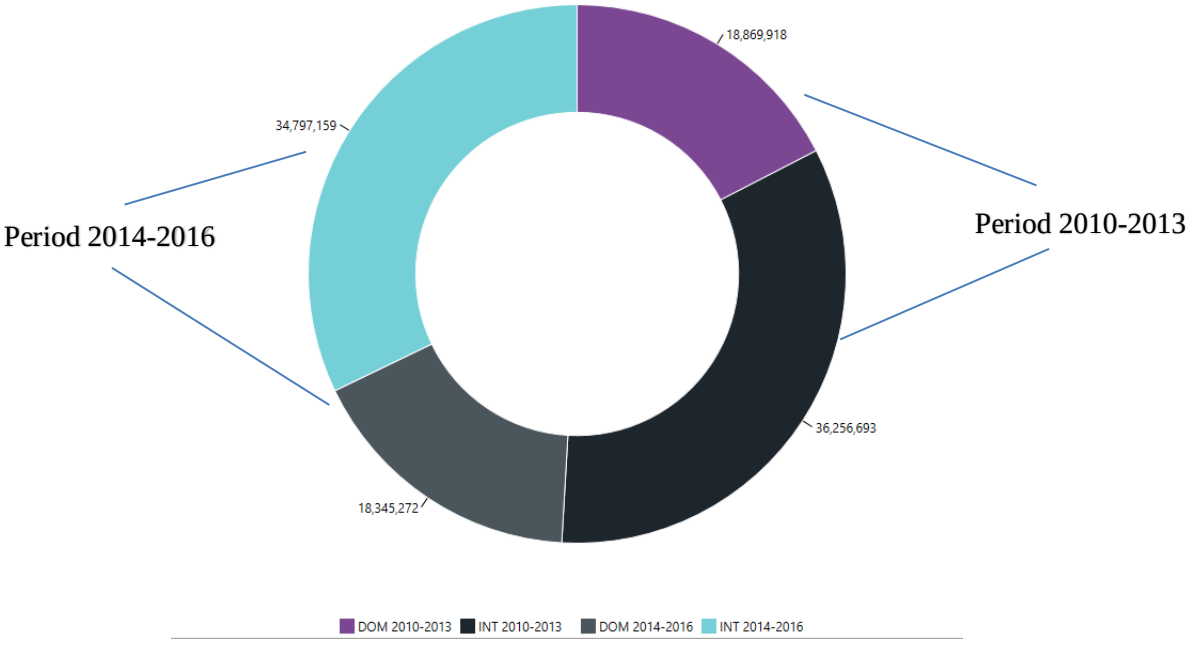
Chart Q3.3. illustrates the decline of both international and domestic passengers traffic from 2010 to 2013. Specifically, there was a slide of 15% of international passengers and a 25% of domestic passengers. After 2013 the increase of international passengers was 57% and the one of domestic travelers reached 66%.

Chart Q3.3: Number of passengers per destination per year



The total number of passengers during the crisis period is 55million and 53million during the after-crisis period.

Chart Q3.4: Number of Passengers per destination per period (periods 2010-2013 and 2014-2016)



For the years 2010-2013, Aegean and OA independently transported 54.5% of the total passenger traffic of the specific period having equal transportation numbers as far as the domestic destinations are concerned. They together transported 18m domestic passengers which counter 96% of the domestic traffic for the crisis period.

Table Q3.1: Number of Passengers per Destination per Year (period 2010-2013)

		2010	2011	2012	2013
Total	**Total**	**15,350,493**	**14,381,348**	**12,902,458**	**12,492,312**
Aegean Airlines S.A.	**Total**	**4,801,888**	**4,726,754**	**4,329,959**	**4,789,664**
	International	2,098,206	2,276,512	2,226,055	2,507,028
	Domestic	2,703,682	2,450,242	2,103,904	2,282,636
OLYMPIC AIR	**Total**	**4,115,559**	**3,130,054**	**2,646,716**	**1,903,965**
	Domestic	2,700,092	2,358,249	2,070,813	1,621,376

For the years 2014-2016 the joint Aegean/OA transported 50% of all I/D passengers and 78% of the domestic passengers during the after-crisis years.

Ryanair's passengers numbered the 20% of the domestic passengers sum for the years 2014-2016 grasping its market share in the domestic destinations. Hence, the 98% of the domestic flights after the crisis was still carried out by only two carriers (Aegean/OA and Ryanair) but with greater competition.

The low-cost Ryanair points out its entry with international destinations share as well, leaving EasyJet quite behind. Overall, Ryanair managed to obtain the 12% of the I/D passengers traffic from year 2014 to year 2016.

Table Q3.2: Number of Passengers per Destination per Year (period 2014-2016)

		2013	2014	2015	2016
Total	**Total**	**12,492,312**	**15,146,031**	**18,036,051**	**19,960,349**
Aegean Airlines S.A.	**Total**	**4,789,664**	**7,317,661**	**8,361,236**	**7,217,955**
	International	2,507,028	3,310,474	4,161,779	4,799,907
	Domestic	2,282,636	4,007,187	4,199,457	2,418,048
OLYMPIC AIR	**Total**	**1,903,965**	**432,168**	**629,196**	**2,525,097**
	Domestic	1,621,376	411,519	629,196	2,525,097
	International	282,589	20,649		
RYANAIR Ltd	**Total**		**1,037,128**	**2,449,788**	**3,259,816**
	Domestic		652,080	1,319,607	1,758,942
	International		385,048	1,130,181	1,500,874
LUFTHANSA	**Total**	**603,610**	**607,431**	**613,620**	**611,292**
	International	603,610	607,431	613,620	611,292
EASYJET AIRLINE Co. Ltd	**Total**	**502,873**	**571,889**	**567,604**	**554,226**
	International	502,607	571,367	566,928	553,010
	Domestic	266	522	676	1,216

As stated in Table Q3.3, the airlines that carry out international flights are 230 more than the ones that carry out domestic flights. Bearing in mind that the total number of airlines landed in the airport during 2010-2016 is 284, this table makes a conclusion

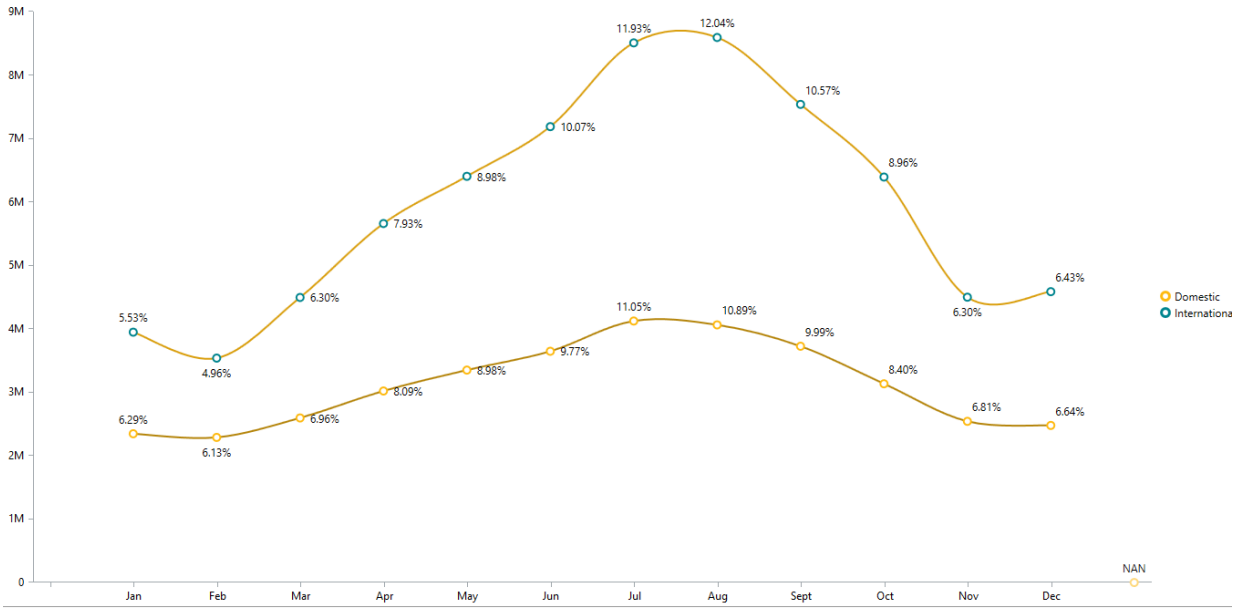
that 38 airlines carried out both domestic and international destination flights. Obviously, in this number the transit flights are incorporated.

Table Q3.3: Number of airlines per destination

	Total	2010	2011	2012	2013	2014	2015	2016
Total	**284**	**148**	**148**	**119**	**111**	**117**	**111**	**117**
Domestic	**46**	22	12	13	13	15	14	16
International	**276**	145	145	116	109	114	108	114

The monthly distribution per destination is presented in Chart Q3.5. The pick of the passengers' traffic is noticed in months July and August for both destinations performing a sharp increase (4% for the domestic and 6% for the international destinations) in traffic from the lowest February.

Chart Q3.5: Number of Passengers per destination per month (% of total destination value)



Q4. Is the number of airlines related to the passengers and flights traffic?

Chart Q4.1: Number of passengers per number of airlines

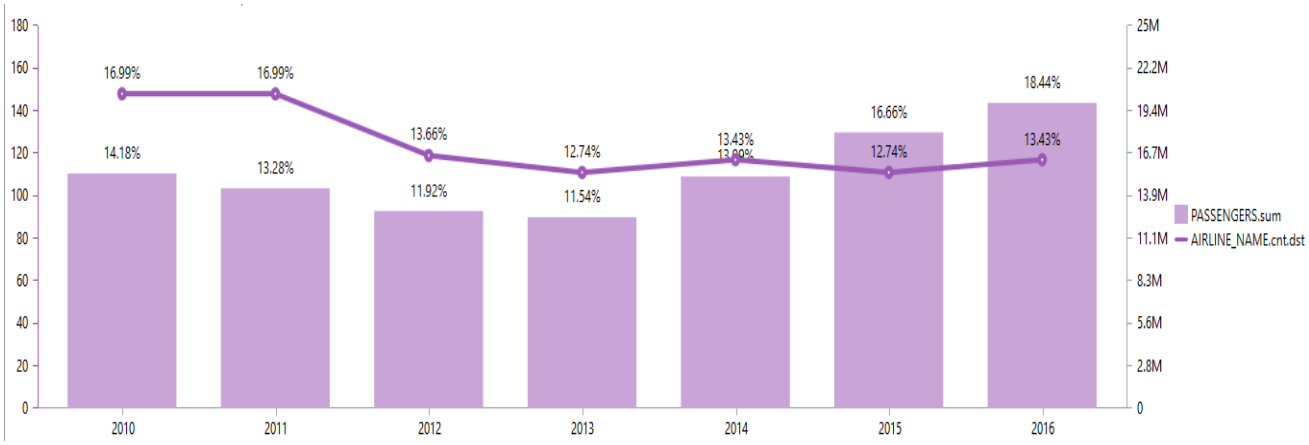


Table Q4.1: Number of airlines per number of flights

YEAR	Number of AIRLINES	Number of FLIGHTS-sum
Total	**284**	**1,018,500**
2010	148	166,420
2011	148	151,381
2012	119	133,424
2013	111	118,601
2014	117	131,946
2015	111	152,326
2016	117	164,402

As indicated in Chart Q4.1, the number of airlines do not influence the number of passengers. In fact, 13.43% of the airlines transferred 18.44% of passengers in 2016 unlike 2010's values when 16.99% of the airlines transferred 14% of passengers. This is proved in Table's Q4.1 values, where nearly the same number of flights in 2010 and 2016 were carried out by 31 less carriers in 2016.

This analysis proves that the global economic crisis resulted in the merger of airlines (like the Greek Aegean & OA) or the termination of the operation of lots of them (mainly charters) due to bankruptcy.

Q5. How are the carriers classified and what is their flight portion at AIA?

During the data preparation of our database, I inserted a new column the rows of which characterized every airline and every flight according to the type and "personality" of the relevant carrier. In this way, I managed to classify the airlines and create some interesting insights. As explained in Chapter 3, the classification was realized according to my findings from the global literature review, AIA's Aerostat Handbook and the research in the official sites of the companies.

Therefore, the airlines are distinguished to Hybrid, Full Service Networks (FSNs), Low Cost Carriers (LCCs), Charters, Business, Cargo, Public (army), Helicopter and PrivateJet. The airlines that ceased their operation at some point during the examined period, are included.

In this work, I will concentrate in the analysis of the first four carrier types, which are the prevailing carriers. The definitions of FSN (Full Service Network carriers), LCC (Low Cost Carriers) and Hybrid are profoundly explained in Chapter 3. Charter airlines are the ones that provide scheduled leisure/holidays group trips usually in cooperation with travel agents.

Table Q5.1 indicates the number of airline companies per carrier type. The lowest number of airlines are the ones characterized as Hybrid, while the highest number are the Charter airlines even though they had a decrease of 39% from 2010 to 2016. The number of the other three airline types had no remarkable change.

Table Q5.1: Number of airlines per carrier type

	Total	2010	2011	2012	2013	2014	2015	2016
Total	**284**	**148**	**148**	**119**	**111**	**117**	**111**	**117**
CHARTER	**139**	66	66	44	46	45	41	39
FSN	**60**	41	42	40	33	36	36	38
HYBRID	**17**	11	12	9	10	12	14	12
LCC	**61**	28	26	26	22	23	18	27

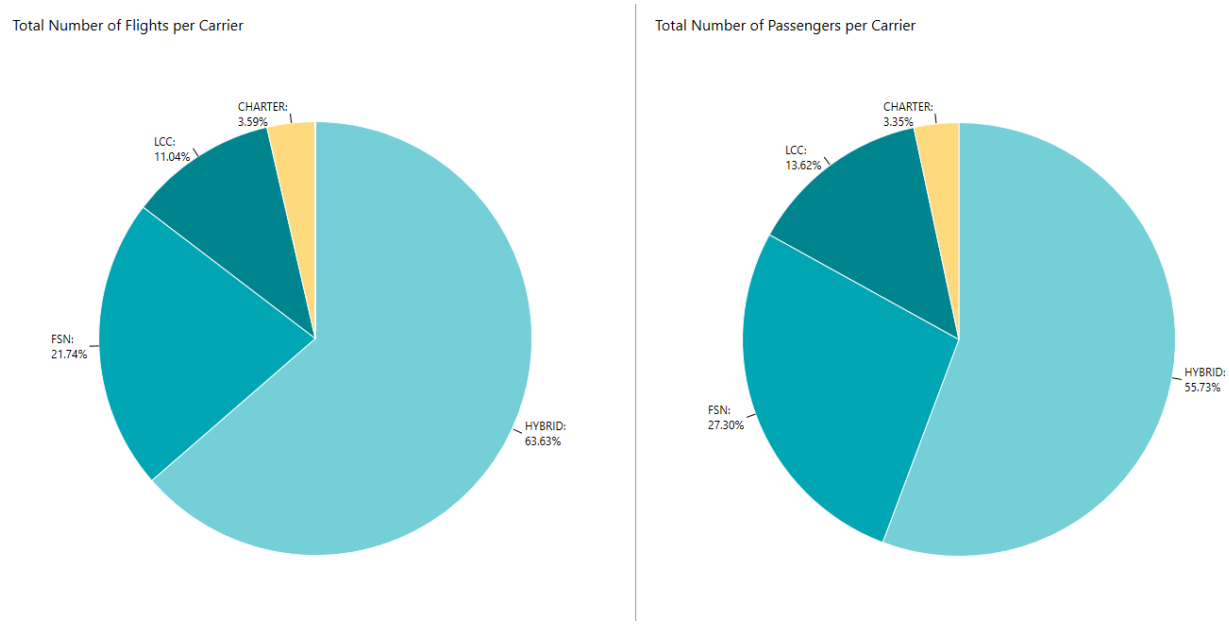
As described in Tables Q5.2 & Q5.3 and Chart Q5.1, the carriers that carried out the largest volume of flights are the Hybrid transferring 55.7% of total passengers. The FSNs follow with the percentage of 27.31% of total passengers, then the LCCs with 13.63% and the Charters with 3.28%. Nearly the same portions are valid for the total of flights carried out.

Tables Q5.2, Q5.3: Number of Flights and number of Passengers per Carrier type

CARRIER	FLIGHTS.sum
Total	**1,018,500**
HYBRID	648,041
FSN	221,378
LCC	112,478
CHARTER	36,570

CARRIER	PASSENGERS.sum
Total	**108,269,042**
HYBRID	60,334,276
FSN	29,560,634
LCC	14,747,691
CHARTER	3,623,248

Chart Q5.1: Number of flights and passengers per Carrier type



The above analysis comes in accordance with the research conducted in Chapter 3. More and more airlines adopt a hybrid business model as an answer to the global alterations in the industry. They combine first class services with low fares supported by unbundled services, as an effort to attract a wider range of customers' requirements.

It also agrees with the increase of Aegean/OA's share which has become a hybrid type airline.

Q6. Which carriers' traffic was increased/decreased?

Chart Q6.1 illustrates the share of each carrier type per year. The FSNs lose share every year while there is a trend of the passengers towards the Hybrid and the LCC companies with their portions getting larger each year. Specifically, the hybrid carriers' passengers constitute the 51,5% of total for year 2016 and the LCCs 24%. In 2010, the LCCs possessed only 6,5% of passengers' traffic.

Chart Q6.1. Number of Passengers per Carrier per Year (percentages on total)

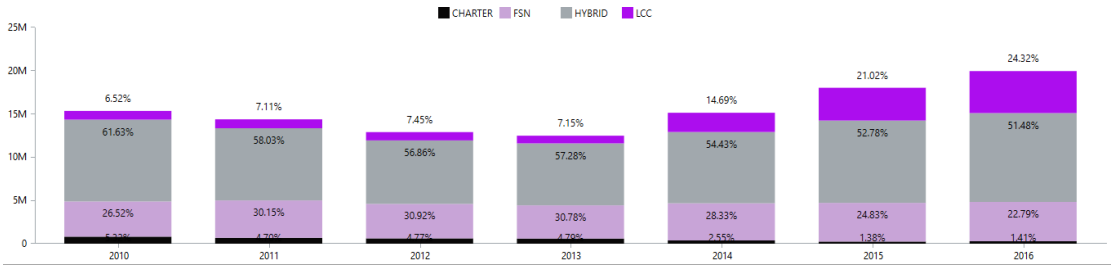


Chart Q6.2 shows the remarkable increase of 440% in LCCs' passengers traffic (Line 3) during the period 2013-2016. The Hybrid carriers follow with an increase of 143% in passengers traffic (Line 1) being still the first preference in passengers' transportation. In 2016 LCCs surpassed FSNs' traffic (Line 2) by merely 6%.

Chart Q6.2: Number of passengers per carrier and per year (percentages of own total values)

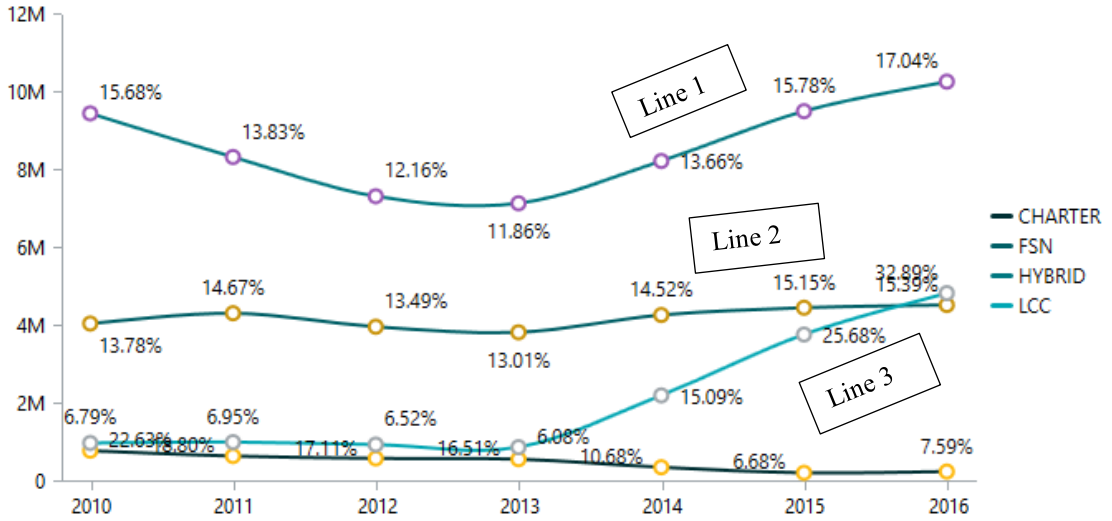


Table Q6.1 indicates that in 2010 the highest percentage of passengers traffic was carried out the Hybrid and the FSNs, while in 2016 the highest percentage of passengers was transported by the Hybrid and the LCCs with the later transferring 305 thousand more passengers than the FSNs.

During the recovery years from 2014 to 2016 the number of passengers summed 53 million, 39 million (a lot more than half) of which were transported with Hybrid and LCC carriers.

Table Q6.1: Number of passengers per carrier and per year

	Total	CHARTER	FSN	HYBRID	LCC
Total	**108,269,042**	**3,623,248**	**29,560,634**	**60,334,276**	**14,747,691**
2010	**15,350,493**	817,284	4,071,094	9,460,807	1,001,154
2011	**14,381,348**	676,540	4,336,209	8,345,571	1,022,948
2012	**12,902,458**	615,514	3,989,632	7,335,846	961,466
2013	**12,492,312**	598,962	3,845,476	7,154,985	892,889
2014	**15,146,031**	385,593	4,291,436	8,244,360	2,224,548
2015	**18,036,051**	248,155	4,477,639	9,517,215	3,790,330
2016	**19,960,349**	281,200	4,549,148	10,275,492	4,854,356

A more analytical drill-in, as shown in Table Q6.2 and in Appendix, explains the above-mentioned findings. Ryanair's entry in AIA's flights map in the beginning of 2014 obviously resulted in the extraordinary increase of LCCs traffic at the airport. Indeed, nearly half of the total LCCs traffic was carried out by Ryanair during beginning of 2014-end of 2016. In the meantime, we can observe the slide in Easyjet's market share. This might also have happened due to new entries like the LCCs Blue Air and Volotea and the Hybrid Niki in 2015 and the bigger share of other LCCs.

*Table Q6.2: Number of LCC passengers per airline and per year**

RYANAIR Ltd	**Total**	**6,747,151**
	2016	3,259,816
	2015	2,449,788
	2014	1,037,128
	2012	288
	2011	131

**Appendix*

Chapter 5: Results and Discussions

The global economic crisis provoked many changes in the airlines industry and the airports around Europe. When the global economy is in decline, the number of passengers is also falling. The world economy has become dependent on air transport industry and vice versa.

As a result of the harsh Greek economic crisis, Athens International Airport had suffered a six-consecutive-years decline in traffic (2008-2013) and managed to fully recover in 2015.

The analysis presented in this thesis describes AIA's traffic decline in numbers and offers insights regarding the reasons of a remarkable positive change for year 2010-2016. The Business Intelligence suite TARGIT was used as a tool for processing the CRISP methodology followed.

The findings of the analysis can be summed up in the following points:

i. The airport passengers' traffic

Per ELSTAT (Chart 3.3.1), 70% of the non-residents arrivals in Greece represent travelers who travel by air. Comparing to AIA's Aerostat Handbook numbers, AIA has contributed by 23% in average to the international non-residents travelers' arrivals in Greece from 2010 to 2015 (2016 statistics are not available from ELSTAT). Traveling by air ranking first in non-residents' preferences, AIA possesses the first place in this category.

Although Athens International Airport's decline was nearly double worse than other European Airports (AIA showed -18,6% decrease while other European hubs demonstrated -7.5% according to Stimac et al, 2015), its traffic was increased by 60% from the crisis year 2013 until the recovery year 2016.

Compared to year 2010 alone, there was a 32% increase in 2016. In particular, the daily movement of passengers in August 2016 reached nearly 80 thousand for the whole month.

If we compare the above number with the past years highest day-records we will conclude the following: the Olympic Games day, 30th of August 2004, was the first high pick passengers' movement day for AIA, recording 69 thousand passengers. The Champions League on the 21-24th of May 2007 showed the highest records ever, servicing 85 thousand passengers. Bearing in mind the over-acting during these highlighted days (new technical infrastructures for the airport, extra seasonal personnel, etc.) we stimulate that AIA is under capacity pressure in an everyday basis for the summer-traffic high period of 2016. This predicts that, should the macroeconomic environment stay the same, the airport's capacity will have to be broadened.

Investigating the analyzed 6-year period, it is derived that 50% of the yearly traffic was succeeded through the summer quarter during months June to September.

The flights traffic had no remarkable increase after 2013 (38%) but managed to reach 2010's numbers.

ii. The number of airlines do not follow this growth,

since there was a diminished percentage of 20% of airlines throughout, from 2013 to 2016. That is, less airlines carried more passengers considering that the number of flights remained about the same. Indeed, the 52% of passengers traffic during 2014-2016 was carried out by only two airlines: Aegean/OA and Ryanair. This is a proof that during the economic crisis many airlines merged or ceased operation.

Another point that can be retrieved is that airlines fully book their flights as an answer to fuel increased fees.

iii. Increase of domestic and international travelers since 2013

The 66% increase of the domestic passengers resulting in the transportation of 1,5million more travelers (4 thousand per day) in 2016 compared to 2010, shows Greek travelers financial recovery supported by the new domestic destinations serviced by LCC Ryanair and the new Aegean/OA Airlines. The later, adopted a more hybrid type business model offering passengers more fare alternatives. This seems to be a great factor of the 57% increase of international passengers after the crisis year 2013. Overall, AIA's customers are more international travelers.

Between 2010-2013 Aegean and OA independently transported 54% of the total passenger traffic of the specific period (30 million passengers in 4 years). After their merge, they mutually achieved 26 million in 3 years (2014-2016) which is the 50% of the international/domestic traffic of the after-crisis period.

This market share gets percentage from the FSN's share and the same does Ryanair's entry that possessed the 12% share for the after-crisis period. It seems that there would have been losses for the national carrier if it was not for its joint with OA when Ryanair appeared in the airport. This point comes into agreement with the research as presented in Charter 3, where Aegean seeks to become stronger with the incorporation of OA's fleet.

iv. The classification of the carriers' types

showed that the main carrier types driving through the airport are the Hybrid carrying 56% of the passengers, the FSNs with 27%, the LCCs with 14% and the Charters with 3%. The unorthodox finding is that the charter airlines number 126 out of 284 and the hybrid number 22 out of 284. So, less airlines with greater seating capacity and fully booked transport more passengers.

v. The Hybrid carriers are the predominant carrier

Chart Q6.2 indicates that not only the hybrid carriers are the predominant ones but also that they contributed to AIA's recovery together with the low-cost flights. This finding totally agrees with the airlines business plan transformation as developed in Chapter 3.

Considering that 57% of the total traffic was carried out by Aegean/OA which is now turned into a hybrid carrier, this can explain the prevalence of this business model. In addition, more and more airlines adopt a hybrid business model pointing their need to prevail in a very competitive environment following global industry alterations.

vi. The increase of LCCs

The analysis showed the extraordinary increase of 540% in Low Cost Carriers passengers' traffic from year 2013 to year 2016. Chart Q6.1 indicates that LCCs contributed to the remarkable airport's recovery while the FSNs' course was quite steady. This leads us to the assumption that the customers of full service carriers are loyal customers that do not change their preferences.

Therefore, Ryanair's entry in the airport at the beginning of 2014 is partly responsible for this increase: nearly half of the total low-cost traffic was carried out by Ryanair during the years 2014-2016 contributing the 12% of the specific period's overall passengers' traffic and the impressive 24% of year's 2016 traffic.

vii. Existence of LCCs before Ryanair.

What did Ryanair do different and changed AIA's map?

Before the signing of contract between AIA and Ryanair in 2014, the only predominant LCC in the airport was Easyjet carrying half a million passengers per year abroad only. There was no LCC for domestic flights since Aegean and OA carried out the domestic destinations.

In addition to Ryanair's multiple domestic destinations to hub-regional airports inside the country, the passengers showed a preference towards Ryanair for the international destinations as well.

The marketing approach of this LCC revealed a new service to the Greek customers that had to do with unbundled products. The airline literary changed customers' behavior as to the ticket purchasing methods (i.e web booking) and baggage unbundled fees in favor of lower flight fares. It was proved that passengers prefer low fares to full service comfortable trips.

Chapter 6: Conclusions

The global recession of 2008 brought changes in citizens' financials and as a result in the airlines industry.

The preceding analysis conducted via the BI platform TARGIT Decision Suite 2017, revealed some very interesting insights regarding passengers' traffic at Athens International Airport during the period 2010-2016. The entry of low-cost airlines changed the runway's map and supported a magnificent recovery of AIA's numbers together with the strengthening of the national carrier Aegean after absorbing former Olympic Airlines.

The development of LCCs is a global phenomenon and it seems that this pulled the European airports (including AIA) out of recession in terms of traffic. Furthermore, there seems to be a trend of the airlines towards a hybrid business model that combines low fares with unbundled first-class services to satisfy more customer preferences.

The above-mentioned findings comply with the scientific papers and the relevant articles presented in Chapter 3, as well as with AIA's Aerostat Handbook editions 2010-2015.

AIA's investment on infrastructure for consumers (i.e. shopping malls) proves to be very wise as low fares stimulate larger volume in passengers' traffic.

In consequence of the preceding analysis I suggest that AIA continues its agreements with low cost or hybrid airlines that can carry out routes to multiple regional airports of the same domestic destinations. For instance, it could support a low-cost airline for the airport of Heraklion/Crete (in conjunction with the airport of Chania) to attract travelers that would prefer traveling by sea to reduce family expenses. In addition, contracts with intercontinental airlines could increase travelers' arrivals from distant continents.

I also exhort further analysis to be conducted regarding the performance of other airport's units, for the specific period (i.e. boarding bridges, generator power units, retail units) and be related to the insights of the analysis presented in this thesis.

Appendix

Table Q6.2: Number of LCC passengers per airline and per year

RYANAIR Ltd	**Total**	**6,747,151**
	2016	3,259,816
	2015	2,449,788
	2014	1,037,128
	2012	288
	2011	131

EASYJET AIRLINE Co. Ltd	**Total**	**3,994,611**
	2010	603,755
	2011	608,876
	2012	585,388
	2013	502,873
	2014	571,889
	2015	567,604
	2016	554,226
EASYJET SWITZERLAND	**Total**	**108,836**
	2012	23,664
	2013	25,268
	2014	27,042
	2015	24,826
	2016	8,036

TRANSAVIA AIRLINES C.V.	**Total**	**650,558**
	2010	977
	2011	49,065
	2012	62,462
	2013	91,911
	2014	128,872
	2015	157,202
	2016	160,069
Transavia France	**Total**	**385,748**

VUELING AIRLINES	**Total**	**793,226**
	2010	**88,792**
	2011	**85,219**
	2012	**71,671**
	2013	**84,803**
	2014	**155,745**
	2015	**161,855**
	2016	**145,141**
NORWEGIAN AIR SHUTTLE	**Total**	**384,440**
BLUE AIR	**Total**	**286,224**
	2015	**99,175**
	2016	**187,049**
GERMANWINGS Flug GmbH	**Total**	**79,795**
	2010	45,399
	2011	34,396
GERMANWINGS GmbH	**Total**	**160,346**
SKY EXPRESS S.A.	**Total**	**190,104**
	2010	**15,338**
	2011	**23,260**
	2012	**14,667**
	2013	**13,551**
	2014	**11,102**
	2015	**17,936**
	2016	**94,250**
VOLOTEA AIRLINES	**Total**	**87,749**
	2012	**230**
	2013	**44**
	2014	**108**
	2015	**31,708**
	2016	**55,659**

Abbreviations

AIA: Athens International Airport, the primary airport hub of Greece

BI: Business Intelligence, the methods and technologies that gather, store, report, and analyze business data to help people make business decisions

BI&A: Business Intelligence and Analytics

CRISP: Cross Industry Standard Process for Data Mining, a data mining process model that describes commonly used approaches that data mining experts use to tackle problems

DM: Data Mining, the computing process of discovering patterns in large data sets

ELSTAT: Hellenic Statistical Authority, the national statistical service of Greece

FSN: Full Service Network carrier, a transportation company, such as an airline or shipping company, that, being locally registered in a given state, enjoys preferential rights or privileges accorded by the government for international operations.

I/D: International/ Domestic, it refers to destinations of flights or passengers from the Athens airport

KDD: Knowledge Discovery in Databases, a data mining process model that describes commonly used approaches that data mining experts use to tackle problems

LCC: Low Costs Carriers, an airline without most of the traditional services provided in the fare, resulting in lower fares and fewer comforts

MOLAP: Multi-dimensional Online Analytical Processing, stores data in an optimized multi-dimensional array storage, rather than in a relational database

OA: Olympic Air, a Greek airline company that once was the national flag carrier

OLAP: Online Analytical Processing, is an approach to answering multi-dimensional analytical (MDA) queries swiftly in computing

ROLAP: Relational OLAP, works directly with relational databases and does not require pre-computation

SEMMA: a data mining process model that describes commonly used approaches that data mining experts use to tackle problems

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