A UNIFIED AND MODULAR ARCHITECTURE FOR TRAVEL SOFTWARE

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The family is one of nature's masterpieces.

— George Santayana

Dedicated to my parents Ignatios and Anastasia for their love and support.

ABSTRACT

Travel industry suffers from the absence of widely accepted definitions, software communication standards, and industry-specific data models that eventually causes inefficient software design. As a consequence, repetitive work needs to be done for new or legacy systems only to provide functionality that has already been implemented. A unified data model with clear definitions will dramatically increase the Travel systems' interoperability and efficiency. In the era of computer networks, data interchange is very common between applications that run on various platforms and a universal model sets the foundation for a well established communication.

We have seen that computer programming is an art,
because it applies accumulated knowledge to the world,
because it requires skill and ingenuity, and especially
because it produces objects of beauty.

— Donald E. Knuth

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THE TRAVEL INDUSTRY

The first part of this thesis sets the knowledge foundation that is required to understand the industry's terminology and build models that represent it.

1 INTRODUCTION

1.1 OVERVIEW

Travel industry suffers from the absence of widely accepted definitions, software communication standards, and industry-specific data models that can be used as a basis for every Travel software.

This fact causes a vast waste of resources, especially human work hours, as it requires a lot of repetitive work and solving problems that have already been solved in the past. The Travel industry is one of the world's largest industries with a global economic contribution (direct, indirect and induced) of over 7.6 trillion U.S. dollars in 2016.[1]

The objective of this thesis is to propose a universal data model for Travel software, which will be valid for every participant/stakeholder of this industry. To achieve this objective, a solid categorization of these stakeholders was required. The software that they already use has also been studied to provide a clear view of the Information Systems that may integrate this model.

1.2 MOTIVATION

The need for a unified and modular data model is motivated by a variety of monolithic information systems. These systems have to implement the same functionality over and over again for similar use cases. Furthermore, they produce information silos which means that data is scattered among many databases in the same organization and one information system or subsystem is incapable to cooperate with others that are, or should be, related. External software-to-software communication in such systems is inherently difficult, if not impossible.

1.3 STRUCTURE

Part 1 of this thesis, "The Travel Industry", sets the knowledge foundation that is required to understand the industry's terminology and build models that represent it. I concluded in such a categorization after an extended and systematic literature review. After reading Chapter 2, the reader will have a clear understanding of the Travel industry's structure: its basic definitions, products and services, stakeholders and importance.

1 www.statista.com

In Part 2 I present the typology of the software that Travel industry uses (Chapter 3), propose the data model that can support Travel related software and finally apply it to real working examples (Chapter 4).

1.4 CONTRIBUTION

The overarching contribution of this thesis is to demonstrate that many Travel organizations can utilize a commonly defined data model and modules of software, even if they have different roles. It also demonstrates that a single organization can use the same components for a variety of use cases instead of a single one. This thesis, also, practically extends and adds to other work with analogous objectives, by providing real computer code to verify its hypothesis.

2 THE TRAVEL INDUSTRY

2.1 INTRODUCTION

In this chapter I will clarify what Travel and Tourism are, the differences between them, their impact on economy, society and environment and finally their characteristics and stakeholders. It is very important for Travel businesses to use a common language in order to develop standard data models. Also this chapter helps to understand customers' behavior that is essential to develop services and software for them.

2.2 DEFINITIONS

2.2.1 *Travel and Tourism*

According to World Tourism Organization (UNWTO, 2008) *Tourism* is a subset of *Travel*.

Travel refers to the activity of *travelers*. A traveler is someone who moves between different geographic locations for any purpose and any duration.

UNWTO Tourism definition is "Tourism comprises the activities of persons traveling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes."

A *trip* refers to the travel by a person from the time of departure from his usual residence until he/she returns: it thus refers to a round trip. A trip is made up of *visits* to different places.

Although these definitions have a solid academic and conceptual importance, within the industry itself the terms are used much more loosely.

A *visitor* is a traveler taking a trip to a main destination outside his/her usual environment, for less than a year, for any main purpose (business, leisure or other personal purpose) other than to be employed by a resident entity in the country or place visited.

A visitor is classified as a *tourist* if his/her trip includes an overnight stay, or as a *same-day visitor* (or *excursionist*) otherwise.

All tourists are visitors and all visitors are travelers but the opposite is not always correct. The following examples and Figure 1 will make this concept clear.

Travelers that are not Visitors: Border workers, Transit passengers, Nomads, Refugees, Armed Forces Member, Representation of consulates, Diplomats, Temporary immigrants, Permanent immigrants. (Holloway, Humphreys, and Davidson, 2009; UNWTO, 2008)

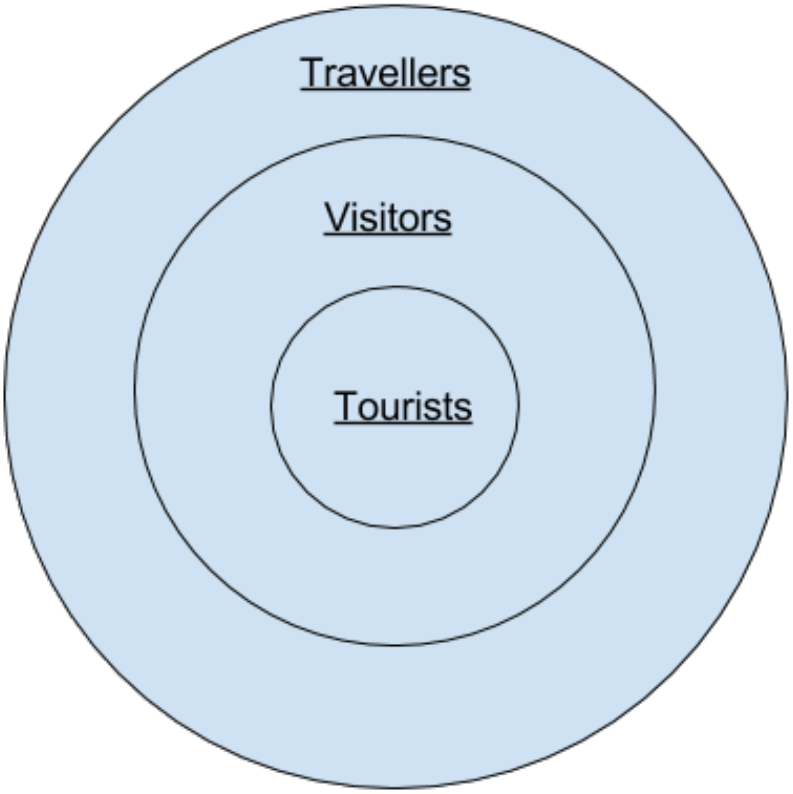


Figure 1: Travelers is a superset that contains visitors and tourists.

Visitors that are not tourists: Cruise passengers, Day visitors, Crews. (Holloway, Humphreys, and Davidson, 2009; UNWTO, 2008), Excursionists.

Tourists (who are also Visitors and Travelers) travel with the purpose of: Holidays, Business, Health, Study, Visiting family or friends, Religion, Shopping, Sports, Others (Holloway, Humphreys, and Davidson, 2009; UNWTO, 2008).

2.2.2 *Forms of tourism*

In relation to the country of reference, three basic forms of tourism can be distinguished:

Domestic[1] tourism, which involves trips made by residents within their own countries.

Inbound tourism, which involves trips made by non-resident visitors within the country of reference.

1 In the national accounts context, domestic tourism corresponds to what is called national tourism in tourism statistics.

Outbound tourism, which involves trips made by resident visitors outside the country of reference.

The three basic forms of tourism set forth above can be combined in various ways to derive other forms of tourism:

Internal tourism, which involves resident and non-resident visitors within the country of reference as part of domestic or international tourism trips (domestic + inbound).

National tourism, which involves resident visitors within and outside the country of reference, either as part of domestic or outbound tourism trips (domestic + outbound).

International tourism, which involves resident visitors outside the country of reference, either as part of outbound tourism trips and the activities of non-resident visitors within the country of reference on inbound tourism trips (inbound + outbound).

2.3 TRAVEL PRODUCTS

Defining the tourism products is a challenging task due to their inherent complexity and the fact that authors of the related literature seem to lack a common understanding. UNWTO does not provide an international recommendation for this type of classification because "tourism products are still not sufficiently characterized in a uniform way".

In a paper titled *Understanding the Tourist Product*, Koutoulas proposes a marketing-oriented definition of the *total tourism product* as well as a classification system of its components. Its understanding is very useful to efficiently model these products in any data intensive application. In the rest of the section, I will try to simplify and sum up his research in order to make this business entity clear.

2.3.1 *Defining Travel Products*

Marketing theory views a product as fulfilling two distinct tasks (Burkheiser, 1969; Scheuch, 1993):

Products as Need Satisfiers

- satisfaction of a consumer's need through the benefit(s) it incorporates.
- achievement of the organization's marketing targets through their sale.

Travel products are the means to satisfy travelers' needs. These needs can be grouped into two distinct categories (Paul, 1977):

- Primary traveler needs are those that urge a person to make a trip in order to satisfy them.

Traveler needs

- Secondary or derived travel needs are those arising from the decision to make a trip.

Total VS Specific Tourism Products

Tourism products can be determined on two distinct levels (Freyer, 1993; Middleton, 1989; Tietz, 1980):

- *The total tourist product* comprises the combination of all the elements, which a tourist consumes during his/her trip.
- *The specific products* are components of the total tourist product and can be sold as individual offerings such as accommodation, transport, attractions and other facilities for tourists. In other words, specific products are the offerings of the individual tourist enterprises.

The total tourist products can be understood as bundles of tangible and intangible components based on an activity at a destination (Middleton, 1989). According to Middleton, "all tourists buy, either separately, or as an inclusive tour, the various components of the tourist product. Either way, the end result of all these purchases is a 'package.' This view of the tourist product holds good whether a business trip, a holiday or, indeed, any other form of tourism, international or domestic, is under consideration. Airline seats or hotel beds may be individual products in the eyes of their producers, but they are merely elements or components of a total tourist product, which is a composite product."

Koutoulas' extensive analysis has concluded to useful findings in understanding the travel products. Some useful to our context are:(Koutoulas, 2001):

1. The tourist product should not be seen from the point of view of the individual producer (such as the hotelier or the transportation company) but from the point of view of the consumer, thus equating the tourist product with his/her total travel experience. The tourist product should be perceived as including all the elements that are part of a trip. These elements may be everything the traveler spends part of his budget on, like a map, transportation, food, gasoline, accommodation etc.
2. These elements can be found at the destination of the trip, the transit routes and the place of residence (Leiper, 1990:81). The consumption of these elements takes place before, during and after the trip.
3. A tourist product can only be determined in relation to a specific destination, a fact that makes each product unique.
4. The destination is not the product. A destination offers several products to its visitors, with each distinct travel experience constituting a tourist product (Jeffries, 1971:4) For instance, the island of Lesbos allows for a cosmopolitan beach vacation in

Molyvos; a serene beach vacation in a secluded village; a geological tour; a tour of the historic sights; small or medium-sized conferences; culinary experiences related to the local ouzo drink, sardines, olives and olive oil; and the list goes on (Koutoulas, 2001).

5. The tourist product should be distinguished from the inclusive tours or package tours. An inclusive tour is not a total tourist product but a specific tourist product as discussed above, even though it is a composite one. An inclusive tour is essentially a selected combination of individual elements of the total tourist product, marketed under a particular product or brand label, and sold at an inclusive price (Middleton, 1988).

6. The tourist product is a composite product consisting of several components (Burkart and Medlik, 1981).

7. It is not the production but the consumption of the tourist product that explains its composite nature. Each component is produced independently by the respective enterprise and it provides only a limited benefit or no benefit at all to its consumer if it is not combined with the other components of the tourist product. It is only the whole bundle of components that fully satisfies the primary and secondary needs of a tourist.

8. Each tourist experiences his/her own unique tourist product, based on socio-economic and psycho-demographic variables as well as on his/her previous travel experiences, motivation, conceptions and expectations etc.

9. The tourist product, i.e. the travel experience and the various elements - goods, services and facilities - used and consumed by a tourist as part of his/her trip, has a total price. This price is not settled in one payment; on the contrary, it takes several transactions to obtain all elements of the product, even in the case of an all-inclusive package tour (Koutoulas, 2001).

10. Some of the tourist product's components are not produced specifically for the tourist market, with the respective businesses serving other markets, as well. It is the consumption phase - and not the production phase - that makes some elements part of the tourist product. For instance, restaurants that have tourists among their customers, but their clientele is predominantly the local population.

In line with the above findings we can define a tourism product with the following simplified version of Koutoulas' definition:

The tourism product is the total bundle of functionally interdependent tangible and intangible elements that enables the tourist to en-

gage in a specific activity at one or several destinations and to facilitate the transition to the destination(s). The tourism product satisfies both the primary and secondary tourist needs. The tourist product's components are found in different geographical locations and in different time periods (before, during and after the trip). From the tourist's point of view it is equated with her total travel experience that is perceived in a subjective manner; for this experience she pays the total travel expenses. The tourism product satisfies the tourist needs and produces income for the tourism enterprises.

2.3.2 *The Components of Travel Products*

Due to their complex nature, tourism products consist of numerous components. These components come in various forms (Koutoulas, 2001):

Forms of Travel Product's components

- *Integral products* that can be sold independently on the market (such as hotel accommodation, air transport, admission to visitor attractions etc.)
- *Free / public goods*, such as the climate and the scenery, that can be used or consumed by tourists free of charge (Scheuch, 1993).
- *Complementary services* that cannot be sold independently on the market, such as the services provided by a tourist information office or by a tour leader.

Definition of Travel Product's Componenets

According to Koutoulas, "Components of the tourist product are those integral products, "free and public goods" and complementary services that perform a specific functional role in the framework of the total product and that are part of the product because of their functional characteristics. Components are, therefore, a prerequisite for the total product, so that the latter can provide the expected benefits to the consumers. The functional characteristics have been incorporated into the components either by their respective producers following a conscious managerial decision (in the case of integral products and complementary services), or by the nature and culture of the destination (in the case of the "free and public goods"). More specifically, it is final products and not intermediate products or inputs of a production process that are considered integral products. In addition, integral products should be produced and/or sold by tourist enterprises that fulfill two characteristics in order to be considered as components of the tourist product: (1) the products - good and services - provided by these enterprises directly satisfy the needs of tourists; (2) these enterprises come in direct contact with tourists when trading their products. Components complement each other, i.e. they are functionally interdependent as each one provides only a part of the total sum of benefits sought by tourists."

2.3.3 *Classification of Travel Product Components*

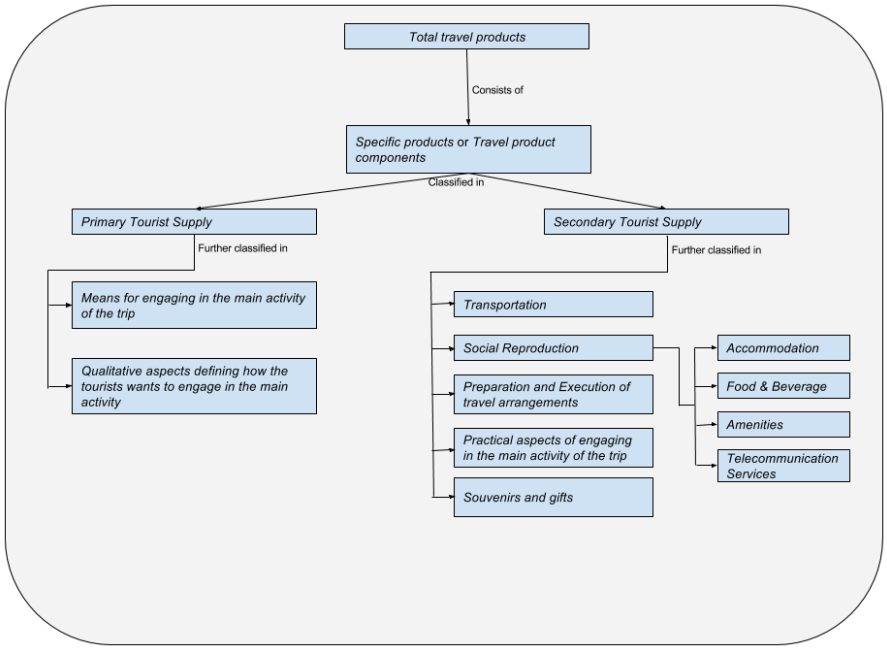


Figure 2: Travel product components and classification.

Components of tourism product are classified into categories in the literature with several criteria: i) Purpose of creation, ii) Origin (e.g. man-made elements vs natural element), iii) Tangibility, iv) Variability, v) Time of consumption and vi) Functional role: Components attracting tourists to the destination are classified as primary tourist supply or as attractions (the "primary causal elements"); components facilitating the travel and stay at the destination are classified as secondary tourist supply or as amenities or as facilitators (Medlik and Middleton, 1973; Coltman, 1980; Gunn, 1993).

According to Koutoulas, 2001, the most suitable classification criterion is the functional role of components. Using this criterion, components are classified in the following categories:

1. *The Primary Tourist Supply* includes all the attractions that draw the travelers to a destination and satisfy their primary needs. They can further be classified into:
    a) *Means and conditions for engaging in the main activity of the trip at the destination or inside the mode of transportation* (as in the case of cruise ships and luxury overnight trains): natural conditions, natural and cultural heritage, people, socio-economic conditions of the destination, artistic creation, events, facilities, equipment, goods and service related to the main activity.

   b) *Qualitative aspects defining HOW the tourist wants to engage in the main activity and to live the total travel experience*: e.g. familiar or exotic destination; short or long distance between the place of residence and the destination; luxurious or traditional ambience, the particular character of the destination; hospitable attitude of the local population; good weather; protected natural environment, secure environment etc.

2. *The Secondary Tourist Supply* includes all the amenities needed by a tourist to visit a destination and to consume its attractions. It also includes souvenirs and gifts of all kind. The benefits offered by the amenities satisfy the secondary or derived tourist needs, i.e. those needs arising from the decision to make a tourist trip. They can further be classified into:
   a) *Modes of transportation and other components of the transportation systems*.
   b) *Means for the tourist's social reproduction during the trip*: elements performing household functions as well as allowing the tourist to engage in leisure activities, to communicate with other places, to socialise and to stay informed. This category includes accommodation, food and beverage, cleaners, hairdressers, telecommunication services, postal services, sports and other leisure facilities, cultural events, retail outlets (for recreational shopping) etc.
   c) *Several aspects regarding the preparation and execution of the travel arrangements* in regard to making the trip easier, safer and more affordable, to prevent or to heal injuries and sickness, to enter a foreign country, to finance the travel expenses, to make prior payments etc. This category includes all means of tourist information (travel guidebooks, maps, national tourist organisations, travel-related websites, local tourist offices etc.); telecommunications; services provided by tour operators, travel agencies, escorts, translators, certified travel guides and porters; vaccines, sun protection, medicine and healthcare services; passports and visas; travel insurance; credit cards and other financial services; as well as numerous goods such as suitcases, clothes, photo cameras and films etc.
   d) *Practical aspects of engaging in the main activity of the trip*. These aspects do not constitute attractions but merely support the tourist in engaging in the activity (e.g. sale or rental of sports equipment, lessons by sports instructors, sports apparel etc.).
   e) Souvenirs and gifts, usually bearing sentimental and symbolic values for the tourists. They allow tourists to remem-

ber and relive their experiences, thus prolonging the pleasure of the trip. They are also used for sharing the travel experience and for strengthening the ties with other people (both at the place of origin and at the destination). Souvenirs and gifts include a vast range of goods - such as typical products of the destination or the place of origin - as well as items found or made by the tourist or received as a gift.

It should be noted that the same component may have two or even more functional roles. In addition the very same component can have a different functional role for different people.

2.4 TRAVEL INDUSTRY STAKEHOLDERS

In this section, I will describe the various stakeholders that form the Travel and Tourism Industry and will clarify their roles.

2.4.1 *Travelers*

Although travelers do not equal tourists as I have explained in Section 2.2, they have many common attributes so the terms will be used interchangeably.

2.4.1.1 *Classification*

The dominant typologies of tourists are those of Cohen, 1972 and Plog, 1974. Both classify tourists according to psychological characteristics and are very similar.

- Cohen's classification of tourist is based on the theory that tourism combines the curiosity to seek out new experiences with the need for the security of familiar reminders of home.

  He identifies four tourist types (Cohen, 1972):

  1. *Organized Mass Tourist* is the least adventurous tourist that spends most of his time in her comfortable environmental bubble[2] throughout her trip. The trip is organized in advance and the tourist has no decisions on it.
  2. *Individual Mass Tourist* is similar to the organized mass tourist, except that the tour is not entirely fixed. The tourist has a certain amount of control over her time and itinerary, and is not bound to a group. However, all the major arrangements are still made through a tour agency.

2 In the context of mass tourism, Cohen described the environmental bubble as a familiar, comfortable microenvironment within a novel, foreign macroenvironment.

3. *Explorer* arranges her trips alone and tend to visit an unusual destination but still seeks comforts in accommodation and transportation. She tries to mix with the locals and dares to leave the environmental bubble.
4. *Drifter* goes further away from the environmental bubble and keeps away from tourism establishments such as hotels or tour coaches. The drifter has no fixed itinerary or timetable and makes the trip decisions herself.

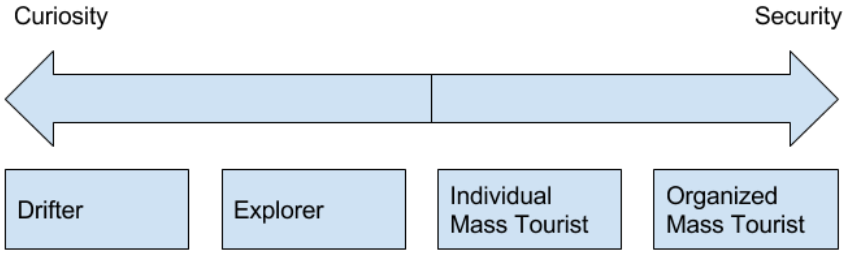


Figure 3: A visual representation of Cohen's typology.

- Plog suggests that travelers can be classified into three main types based on their different personalities (Plog, 1974):
    1. *Allocentric* seeks new experiences and adventures and is outgoing and self-confident. She prefers to explore new, unusual areas and to meet foreigners.
    2. *Psychocentric* is more conservative and tends to be inhibited and less adventurous. She prefers to drive to destinations and stay in typical tourist accommodations. Safety and security are her main concerns.
    3. *Mid-centric* is the most common type that falls between the other two types.

2.4.1.2 *Motivation*

Igoumenakis, 1991 analyzes travel motivations into four distinct categories:

1. Natural and Climate - like sunshine, temperature and sea.
2. Cultural - like education, religion, museums and points of archaeological interest.
3. Economical - like business.

4. Psychological - like escape from a perceived mundane environment, exploration and evaluation of self, relaxation, prestige, regression, personal relationships and facilitation of social interaction.

Motivations define new travel genres.

Motivations can also be found in the industry's marketing as tourism genres. According to Anuzsiya, 2014, any motivation of travel is a potential seed for a genre of tourism. She also proposes that the underlying motive is what Gunn and Var, 2002 termed personal rewards.

In the modern era, many tourism genres are identified in the literature. These are often called *Adjectival Tourisms* or *Niche Tourism Markets* or *Specialty Tourisms*. *Adjectival Tourism* 2016 provides a wide list of different forms of tourism related to the motivation of travellers. Because the list is very extensive I will refer only the most wide-spread: Active Tourism (participating in sport activities), Aerial Tourism (also Flightseeing), Agritourism (or Farm Tourism), Dive Tourism, LGBT tourism, Drug tourism, Religious Tourism, Sex Tourism, Space tourism, Wine Tourism, Virtual Tourism, Volunteer Tourism.

2.4.2 *Travel Providers*

A travel provider is a person or organization that provides travelers with travel products or services. Travel providers greatly vary in size and place of activity and can range from an independent guide to an international tour operator.

2.4.2.1 *Hospitality*

Hospitality sector refers to those companies or organizations which mainly provide accommodation and/or food, drinks to their guests. However, they can also provide a plethora of other complementary services. Usually, it can be further divided into two main sectors: *accommodation* sector and *food & beverage* sector.

2.4.2.2 *Accommodation*

The accommodation sector comprises widely differing forms of sleeping and hospitality facilities. Accommodation typology is based on criteria such as location, architecture or even the visit purpose. The most important of them are (*Luxury Accommodations* 2016):

- Hotel: An establishment that provides short term overnight accommodation. They are rated from one to five stars according their amenities but the rating system may vary across countries.
- Motel: roadside hotels equipped with minimal amenities and ample parking areas for motor vehicles.

- Hostel: A budget hotel with shared bedrooms and bathrooms. Some hostels offer private bedroom or bathrooms at an extra price.
- Bed & Breakfast: Breakfast is included in the price.
- Boutique Hotel: A unique architecture or theme-styled hotels that usually don't exceed 150 rooms.
- Resort: Accommodation providing a wide variety of amenities and recreational facilities. It is more about the experience. Usually used for vacation or getaways.
- Villa: A luxurious country residence.
- Apartment/Flat: A unit in a building that usually features a kitchen.
- Camp: A collection of tents.
- Pop-up hotel: A temporary hotel to house guests of an event.
- Tent: A portable shelter made of fabric.
- Yacht: A luxury boat.
- Recreational Vehicle (RV): A motor vehicle or trailer equipped with living space and amenities found in a home. (Wikipedia)
- Guesthouse: A private house that can be rented for short-term accommodation.
- Aparthotel: A hotel that offer apartments combined with hotel services for long-term accommodation.

2.4.2.3 *Food & Beverage (Catering)*

The food and beverage sector is also broad and comprises many catering facilities, the most common of them being restaurants, cafes and bars.

2.4.2.4 *Transportation*

Transportation sector refers to every carrier that undertakes to transfer a traveler from one place to another. There are three possible channels: air, water and land.

- Air Transportation: the aviation business is run by the airlines. They usually provide 3 different classes of services: first, business and economy class. There are two types of flights:
    1. *Scheduled*, that are operated regularly with published timetables and

2. *Chartered*, that are booked by a group or consortium responsible for all seats on the flight.

- Water Transportation: the most common types of water transportation are: i) Cruise Ships, that offer a vacation trip by water on rivers, large lakes and oceans. ii) Ferries, that offer a port to port transportation.
- Land Transportation: includes road transportations like buses, cars (rental and taxis), motorbikes and bicycles. Rail, regular and underground.

2.4.2.5 *Attractions*

By attractions in this context I refer to man-made attractions for entertainment, recreational and other purposes. The most common representatives are: theme parks, wildlife parks, museums, theaters and casinos.

2.4.2.6 *Other Facilitators*

The following travel providers have a determinant role in Travel Industry but cannot be categorized in the preceding categories: Travel Insurance Organizations, Foreign Exchange service providers, Travel Publications and Information Providers, Travel Portals.

2.4.3 *Travel Distributors*

Pearce and Tan, 2004 state that distribution channels in tourism create the link between the suppliers and consumers of tourism services, providing information and a mechanism enabling consumers to make and pay for reservations.

There are two ways for travelers to book a reservation:

1. *Direct*: They make a booking directly with the supplier without the mediation of any intermediary.
2. *Indirect*: They make a booking through an intermediary.

The Travel Distribution System has changed dramatically since the Internet users increased significantly. Nowadays, we can safely distinguish it into *Traditional* and *Digital* Travel Distribution System.

The Travel Distribution System has been originally very structured with clearly defined functions for each role in the chain.

For a better understanding of their role, I will use the Marketing diagram of the distribution chain and I will adapt it to the Travel Industry to make the analogy clear.

Of course, the links in the chain can be bypassed to form a direct booking.

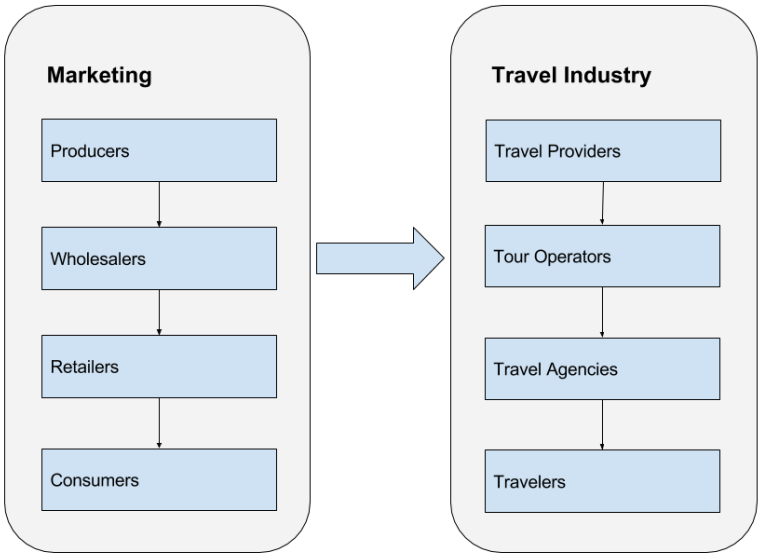


Figure 4: The 1-to-1 analogy of Marketing and Traditional Travel distribution systems

Networks and technology have transformed the Travel Distribution System into a complex system with an increasing amount of crossover in the roles and functions of its parts, known as Digital Travel Distribution System. At the time of this writing, this is the current Travel Distribution System that also contains the simplified Traditional one. Figure 5 visualizes it for a better understanding.

2.4.3.1 *Tour Operators*

Tour Operators can be considered as the wholesalers on the Travel Industry Distribution Chain. However, in many cases they span more links in the chain. It is usual for some to own a hotel, an airline or travel agencies, thus forming a fully vertical integration.

UNWTO defines Tour Operator as a service company which prepares before demand, the travel and accommodation of tourists, organizes transportation, makes reservations at various tourism providers and takes care for all other services required at the place of a destination (excursions, recreation). This company offers a range of services (tour packages) destined to be sold, either directly from its own travel agencies either indirectly via independent travel agencies, groups or individuals at a fixed price and with departure and return dates specified in advance.

TOs managed to dominate the Travel Industry because of their comparative advantages against individual traveling: low cost (economies of scale) and security.(Middleton, 1988)

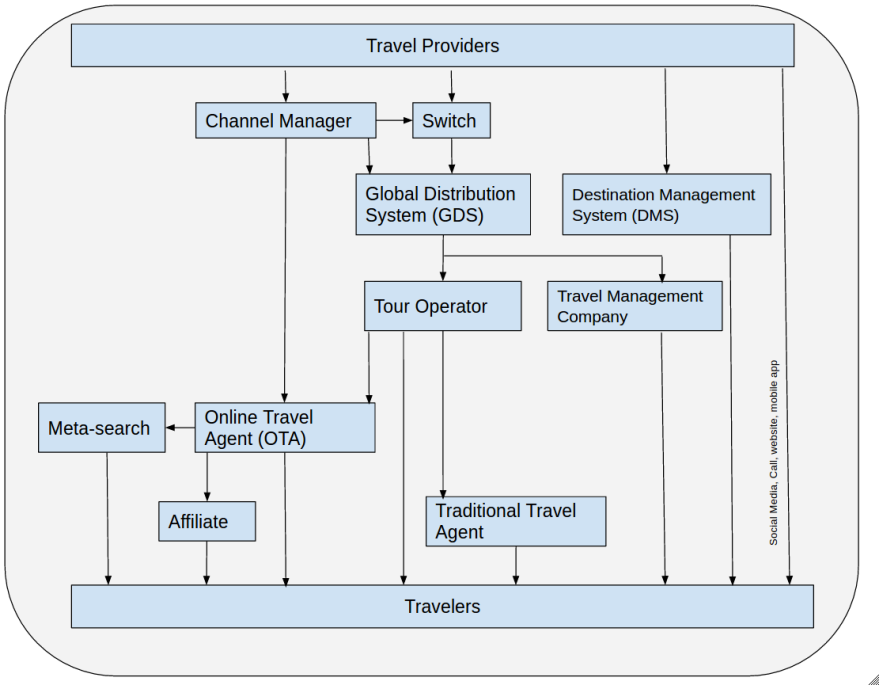


Figure 5: The digital Travel distribution systems. Adapted from Sheldon.

2.4.3.2 *Travel Agencies*

Travel agents have the role of the Retailer in the Travel Industry distribution chain. They serve both Travel Providers and Travelers (Chitiris, 1995) by: suggesting or selling a combination of providers' product components informing Travelers about tour packages according to their special needs and preferences (cost, destination, etc.)

Holloway states that traditionally, agents did not charge for their services as they were remunerated in the form of a commission on each sale they negotiated. However in recent years, a significant change has been the tendency for suppliers to either reduce commission payments or scrap them altogether, forcing agents to charge their clients for their services. Airlines were among the first principals to withdraw commission-able sales, mainly in the belief that they could reach the consumer more cheaply by direct contact via the Internet, than by depending on agents who, for the most part, retain no particular loyalty to any one supplier. This means that many agents are now obliged to add a fee when selling most airline tickets.

Another important aspect of Travel Agencies is that they provide one-stop tourism products and thus contribute to the promotion and development of the Travel Industry.

2.4.3.3 *GDSs*

Global Distribution Systems (GDSs) companies have a very significant role in the distribution chain. By developing their GDS Infor-

mation System, they provide other travel intermediaries with access to different suppliers and assist them with information organization and booking capabilities. They also enable suppliers to increase sales in new markets they could not reach by their own.

2.4.3.4 *Channel Managers*

Channel Managers enable suppliers to distribute their inventory efficiently to other online intermediaries, by automating tasks like updating occupation statuses after reservations and by sending data to every connected part at once. Channel managers can charge commission fees, a monthly payment or both.

2.4.3.5 *Online Travel Agencies (OTAs)*

The rise of Internet and Web has enabled the existence of a new travel intermediary, the Online Travel Agency. It is actually an online form of the traditional travel agency (retailer). The global nature of Internet enabled them to internationalize their activities in more than one country, although they can still be local.

2.4.3.6 *Internet Booking Engines*

Internet Booking Engines are companies that provide suppliers with a booking engine, usually in the form of Software as a Service, that can be used in various channels (supplier websites, mobile apps, social media) to enable reservations. Some of them can also charge commission fees.

2.4.3.7 *Destination Management Company*

A for-profit organization that promotes and sells services in a specific destination.

DMCs often work with local hotel and tour & activity operators to sell tourism related products to travelers visiting a destination. In many cases, DMCs act as an online travel agency negotiating net rate contracts with local operators and reselling tours and activities to travelers online. These DMCs are the merchant of record for the credit card transactions and provide front end customer support.

When working with a DMC, tour operators need to ensure they provide enough margin in their pricing to support the DMC's net rate or commission requirements. When DMCs resell a tour on behalf of a local provider, they will provide the consumer with a voucher that they can use to redeem for the tour or activity that they have booked. It is important to ensure that the voucher is valid for the customer and, as such, if the DMC offers a verification mechanism such as a web check-in, the operator should ensure that they use such a mechanism.https://www.rezgo.com/glossary/dmc

2.4.3.8 *Destination Management Systems*

According to Frew and Horan, 2007 "Destination Management Systems are systems that consolidate and distribute a comprehensive range of tourism products through a variety of channels and platforms, generally catering for a specific region, and supporting the activities of a destination management organisation within that region. DMS attempt to utilise a customer centric approach in order to manage and market the destination as a holistic entity, typically providing strong destination related information, real-time reservations, destination management tools and paying particular attention to supporting small and independent tourism suppliers."

2.4.3.9 *Travel Management Company*

A travel management company is a specialized travel agent for businesses that manages an organisation's business travel requirements. In addition to making reservations, a travel management company helps an organisation gain control and insight over their business travel expense.

2.4.3.10 *Meta-search Engines or Aggregators*

Meta-search engines search multiple online intermediaries and compare inventory prices in order to help traveler choose a supplier. They do not process bookings and refer travelers to other websites. They are usually paid by fees upon a completed booking.

2.4.3.11 *Affiliates*

OTAs enable other businesses to monetize their channel (for example website or web app) by providing a booking service for integration, usually in the form of a widget. The affiliates are paid with commissions or cost-per-click fees.

2.4.3.12 *Switch Companies*

A switch provides hotels and other lodges exposure to all distribution channels including OTAs, meta search engines and GDSs. This is achieved by delivering messages in XML format that complies with Open Travel Alliance[3] standards. (Dhisco, 2017)

3 The OpenTravel Alliance is a not-for-profit trade association, founded in 1999 by travel companies, with a primary focus on the creation of electronic message structures to facilitate communication between the disparate systems in the global travel industry, including the use of XML. (Wikipedia, 2017)

2.4.4 *Regulatory Agencies & Travel Associations*

The enormous development of tourism as a socioeconomic phenomenon obviously had a huge impact both at local, national and international level. This rapid growth led to the establishment and strengthening of various national and international scale Travel organizations. We will examine the most important ones below.

2.4.4.1 *World Tourism Organization UNWTO*

UNWTO, according to its official website, is the United Nations agency responsible for the promotion of responsible, sustainable and universally accessible tourism. It promotes tourism as a driver of economic growth, inclusive development and environmental sustainability and offers leadership and support to the sector in advancing knowledge and tourism policies worldwide.

UNWTO encourages the implementation of the Global Code of Ethics for Tourism, to maximize tourism's socio-economic contribution, while minimizing its possible negative impacts, and is committed to promoting tourism as an instrument in achieving the Sustainable Development Goals (SDGs), geared towards reducing poverty and fostering sustainable development worldwide.

UNWTO generates market knowledge, promotes competitive and sustainable tourism policies and instruments, fosters tourism education and training, and works to make tourism an effective tool for development through technical assistance projects in over 100 countries around the world.

UNWTO's membership includes 157 countries, 6 Associate Members and over 480 Affiliate Members representing the private sector, educational institutions, tourism associations and local tourism authorities.

2.4.4.2 *International Air Transport Association (IATA)*

The International Air Transport Association (IATA) is the trade association for the world's airlines. According to its official website, IATA's mission is to represent, lead, and serve the airline industry.

It was established in 1945 in order to promote safe, regular, and economical air transport. The members of IATA are individual international airlines. It represents 260 airlines or 83

2.4.4.3 *Pacific Asia Travel Association PATA*

The Pacific Asia Travel Association (PATA) is a membership association acting as a catalyst for the responsible development of the Asia Pacific travel and tourism industry.

In partnership with PATA's private and public sector members, PATA enhances the sustainable growth, value and quality of travel and tourism to, from and within the region.

2.4.4.4 *Destination Management Organizations (DMOs)*

According to UNWTO "Destination Management Organization is the co-ordinated management of all the elements that make up a destination (attractions, access, marketing, human resources, image and pricing). It takes a strategic approach to link-up very separate entities for the better management of the destination."

According to Rezgo, 2016, DMO is an organization (non-profit or for profit) that promotes a specific location such as a city, state/province, or country.

DMOs are traditionally governmental or pseudo-governmental agencies that are tasked with the promotion of their specific regions and to drive tourism spending. Most organizations are funded using one of two primary models:

Tax funded – These DMOs derive their funding from the collection and redemption of a bed or hotel tax collected by hotels in the region. The budget of the DMO may be augmented with additional government grants and advertising revenues. Due to the nature of the tax collected, these organizations tend to be driven by increasing hotel night stays. Member funded – These DMOs derive their funding through membership dues paid by corporate members. Budgets for these DMOs may be augmented with additional grants, advertising, and sponsorships. Member based DMOs have the challenge of ensuring they provide value to members in order to maintain membership. DMOs have traditionally focused on traditional marketing but have recently begun aggressively moving into digital marketing in order to stay relevant. Some destinations, such as Australia, have developed databases of products and suppliers that help them to better market their destinations. (*Rezgo* 2016)

2.4.4.5 *Other*

Most developed countries have a national Tourism Organization that coordinates and organizes the Travel and Tourism services on a national level.

2.5 IMPORTANCE

2.5.1 *Positive Impacts*

Travel Industry has significant impacts in various sectors of the modern society. First off, it can raise exponentially the life standards of the

residents of a destination, by increasing employment, investments, export revenues, and infrastructure development. Travel Industry, with its tremendous economic impact is a determinant in poverty alleviation.

Some other benefits are the cultural exchange that happens by bringing people of different nationalities in contact with each other.

2.5.2 *Negative Impacts*

Travel Industry has also some negative impacts that include environmental pollution, moral issues like sex tourism etc.

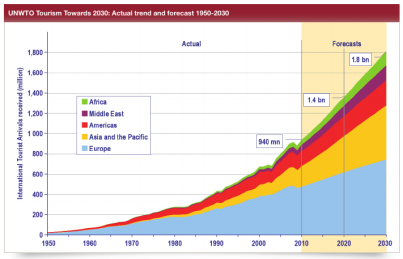
2.5.3 *Some statistics*

In 2014, UNWTO recorded the key trends and outlook: International tourist arrivals (overnight visitors) increased by 4.3% in 2014, reaching a total 1133 million after topping the 1 billion mark in 2012. The Americas recorded the strongest growth with an 8% increase in international arrivals, followed by Asia and the Pacific and the Middle East (both +5%). In Europe arrivals grew by 3%, while in Africa they were up by 2%. International tourism receipts reached US$ 1245 billion worldwide in 2014, up from US$ 1197 billion in 2013, corresponding to an increase of 3.7% in real terms (taking into account exchange rate fluctuations and inflation). France, the United States, Spain and China continue to top the rankings by both international arrivals and receipts. Mexico re-entered the Top 10 by arrivals at position 10. China and the United Kingdom both moved up two places in exports, to 3 and 7 respectively. China, the world's top tourism source market, has continued its 1.5 trillion exceptional pace of growth, increasing expenditure in exports abroad by 27% in 2014 to reach a total of US$ 165 billion. Forecasts prepared by UNWTO in January 2015 point to a 3% to 4% growth in international tourist arrivals in 2015 – in line with the Tourism Towards 2030 long-term forecast of 3.3% a year. By UNWTO region, prospects for 2015 are strongest for Asia and the Pacific and the Americas (both +4% to +5%), followed by Europe (+3% to +4%), the Middle East (+2% to +5%) and Africa (+3% to +5%).

2.6 CONCLUSION

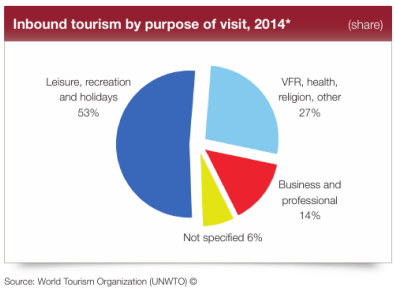
From the preceding sections, it is drawn the conclusion that Travel Industry is a fairly wide sector with a lot of different units playing different roles. Information technologies like networks made crucial changes in the way that the Travel ecosystem functions. The industry continues to grow year after year and it is granted that it will have a decisive role in shaping the global economy.

(a) International export earnings.



(b) Tourism towards 2030.

(c) International tourism 2014.



(d) Inbound tourism by purpose of visit.

Figure 6: Statistics show that Tourism is a vast industry and its growth will continue.

Part II

INFORMATION SYSTEMS IN TRAVEL INDUSTRY

The second part describes the industry's information needs, proposes the data model and applies it to working examples.

3

APPLICATIONS OF INFORMATION SYSTEMS IN TRAVEL INDUSTRY

3.1 INTRODUCTION

In this chapter I will describe how Information and Communication Technology is being used by the Travel Industry to achieve several business goals.

Information and Communication Technology plays an enabling role in Travel Industry. It provides powerful tools for economic growth of the industry and enables organizations to maximize their efficiency.

ICT and especially the World Wide Web gave small to medium enterprises the opportunity to compete equally with larger organizations, by shifting the geographic and capital restrictions. In the new information society and knowledge-based economy that arose, every enterprise can become global using far less resources than ever.

Internet bridges the gap between consumers and suppliers and provides opportunities for disintermediation and re-intermediation (Buhalis, 2003).

IS are required nowadays because they help businesses achieve 6 important goals: business excellence, new products and services, better decisions, competitive advantage and survival. (Laudon and Laudon, 2009)

The impact of IT on Travel Industry

Travel and IT industry are two of the largest and most dynamic industries in the world. As a consequence, the intersection of them is also a fast growing and very dynamic entity, that contributes significantly to many economies.

Travel Industry is an information intensive industry, as it produces large volumes of information to be processed and communicated (Sheldon, Benckendorff, and Fesenmaier, 2014) . On the current era of digitalization and globalization, IT is the main catalyst in this information management.

IT enables the distribution of static and dynamic information that the Travel Industry produces. Electronic media are used to spread product descriptions, transportation schedules, routes and rules, maps, digital brochures etc. They also spread critical dynamic information, like availability, fares and rates or weather conditions.

3.2 DEFINITIONS

Information Technology Information System

Every organization of every size has at a minimum 4 business functions: Manufacturing & Production Sales & Marketing Human Resources Finance & Accounting

IS are required nowadays because they help businesses achieve 6 important goals: business excellence, new products and services, better decisions, competitive advantage and survival. (Laudon and Laudon, 2009)

3.3 THE BASIC SUITE

Almost all organizations in the Travel Industry but also in every other industry, need to use a collection of information systems that is not tied coupled with their specific activities and functions. *The Basic Suite* includes all these information systems. However, that does not mean that there is not need to customize an IS in this suite to meet the exact business needs. Furthermore, the usage of every IS in the suite is not required and depends on the level of the automation that someone wants to achieve, the budget, the size of the organization (typically smaller ones have fewer needs) and other factors. The Basic Suite includes:

1. a CRM
2. an HRM
3. an Accounting (or Finance) system
4. a Management Support System (MSS)

As we can see, the two of them (HRM and Accounting) are Operation Support Systems and every one corresponds to a basic business function. The last one is an information system categorized as MSS and is vital for the management of the organization. CRM is a cross-functional, enterprise level system.

One can argue that a Computer Reservation System could be in the basic suite of Travel Industry, but there are two reasons not to be: i) CRSs differ a lot among travel providers and ii) not every provider needs one.

3.4 TRAVEL PROVIDER APPLICATIONS

In this section I will examine the IS specific needs of each Travel Industry stakeholder (as defined in chapter 1), that are unique to its nature.

3.4.1 *Transportation*

3.4.1.1 *Airlines*

Aviation is a very information intensive industry that requires technology and critical real-time data in order to operate. Airlines mainly use the following information systems:

1. Airline Reservation System (ARS): The core of their IT systems. It includes a database with flight schedules, availability and fares. According to Sheldon, main functions are:
    - Display flight schedules and seat availability to passengers, staff or distributors
    - Store fare rules like seat classes (business, economy etc)
    - Store and transmit passenger information: Individual and group bookings are stored using the Passenger Name Record (PNR). Before flight departure the passenger name list (PNL) is transmitted to gate control systems to enable passenger check. Other information that is stored is special preferences for catering and frequent flyer accounts.
    - Electronic ticketing: when the booking is confirmed, the ARS issues an electronic ticket that contains itinerary details and allows online check-in or at the airport to obtain the boarding pass.
2. Decision Support Systems (DSSs): DSS is a non aviation-specific information system category that is also used in many other industries. It provides support to managers to help them make critical decisions. They are based on Operations Research models which use what-if and sensitivity analyses. The DSSs used by airlines are:
    a) Fleet management system: Acquisition, assignment of aircrafts to routes, maintenance timing and monitoring.
    b) Flight scheduling system: a complex task that depends on many factors like strategic goals, demand, alliances, aircraft type, availability of the staff, restrictions and regulations.
    c) Crew scheduling system: it includes a program called Pairing Optimizer that is used to pair flight schedules with crew members based on preferences, work rules and other factors.
    d) Revenue Management System: a component of the DSS is the Revenue Management System that focus on revenue maximization by calculating and analyzing historical data, forecasts and overbookings.

3. Marketing & Sales systems: Internet booking engines, usually hosted on a Website to sell directly their inventory and bypass intermediaries.

4. Flight Operations System: this system supports the operation of a flight. The main components are the Flight Catering System that handles the requests and preparation of the meals, and the Safety Management System that monitors and ensures the proper function of the aircraft.

5. Departure Control System (DCS) and their next generation Passenger Services Systems (PSS): enables check-in, issues boarding passes, allocates seats, scans passports, etc.

6. Flight Dispatcher: it prepares a flight by calculating critical parameters like delay time, route, distance, fuel required, arrival time, meteorological conditions etc.

7. Geographical Information System (GIS): it is an IS that is used in-flight to display the location of the aircraft.

8. the generic suite like CRMs etc.

3.4.1.2 *Water Transportation*

Water Transportation providers, including ferries and cruise ships require:

1. Computer Reservation System (CRS) to enable bookings for passengers and vehicles. For ferries, the underlying database is fairly simple and stores information about vehicle type and length to allocate the proper space. On the other hand, for cruises more complex information have to be stored, including a PNR, cabin type and destination. According to Sheldon, only 10% of cruise bookings are booked through online portals because of the complexity of the product. Instead, travel agencies are preferred.

2. Geographical Information System (GIS) with GPS technology that helps with navigation.

3. Point Of Sale systems that are used for food and beverage sales.

4. Specialized custom systems especially for cruise lines that help passengers locate themselves on the ship, track their children, buy on-board activities etc.

3.4.1.3 *Land Transportation*

i) Vehicle Rentals require:

1. CRS: Vehicle rental companies require computer reservation systems in order to efficiently process bookings. Many rentals have different offices across one town or country making a centralized system essential to allocate a free vehicle.

2. GIS: A GIS gives vehicle rentals the ability to monitor each car in real time, receive SMS alarms when an emergency occurs and even project vehicles' stops and trajectories on online maps like Google Maps.

3. Fleet Management Systems: A Fleet Management System offers the following functions: vehicle expenses tracking, creation of maintenance programs and service schedules, fuel consumption monitoring, track vehicle value and depreciation, and manage driver records.

4. General Suite

ii) Rail Transportations: basically require CRS systems, either web-based or at automatic ticket machines in the stations. Their CRSs are often linked together via a GDS system so that passengers can book easily multi-country itineraries.

iii) Taxis: In the recent years, many applications have been created that allow customers to find nearby taxis, pay online and even review taxi drivers. They serve as an extra distribution channel different than the traditional ones. Also a new C2C business model also known as "sharing economy" has emerged that allows car owners provide transportation to travelers, usually with the mediation of a company that makes the booking through a Website and processes the payment.

3.4.2 *Hospitality*

Hospitality sector makes one of the heaviest usages of Information and Communications Technology. As the Accommodation sector sometimes includes Food & Beverage services, some of the ICTs are shared among the two sub-sectors.

3.4.2.1 *Accommodation*

The lodging sector uses an integrated solutions called Property Management System or Hotel Management System (and is actually an ERP) that serve the following IT applications:

Property Management System (PMS): According to Hotel and Committee, 2002, the PMS "is a misnomer because it doesn't actually manage the property in the commercial real estate sense". On the contrary, it manages almost every interaction of the lodge with the guests during their stay. A hotel's PMS is the core of its ICT systems handles all the basic functions:

- Reservations, a CRS actually (+ interconnectivity)
- Front-office operations
- Some back-office operations

PMSs evolved over time to an integrated suite of many subsystems or modules. The commercial PMSs come to many versions to satisfy every hotel need, from a hotel chain to a small individual property. The functions and features included are not standard across PMS vendors. It is usual for a PMS to include only the three or four functions, or the whole functionality a hotel would ever need. The following functions can be found either as stand-alone systems or as modules of a PMS suite:

1. **Management**: A management IS that supports executives by providing reports and statistics.
2. **POS**: In the context of Food & Beverage, POS manages the ordering and delivery of all menu items in one or more restaurants and/or bars (Hotel and Committee, 2002). A POS can also support other hotel's shops (e.g. clothes shops, hair salons, spa and other amenities).
3. **Accounting**: Usually provides general ledger and accounts payable functions. May also include payroll. Fixed asset accounting is rarely implemented at the property level. These are among the most mainstream systems used in the hospitality world, with few, if any, specific changes from standard accounting products. Many properties use general packages (like QuickBooks). (Hotel and Committee, 2002)
4. **Food & Beverage**: Provides offline and online table reservations functionality, manages and keeps track of the availability of foods, drinks, supplies, etc (Oracle, 2017).
5. **Connectivity**: Includes a Channel Manager that connects the PMS with external booking systems, OTAs, wholesalers, etc.
6. **House Keeping**: Keeps track of cleaning and maintenance with automated status and reminders. Displays queue rooms that need to be cleaned and schedules room moves (Oracle, 2017).
7. **Events**: provides managerial capabilities for conferences, events, meeting rooms and seating arrangements (Oracle, 2017).
8. **Amenities**: Supports multiple leisure facilities, including sports or wellness treatments. Controls availability of car park spaces, courts, beach huts, etc (Oracle, 2017).
9. **CRM**
10. **HRM**

3.4.2.2 *Food & Beverage*

1. Restaurant Managament system
2. POS
3. General Suite

3.4.3 *Attractions*

Attractions like any other Travel Provider have specific needs in ICTs:

1. CRS: Handles reservations from individual travelers or groups. Many CRSs on attractions are connected to hardware that identifies the traveler (with biometrics) or the ticket using barcode or even RFID technology.
2. Navigation assistance systems: Traditionally this service was provided by maps or signs but as the new era of IT emerged, attractions now use digital systems to navigate their clients through their facilities. These systems provide information on monitors, kiosks or audio media about the location and can also have a mobile app interface that utilizes GPS
3. Queue Management Systems: Its main task is to improve the quality of customer service by making the waiting experience better and shorter. The main functions are to provide ticketing capabilities, direct customers to the right counter with video displays and create virtual queues.

3.5 TRAVEL DISTRIBUTORS APPLICATIONS

3.5.1 *GDS Companies*

GDS companies sell and use their own GDS. A GDS is an information system that enables automated transactions between travel providers and travel intermediaries.

Brief History: The roots of GDSs are the Computer Reservation Systems (CRSs) originally developed by airlines to electronically support bookings. Before them bookings were done manually with filing cabinets, index cards, etc. In the early CRS era, CRSs were used almost exclusively by the airline ticketing offices and travel agents had to contact each airline by phone to ask for availability and prices. Then they had to contact again the airline to book a seat. In 1970s, travel agents requested access to CRSs but having a terminal for each airline CRS was not practical, so the need for a multi-airline distribution system emerged. In the mid-1980s, SABRE, a formerly CRS developed in 1962 by American Airlines and IBM, evolved into a GDS by including into its databases itineraries from other airlines. In Europe,

Galileo and Amadeus were developed by two groups of airlines and Abacus in Asia. In 1990s another major GDS, Worldspan, was created by the consolidation of DATAS and PARS. In 2006 and 2007 Galileo and Worldspan were sold to form Travelport. As of 2016, three major GDSs compete for a large market share: Sabre, Amadeus and Travelport.

Functions: Although the main role of GDSs is to provide other travel intermediaries with travel information and a booking interface, they also offer a wide variety of other IT services.

Main functions:

- Inventory Availability: The GDS displays the availability of travel products that are collected from individual CRSs.
- Booking: Booking requests are handled by the GDS servers or forwarded to a CRS.
- Traveler information: GDSs have databases with personal information and communication.
- E-ticketing & Itinerary management: GDS can issue an e-ticket instead of a paper one. It can also handle interline tickets (multiple carriers within the same itinerary).

Secondary functions:

- Back-office: integrated solutions that automate management tasks
- Decision support systems (DSS): tools for executives and managers that generate reports to support decision making.
- Financial management: solutions for invoices, commission handling, currency conversion, etc.
- E-commerce tools: tools that help providers sell their products through electronic channels.

GDS companies also operate businesses in related markets and make revenue streams by providing services like travel insurance, web development for Travel businesses and hospitality suites.

3.5.2 *Tour Operators*

Tour operators need software packages that allow them to: Create tour packages: in a database which can handle almost any travel service or package with multi-currency and multilingual support Distribute their packages: usually via a Website with online booking capabilities, media libraries and product information. Manage reservations on the inventory with a CRS and all the basics (financial, CRM etc)

3.5.3 *Travel Agencies*

Travel Agencies basically utilize the IT solutions they have been given from the GDS they partnered with. Through GDSs they can access inventory and book for the final customer, develop itineraries etc. They also use the basics (back office) finance, CRM etc.

3.6 CONCLUSION

Information Technology has a strong impact on marketing and producing almost all tourism products. Airlines use them for selling itineraries, luggage handling, marketing programs like frequent flyer databases, etc. Travel agents and tour operators use IT heavily for marketing and production as their product is intangible and they deal with big amounts of information. Hotels, although traditionally resisted IT and the Digital Era, have now started to make use of the new technologies like property management systems, reservation engines etc. In the attraction sector, the IT can be either vital or non useful at all, depending on the attraction type. For example, a big Water Park can utilize a lot of ICT: RFID bracelets for entrance and payments, reservation systems, queue management systems etc. On the other hand, a watersports business may use none of these.

Another significant effect of IT on Travel Industry is the change that it has provoked. Innovative technologies did and will open windows of opportunities for new players, and those who refuse to evolve will face great risks of losing market share. We have already seen this happen when a lot of travelers shifted from traditional travel agents to online travel agents (OTAs).

4

THE UNIFIED DATA MODEL

4.1 INTRODUCTION

To achieve better machine to machine communication and interoperability among services it is essential to study and develop universal data models for the Travel Industry. Connectivity among travel software has evolved from a nice-to-have feature, to a non negotiable requirement.

Why a universal data model is important

A lot of common structures, like company or address, have been modeled repeatedly by different enterprises. This costs great amounts of time and money in the system development process. Silverston believes that 50% of a data model consists of constructs that are globally applicable, 25% is industry specific and only 25% is enterprise specific. (Silverston, 1997) A universal data model could save time and money to Travel enterprises, promote data integration among different systems and provide a solid basis for machine-to-machine communication with messages.

4.2 DEFINITIONS

In this section I define some basic terminology concerning software architecture, database and data modeling and other subjects that will help the reader understand the software I will build.

Data model definition

A *data model* describes the data that flow through the business processes in an organization. It is a formal way of representing the data that are used and created by a business system; it illustrates anything about which information is captured and how they are related to each other. Depending on the system development phase, the data model may present the logical organization of data without indicating technical details or it can reflect exactly how the data will be stored in databases and files. (Dennis, Wixom, and Roth, 2012)

Data models can have the following forms according to the phase of the database design:

Data model forms

- *Conceptual*: This is the first step, from the users perception of data, towards a formal description of it. The result, the conceptual data model is at a very high nonsystem-specific level.
- *Logical*: After this step the data model, called the logical data model, is in an implementable form. All logical aspects such as object types, attributes, data types and relationships between

object types are defined completely but, without considering physical details.

- *Physical*: Here the physical aspects in terms of indexing, clustering, partitioning and so on, are modeled and result in the physical data model.

Software delivery methods

There are three main ways for a business to acquire software. The most usual delivery methods are:

1. *On-premise*: The traditional model. The business acquires a software license and runs it on its own servers.
2. *Hosted*: The business acquires a software license but runs it in a remote data center operated by an expert third-party hosting provider.
3. *Software as a Service (SaaS)*: a third-party provider hosts applications and makes them available to customers over the Internet. SaaS is one of three main categories of *cloud* computing, alongside infrastructure as a service (IaaS) and platform as a service (PaaS). There are usually 3 ways to access SaaS: i) via a client app, ii) via a web-browser GUI, iii) via an API

Software pricing models

There are three basic pricing models:

1. *Upfront perpetual license*
2. *Subscription-based*
3. *Pay-per-use*, (aka *Pay-as-you-go* or *Utility pricing)*

Software architectures

According to Dennis, Wixom, and Roth, 2012 there are 3 families of software architectures:

1. Client-Server
2. Server-based
3. Client-based

Client-Server architecture is the dominant one nowadays. It has 4 main benefits: i) it is scalable, ii) supports a wide variety of different clients and servers, iii) easily separates the different logic layers and iv) high availability. (Dennis, Wixom, and Roth, 2012)

"Service oriented computing (SoC)", i.e. the compute paradigm behind service-orientation. Service Oriented Architecture (SOA) is an architectural realization of this compute paradigm. You may compare this with "client/server computing" as paradigm and "browser/web server" or "DB-client/stored procedure" as two (of various other) architectural realizations of this paradigm. (*Web Services Guru Dr. Frank Leymann on SOA* 2006)

Fielding, 2000, in his doctoral dissertation defined *the Representational State Transfer (REST)* architectural style. REST is an abstraction of the architectural elements within a distributed hypermedia system, thus providing interoperability between computer systems on the Internet. REST-compliant Web services allow requesting systems to access and manipulate textual representations of Web resources using a uniform and predefined set of stateless operations.

For my module I will use a 3-tier client-server architecture that implements Service Oriented architecture and uses the Object Oriented Programming paradigm. It will be RESTful, available as SaaS and will leverage all the three aforementioned methods to access it (client app, web-browser GUI and API).

4.3 A UNIVERSAL DATA MODEL FOR TRAVEL INDUSTRY

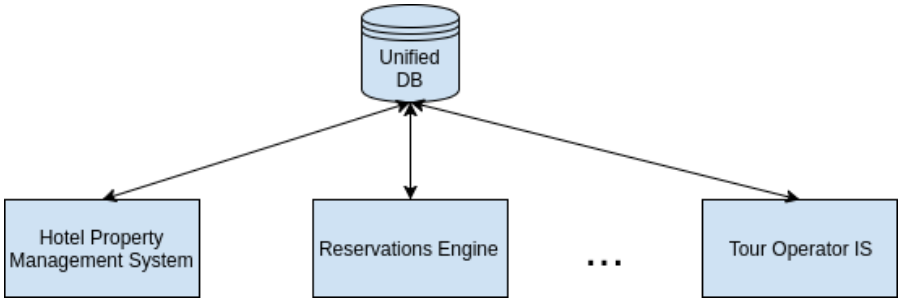


Figure 7: A unified data model will enable data colelction in a single database that can be accessed by various applications.

The concluded model is heavily inspired by Len Silverston's work on Universal Data Models and my personal literature research. The granularity of the model presented in this thesis is medium, for the sake of simplicity and in order to help the reader to avoid getting lost in details.

I will begin with the conceptual or business data model. For this model form I have used the Barker's notation for the entities, where a sub-type (or is-a hierarchy) is shown by a rectangle inside another. The Crow's Foot notation was used to model relationships and their cardinality and modality[1]. Attributes are not shown in the conceptual model for the sake of simplicity.

1 Cardinality is the maximum number of associations between one entity instance and its related instance. Modality is the minimum number of times that an instance of one entity can be associated with the related entity.(*Crow's Foot Notation* 2017)

4.3.1 *Fundamentals*

Travel organizations include travel agencies, hotels, tour operators and all enterprises whose goal is to transport individuals from one place to another (Silverston, 1997).

I will focus on the information needs associated with their activities.

While it is common to think of each type of travel organization as having completely different information needs, there are significant common data structures within most of them.

These common structures will be presented by this data model in 3 steps:

1. I will define the total conceptual model and provide examples for its entities.
2. I will transform a part of this model into a logical model so it can be used in a simple Hotel Booking Engine application. Please note that only the essential entities that are needed for this app will be transformed.
3. I will transform this logical model into a physical one (MySQL).

The data model is split into further parts (models) to be easier understandable.

4.3.2 *People and Organizations in Travel (The Party models)*

The foundation of our data model are the stakeholders of the Travel Industry and every party that interacts with them and its data are important.

We begin with a PARTY entity that can be either a PERSON or an ORGANIZATION. The PARTY entity is only sub-typed with criteria that will not change over time, i.e. an organization may be legal (with Tax ID) or informal (a family or a project team).

Parties can be further classified in many ways with various criteria. If so, a many-to-many relationship with a PARTY CATEGORY entity is needed.

A PARTY may be a customer, supplier, employer, employee, or internal organization. According to Silverston, the PARTY entity defines the nature of the party, which will not change over time. The PARTY CATEGORY classifies the party into certain categories. The PARTY ROLE entity defines how a party acts or, in other words, what roles the party plays in the context of the enterprise's environment (Silverston, 1997). A different approach can also be followed that subtypes PARTY into different roles.

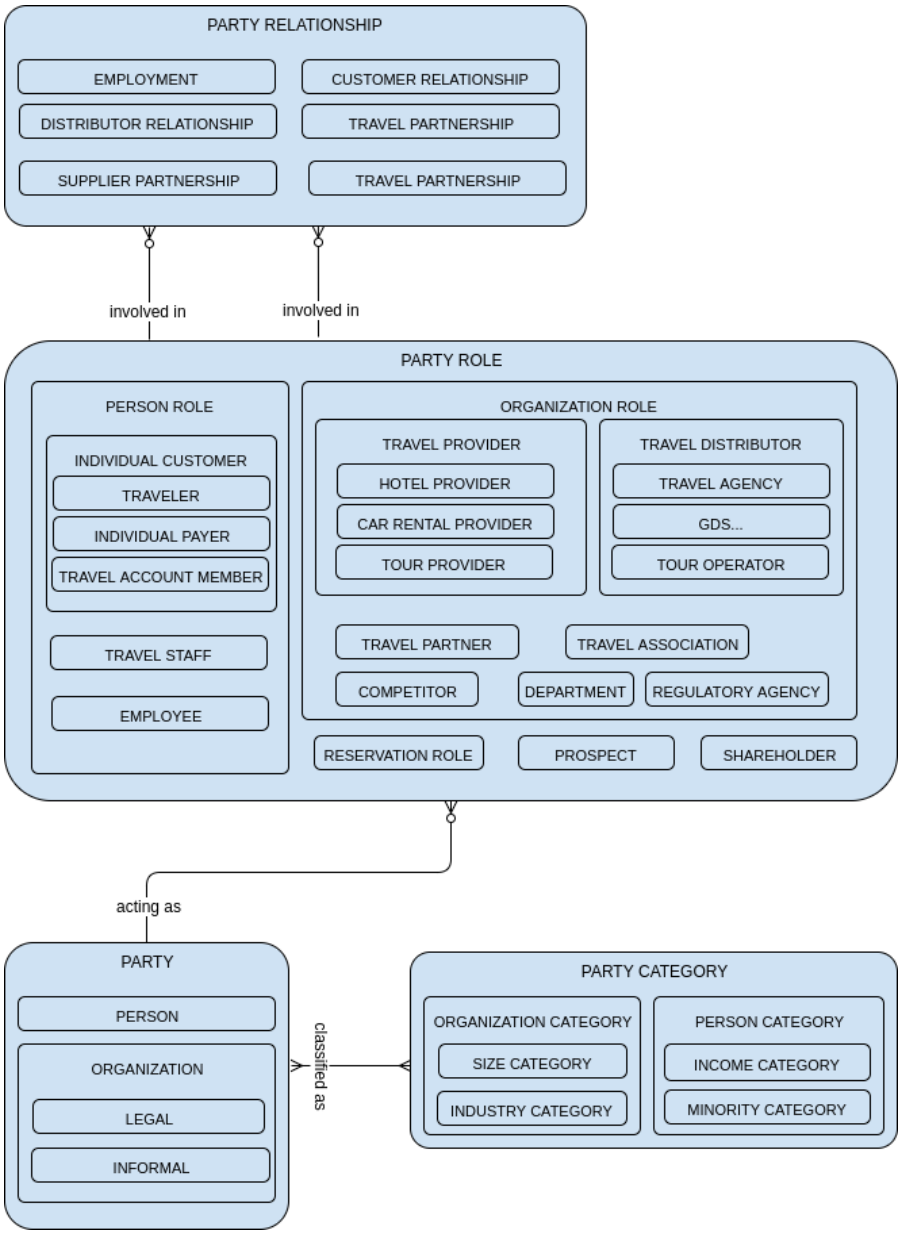


Figure 8: Party roles & Relationships.

As we saw in Chapter 2 the Travel specific party entities that we will use are: TRAVEL PROVIDER, TRAVEL DISTRIBUTOR, TRAVEL PARTNER, TRAVEL ASSOCIATION and REGULATORY AGENCY.

A party may play any number of roles. Many roles make sense only in relation to another party.

A relationship is defined by two parties and their respective roles. Some of the relationships that the Travel Industry needs to track are: Distributor Relationship, Employment and Travel Partnership.

4.3.2.1 *Examples*

To better understand the model, I will provide some examples that can be modeled with these entities.

- A PERSON (subtype of PARTY) would be me, "Antonis Grigoriadis", with attributes like age, income, occupation.
- A LEGAL ORGANIZATION would be "Mitsis Hotels", "Enterprise Car Rental", or "Aegean Airlines", with attributes like Tax ID.
- An INFORMAL ORGANIZATION would be my family, "Grigoriadis Family".
- A SIZE CATEGORY could be "Small to medium enterprise", or "Corporate".
- An INDUSTRY CATEGORY could be "Travel Industry", "Construction Industry", etc.
- An INCOME CATEGORY could be a "50-100k annually", "100k+ annually", etc

As we saw, PARTY ROLEs could also be just extra PARTY CATEGORIES. Some examples are:

- Every PERSON (e.g. "Antonis Grigoriadis") could be a TRAVELER, PAYER, TRAVEL ACCOUNT MEMBER, TRAVEL STAFF or EMPLOYEE in different Travel IS.

Every organization in Travel Industry could be (acting as) any ORGANIZATION ROLE.

- "Mitsis Hotels" is a HOTEL PROVIDER, but in another IS can also be a TRAVEL PARTNER or a COMPETITOR.
- "IATA" is a REGULATORY AGENCY.
- "TUI" and "Thomas Cook" are both TOUR OPERATORs, while "Mouzenidis Travel" could be a TRAVEL AGENCY.
- "Sabre" and "Amadeus" are GDSs.

Any PARTY can be involved in a PARTY RELATIONSHIP.

- The PERSON "Antonis Grigoriadis", acting as EMPLOYEE (role) could be in a EMPLOYMENT relationship with the ORGANIZATION "Mitsis Hotels", acting as EMPLOYER (role, not shown).
- The ORGANIZATION "Booking.com", acting as TRAVEL DISTRIBUTOR, could be in a DISTRIBUTOR RELATIONSHIP with the ORGANIZATION "Mitsis Hotels", acting as HOTEL PROVIDER.

4.3.3 *The Travel Product models*

As we explained in Section 2.3 travel products are split into 2 categories: Primary and Secondary Tourist Supply. We will model only the secondary Tourist Supply because these are the marketable products that we are interested in.

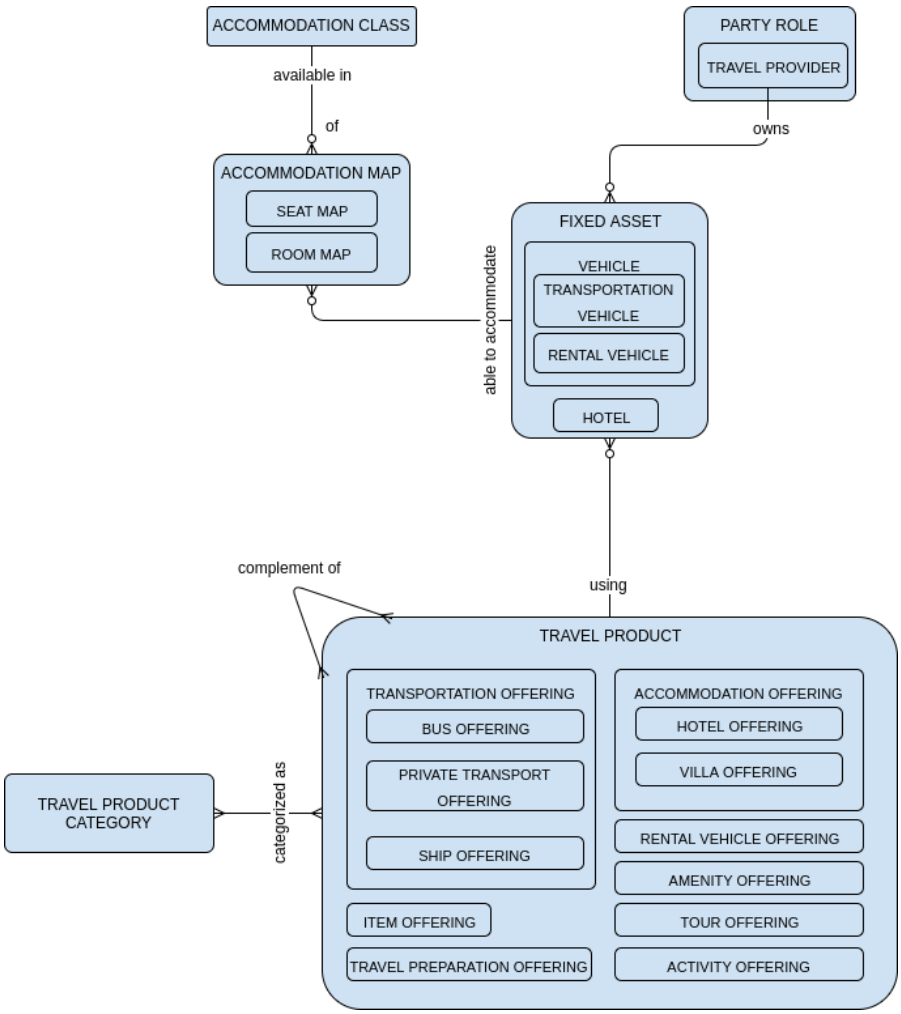


Figure 9: Travel Products.

As we can see in the Figure 9, our entities do not reflect exactly the components classification from Koutoulas. Top-level classifications were omitted to avoid unnecessary entity sub-typing that would make the model complex.

A TRAVEL PRODUCT, like PARTY, can have many sub-types; meaning different product natures that will not change over time. But they can also have many TRAVEL PRODUCT CATEGORIES that may change over time. A product can be classified into many custom categories according to various criteria i.e. luxury, vip, budget, etc.

A TRAVEL PRODUCT may have a recursive relationship to itself if a product is a complement to another one.

The sub-types are: TRANSPORTATION OFFERING, ITEM OFFERING, ACCOMMODATION OFFERING, RENTAL VEHICLE OFFERING, AMENITY OFFERING, TOUR OFFERING, TRAVEL PREPARATION OFFERING and ACTIVITY OFFERING, all explained in Section 2.3.

Some TRAVEL PRODUCT OFFERINGS may be associated with a FIXED ASSET, which can be a specific ACCOMMODATION, i.e. HOTEL or a TRASPORTATION or RENTAL VEHICLE.

Each FIXED ASSET is related to one ACCOMMODATION MAP that specifies the number of seats or rooms that are available for each ACCOMMODATION CLASS.

4.3.3.1 *Examples*

To better understand the model, I will provide some examples that can be modeled with these entities.

- A HOTEL OFFERING could be "Honeymoon double suite".
- A VILLA OFFERING could be "Maria's private seaside villa".
- A RENTAL VEHICLE OFFERING could be "Auto-transmission small Diesel car".
- An AMENITY OFFERING could be "1-hour massage".
- A TOUR OFFERING could be a "Jeep Safari on mount Olympus".
- An ACTIVITY OFFERING could be a "SCUBA Dive in Black Sea".
- A TRAVEL PREPARATION OFFERING could be a "Premium Info Guide for Athens".
- A BUS OFFERING could be a "08:00 scheduled route from Athens to Sparta".
- A SHIP OFFERING could be "Lemnos to Syros".
- A TRAVEL PRODUCT CATEGORY could be "Budget", "Luxury", "VIP", "Family", "Solo Travelers", etc.
- A HOTEL would be "Alila" (a type of FIXED ASSET that belongs to the ORGANIZATION "Mitsis Hotels")
- A RENTAL VEHICLE would be the exact vehicle that the RENTAL VEHICLE OFFERING may use, i.e. "IOT 5463", with attributes like brand=Audi and model=Q3.

- An ACCOMMODATION CLASS could be subtyped in ROOM CLASS (not showed in the diagram). A ROOM CLASS could be "Double Suite", "Family Room", etc. It differs from the HOTEL OFFERING entity that is just a service that uses an ACCOMMODATION CLASS.
- Some ROOM MAPs of a HOTEL would be "Double Suite: 200 rooms" and "Family Rooms: 300 rooms".

4.3.4 *The Reservation models*

A RESERVATION is composed of 1 or more RESERVATION ITEMs. Each RESERVATION ITEM reserves exactly one TRAVEL PRODUCT and it can has many RESERVATION ITEM STATUSes like "Payed", Canceled or "Refund needed".

A RESERVATION DEPENDENCY is actually a recursive relationship of the RESERVATION ITEM with itself. It stores an item that depends on another item.

An ACCOMMODATION SPOT is a specific instance of a reservable resource. It can be a specific room or a specific seat in transportation vehicles, usually identified by a unique numeric value.

An ACCOMMODATION MAP maps the ACCOMMODATION CLASSes with the available number of SPOTS that they provide. For example, a ROOM MAP may specify that for the "Basic Suite" class there are 20 rooms available, while for the "Luxury suite" there are 5.

A RESERVATION ITEM may reserve zero or one ACCOMMODATION SPOT of an ACCOMMODATION MAP. Let us clarify this with an example: A reservation item may be for a Hotel Offering named "Luxury Suite", and optionally for the exact suite with number "107". A specific room number is not required for a reservation.

Different PARTIES may play various RESERVATION ROLEs that are involved in the reservation or in specific reservation items. For example "Reserved Traveler", "Reserved By Traveler" or "Distributor".

4.3.4.1 *Examples*

To better understand the model, I will provide some examples that can be modeled with these entities.

- Some RESERVATIONS could be "1234", "36346". Just a unique identifier. Their attributes would be creation date, creator etc. RESERVATIONS are composed of RESERVATION ITEMS.
- RESERVATION ITEMS would store quantity, the reserved travel product, maybe the reserved ACCOMMODATION SPOT, etc.
- A ROOM NUMBER (or just ROOM) would be "101","102", "205", etc

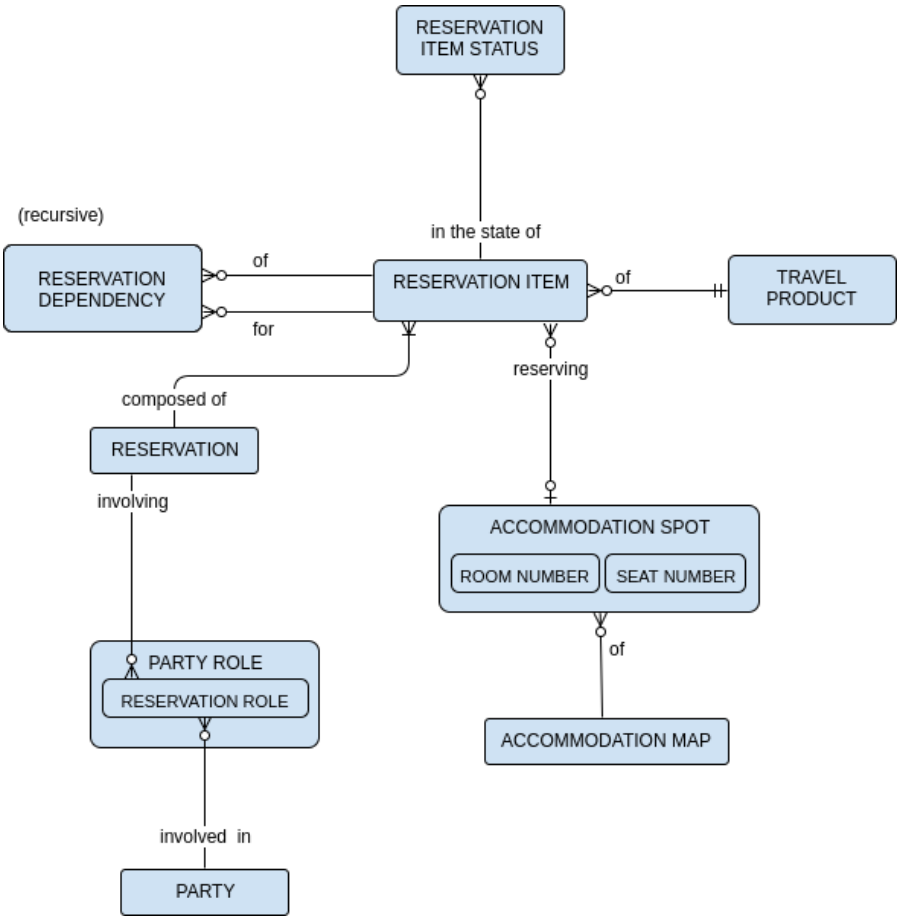


Figure 10: Reservation Models.

- A SEAT NUMBER would be "F14" in a plane or "16" in a bus.

4.4 APPLICATION OF THE DATA MODEL ON A RESERVATIONS ENGINE MODULE

4.4.1 *Requirements*

1. The module can be used by any Travel software.
2. The module can handle CRUD operations on reservation models.
3. The module provides an API that can be accessed by Web GUIs, mobile applications, command line interface or anything which understands HTTP.

4.4.2 *Transforming the conceptual data model to logical*

At the time of this writing, the most common logical model type is the relational. Because there are a lot of resources and open-source

projects to support relational data model design, I have chosen to implement the logical model as a relational one.

For this transformation, we have used a common algorithm (Pinkston, 2007)

- We assign attributes to data entities.
- Each entity set transforms into a relation (table).
- We resolve a many-to-many relationship with an associative or intersection entity.
- Each entity must have a Primary Key (PK) and one-to-many relationships are dictated by Foreign keys (FK).
- Weak entities have a composite PK that includes the strong's entity PK.
- Our entities have generalization/specialization (is-a) relationships in the ER diagram. But relational databases do not support inheritance so the workaround is to resolve the subtypes by implementing the *Concrete Table Inheritance* (Fowler, 2002)

4.4.3 *Transforming the logical data model to physical*

To transform the logical relational model to physical schema we have to choose one specific Database Management System (DBMS). We chose the MySQL because of its popularity, multi-platform support and because it is open-source.

Then we need to write the Data Definition Language (DDL) and pass it to the MySQL client (via Command Line Interface or any other method) that will send it to the MySQL server for execution:

Listing 1: The MySQL DDL to build the physical model

```
CREATE TABLE `persons` (
  `id` INT(10) UNSIGNED NOT NULL AUTO_INCREMENT,
  `first_name` TEXT COLLATE 'utf8mb4_unicode_ci' NOT NULL,
  `last_name` TEXT COLLATE 'utf8mb4_unicode_ci' NOT NULL,
  `created_at` TIMESTAMP NULL DEFAULT NULL,
  `updated_at` TIMESTAMP NULL DEFAULT NULL,
  PRIMARY KEY (`id`))

CREATE TABLE `organizations` (
  `id` INT(10) UNSIGNED NOT NULL AUTO_INCREMENT,
  `name` TEXT COLLATE 'utf8mb4_unicode_ci' NOT NULL,
  `created_at` TIMESTAMP NULL DEFAULT NULL,
  `updated_at` TIMESTAMP NULL DEFAULT NULL,
  PRIMARY KEY (`id`))
```

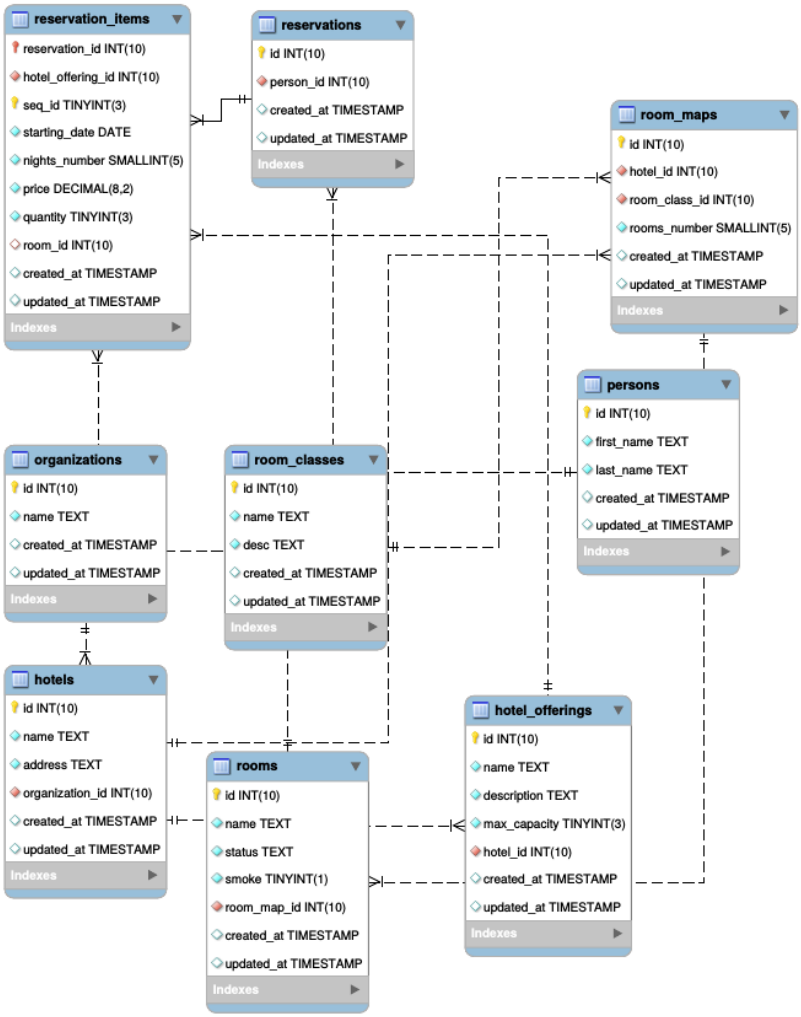


Figure 11: The Logical Relational Model.

```
CREATE TABLE `hotels` (
  `id` INT(10) UNSIGNED NOT NULL AUTO_INCREMENT,
  `name` TEXT COLLATE 'utf8mb4_unicode_ci' NOT NULL,
  `address` TEXT COLLATE 'utf8mb4_unicode_ci' NOT NULL,
  `created_at` TIMESTAMP NULL DEFAULT NULL,
  `updated_at` TIMESTAMP NULL DEFAULT NULL,
  PRIMARY KEY (`id`))

CREATE TABLE `hotel_offerings` (
  `id` INT(10) UNSIGNED NOT NULL AUTO_INCREMENT,
  `name` TEXT COLLATE 'utf8mb4_unicode_ci' NOT NULL,
  `description` TEXT COLLATE 'utf8mb4_unicode_ci' NULL DEFAULT
      NULL,
  `hotel_id` INT(10) UNSIGNED NULL DEFAULT NULL,
  `created_at` TIMESTAMP NULL DEFAULT NULL,
  `updated_at` TIMESTAMP NULL DEFAULT NULL,
  PRIMARY KEY (`id`),
```

```
  INDEX ‘fk_hotel_offerings_1_idx‘ (‘hotel_id‘ ASC),
  CONSTRAINT ‘fk_hotel_offerings_1‘
    FOREIGN KEY (‘hotel_id‘)
    REFERENCES ‘hotels‘ (‘id‘))

CREATE TABLE ‘room_classes‘ (
  ‘id‘ INT(10) UNSIGNED NOT NULL AUTO_INCREMENT,
  ‘name‘ TEXT COLLATE ’utf8mb4_unicode_ci’ NOT NULL,
  ‘desc‘ TEXT COLLATE ’utf8mb4_unicode_ci’ NOT NULL,
  ‘created_at‘ TIMESTAMP NULL DEFAULT NULL,
  ‘updated_at‘ TIMESTAMP NULL DEFAULT NULL,
  PRIMARY KEY (‘id‘))

CREATE TABLE ‘room_maps‘ (
‘hotel_id‘ INT(10) UNSIGNED NOT NULL,
‘room_class_id‘ INT(10) UNSIGNED NOT NULL,
‘rooms_number‘ SMALLINT(5) UNSIGNED NOT NULL,
‘created_at‘ TIMESTAMP NULL DEFAULT NULL,
‘updated_at‘ TIMESTAMP NULL DEFAULT NULL,
PRIMARY KEY (‘hotel_id‘, ‘room_class_id‘),
INDEX ‘room_maps_room_class_id_foreign‘ (‘room_class_id‘ ASC),
CONSTRAINT ‘room_maps_hotel_id_foreign‘
  FOREIGN KEY (‘hotel_id‘)
  REFERENCES ‘hotels‘ (‘id‘),
CONSTRAINT ‘room_maps_room_class_id_foreign‘
  FOREIGN KEY (‘room_class_id‘)
  REFERENCES ‘room_classes‘ (‘id‘))

CREATE TABLE IF NOT EXISTS ‘reservations‘ (
  ‘id‘ INT(10) UNSIGNED NOT NULL AUTO_INCREMENT,
  ‘created_at‘ TIMESTAMP NULL DEFAULT NULL,
  ‘updated_at‘ TIMESTAMP NULL DEFAULT NULL,
  ‘person_id‘ INT(10) UNSIGNED NULL DEFAULT NULL,
  PRIMARY KEY (‘id‘),
  INDEX ‘fk_reservations_1_idx‘ (‘person_id‘ ASC),
  CONSTRAINT ‘fk_reservations_1‘
    FOREIGN KEY (‘person_id‘)
    REFERENCES ‘persons‘ (‘id‘)
    ON DELETE NO ACTION
    ON UPDATE NO ACTION)

CREATE TABLE IF NOT EXISTS ‘reservation_items‘ (
  ‘reservation_id‘ INT(10) UNSIGNED NOT NULL,
  ‘hotel_offering_id‘ INT(10) UNSIGNED NOT NULL,
  ‘seq_id‘ TINYINT(3) UNSIGNED NOT NULL,
  ‘starting_date‘ DATE NOT NULL,
  ‘nights_number‘ SMALLINT(5) UNSIGNED NOT NULL,
  ‘price‘ DECIMAL(8,2) NOT NULL,
  ‘created_at‘ TIMESTAMP NULL DEFAULT NULL,
  ‘updated_at‘ TIMESTAMP NULL DEFAULT NULL,
  PRIMARY KEY (‘reservation_id‘, ‘seq_id‘),
```

```
INDEX ‘reservation_items_hotel_offering_id_foreign‘ (‘
    hotel_offering_id‘ ASC),
CONSTRAINT ‘reservation_items_hotel_offering_id_foreign‘
  FOREIGN KEY (‘hotel_offering_id‘)
  REFERENCES ‘hotel_offerings‘ (‘id‘),
CONSTRAINT ‘reservation_items_reservation_id_foreign‘
  FOREIGN KEY (‘reservation_id‘)
  REFERENCES ‘reservations‘ (‘id‘))
```

4.4.4 *Implementing the architecture*

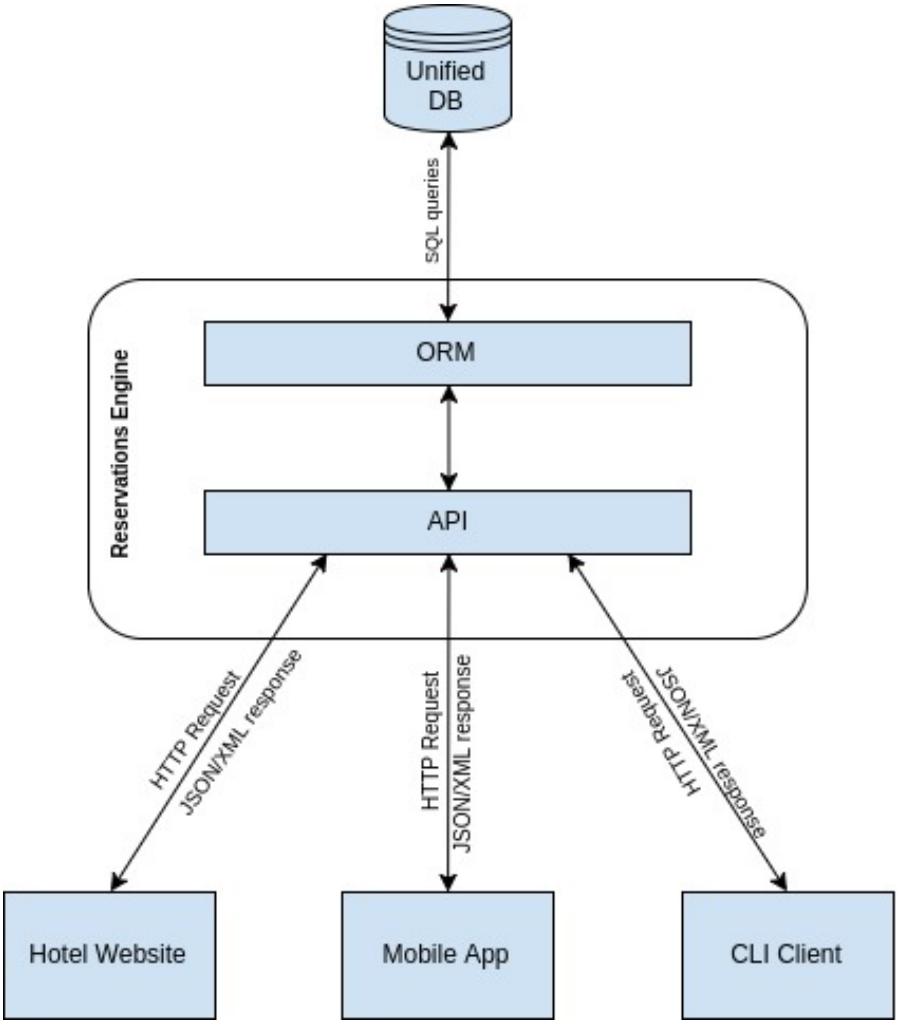


Figure 12: A high level overview of the Reservations Engine's architecture.

Now that we have the physical schema built we need to access this data. For this purpose a RESTful API web service was created. For the implementation we used strictly open-source platforms and components: PHP language, Nginx Web server and the Laravel PHP framework. The programming paradigm chosen is the Object Oriented. An

Object-Relational Mapper handles the conversion of objects into tables and the reverse.

The main concept is that we can access the Booking Engine by various platforms and programming languages with only one requirement: They speak HTTP.

An HTTP request is coming to the Booking Engine. Depending the request, a suitable Controller of the API handles it and calls an ORM layer that queries or stores to the Database. After this procedure, a JSON or XML response is returned to the API client that can further process it or present it to the user in a view of the Graphical User Interface (GUI).

To test this I have built two clients:

- a PHP hotel website that consumes the Booking Engine API to receive JSON, and it presents them to the user via a browser with HTML and CSS views.
- a Python CLI app that queries the Booking Engine and receives JSON responses. It presents them to the user in a beautified text version.

4.4.5 *Use cases with examples*

1. A hotel's website user books a hotel offering
2. The hotel's website admin creates a new offering.
3. The hotel's website admin edits an offering.
4. The hotel's website admin deletes an offering.
5. The hotel's website admin assigns a reservation item to a room.
6. A web developer tests the API from command line using Python.

The home page of the hotel client presents to the user the available hotel offerings, their price and quantity, suitable form controls to select check-in and check-out dates, and text fields for personal data.

The administration panel is a dashboard where the hotel operator can view the upcoming reservations, edit or delete their hotel offerings and also view the accommodation maps. In a strictly modular system where responsibilities of a module are clearly defined, the administrator panel would not be a part of the Booking Engine. This is a Web administrator interface that could be offered as an extra Software as a Service along with the Booking Engine. It could also be an on-premise Hotel PMS that would communicate with the Engine.

The Python CLI app is a very simple client that makes HTTP requests to the Booking Engine API and presents the JSON responses to the terminal. Output is passed into a tool that makes it human readable.

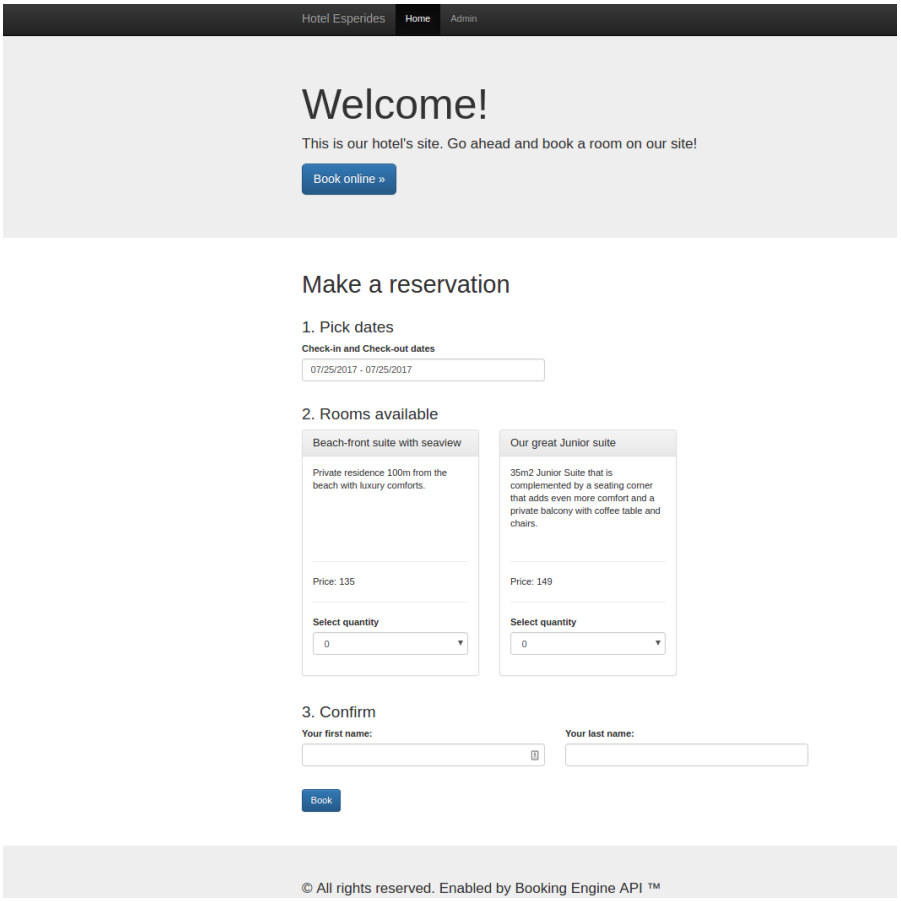


Figure 13: The Hotel-client website home page where a user can book a reservation.

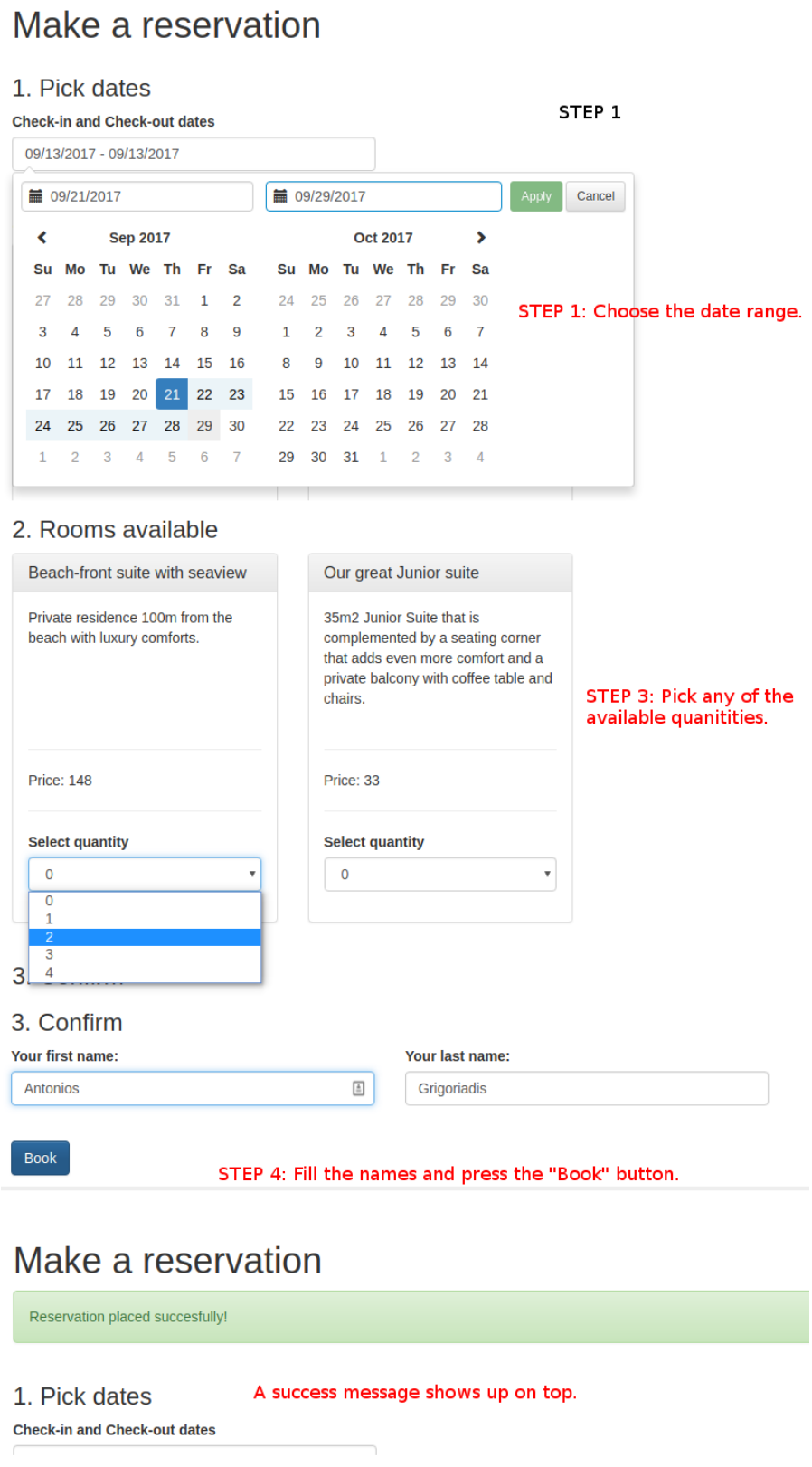


Figure 14: The use case 1 process: A hotel's website user books a hotel offering.

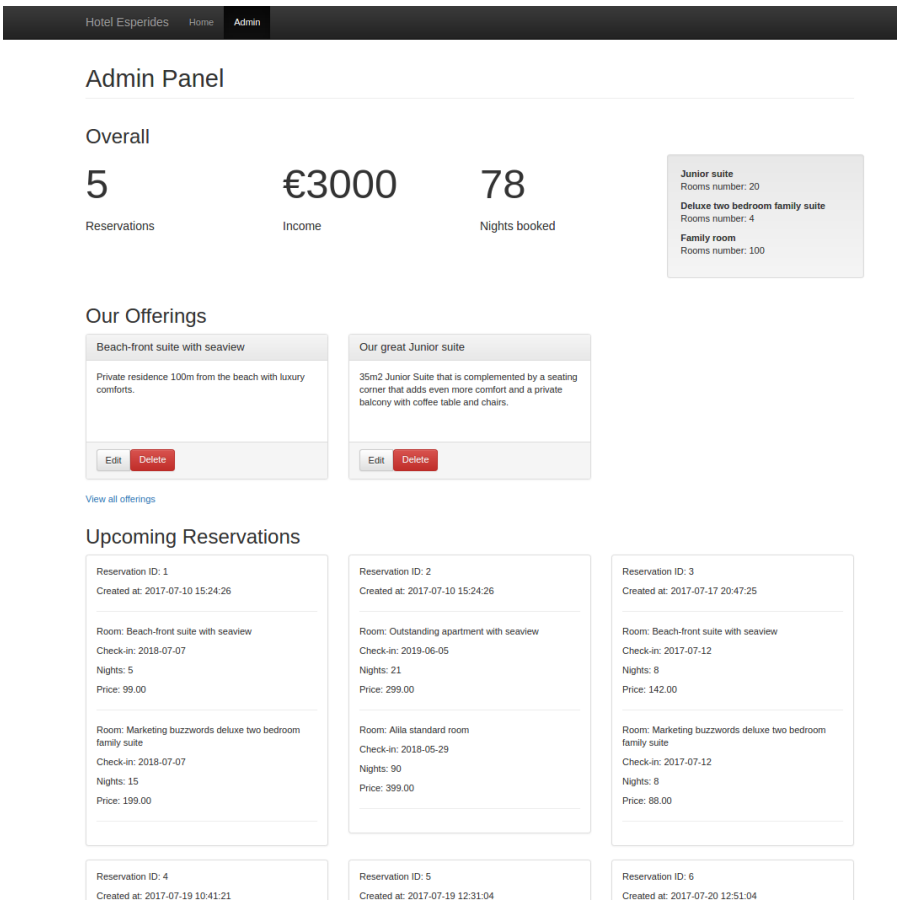


Figure 15: The administration panel of the Hotel-client.

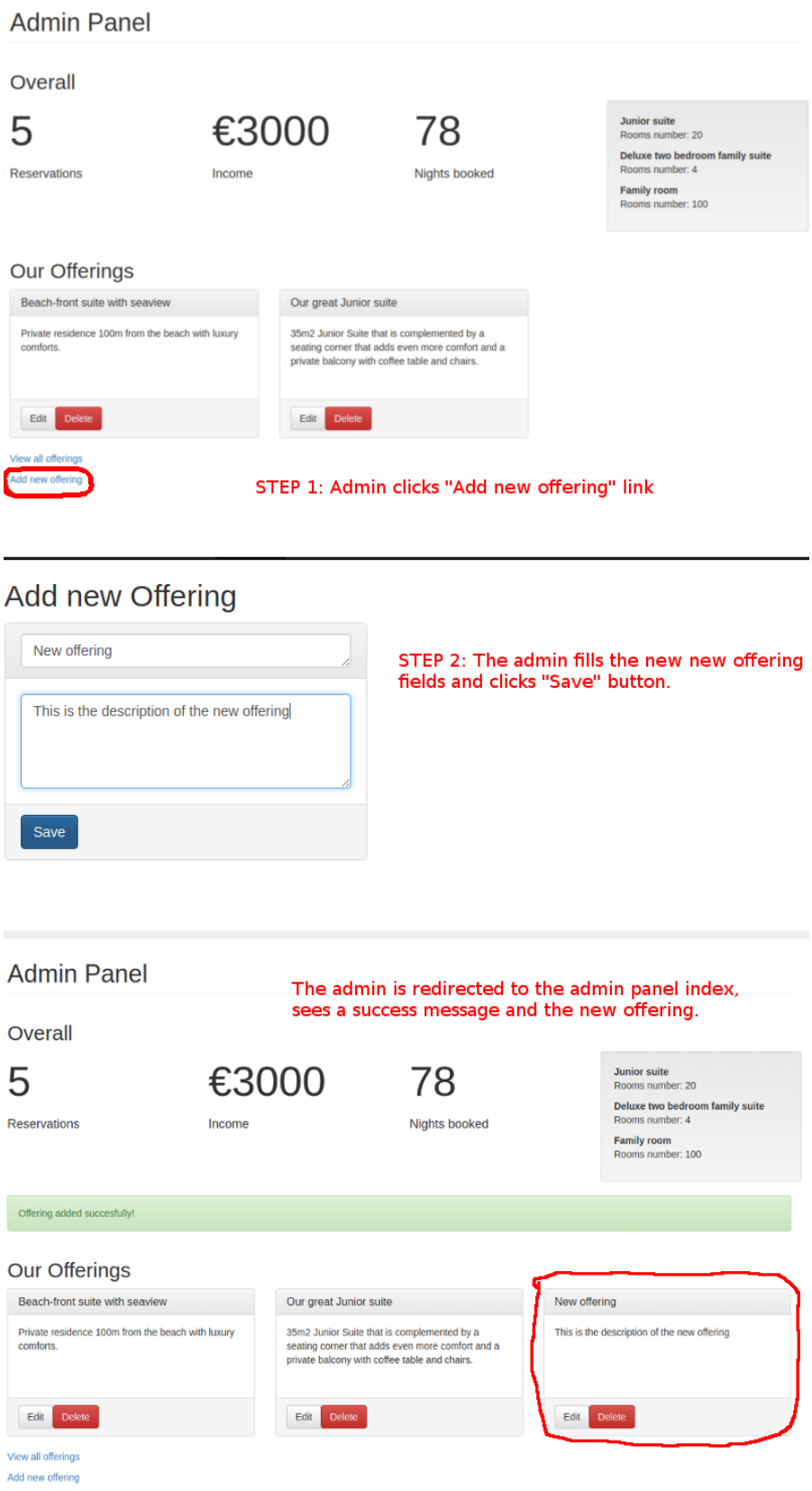


Figure 16: The use case process 2: The hotel's website admin creates a new offering.

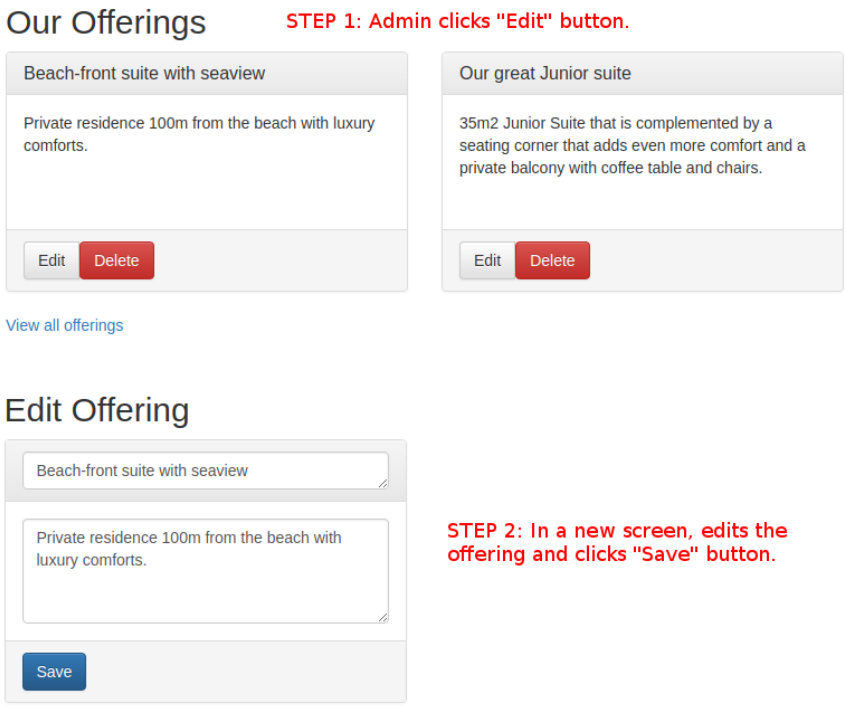


Figure 17: The use case 3 process: The hotel's website admin edits an offering.

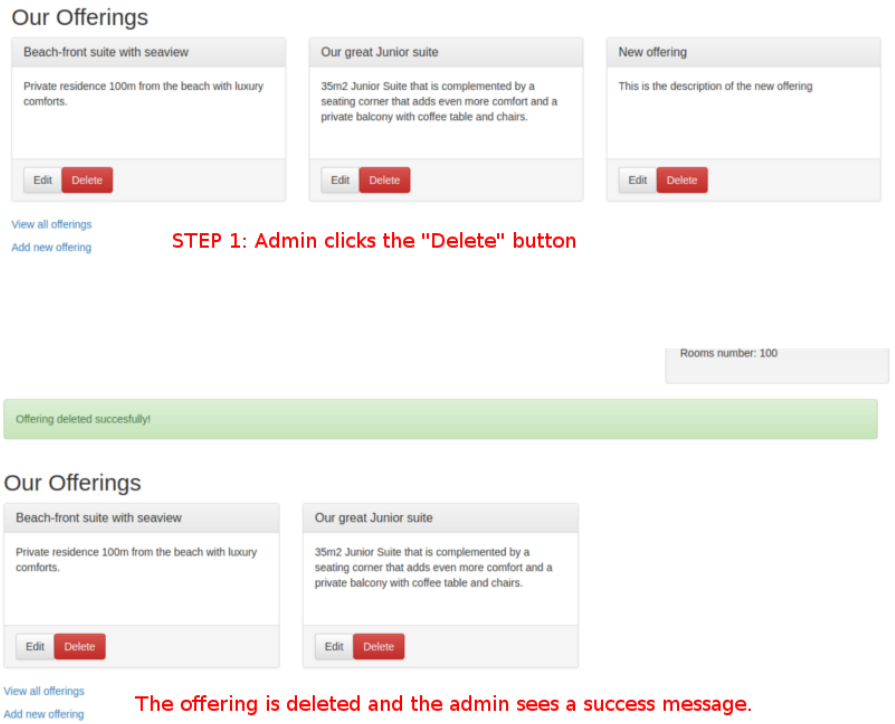


Figure 18: The use case 4 process: The hotel's website admin deletes a new offering.

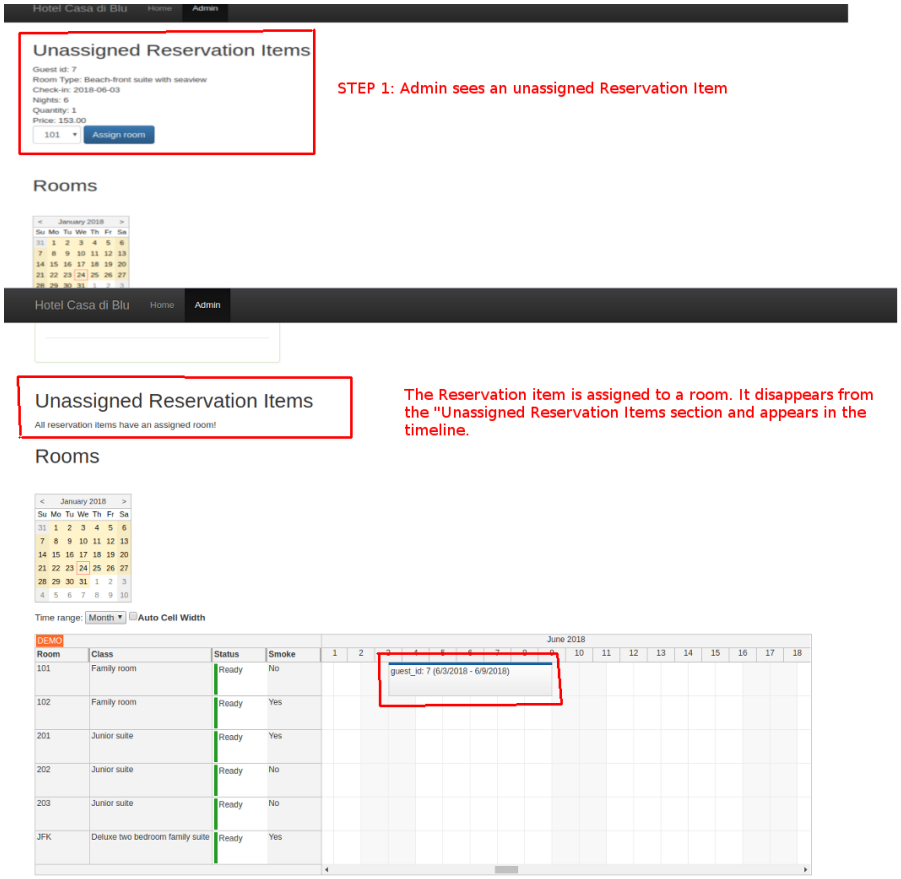


Figure 19: The use case 5 process: The hotel's website admin assigns a reservation item to a room.

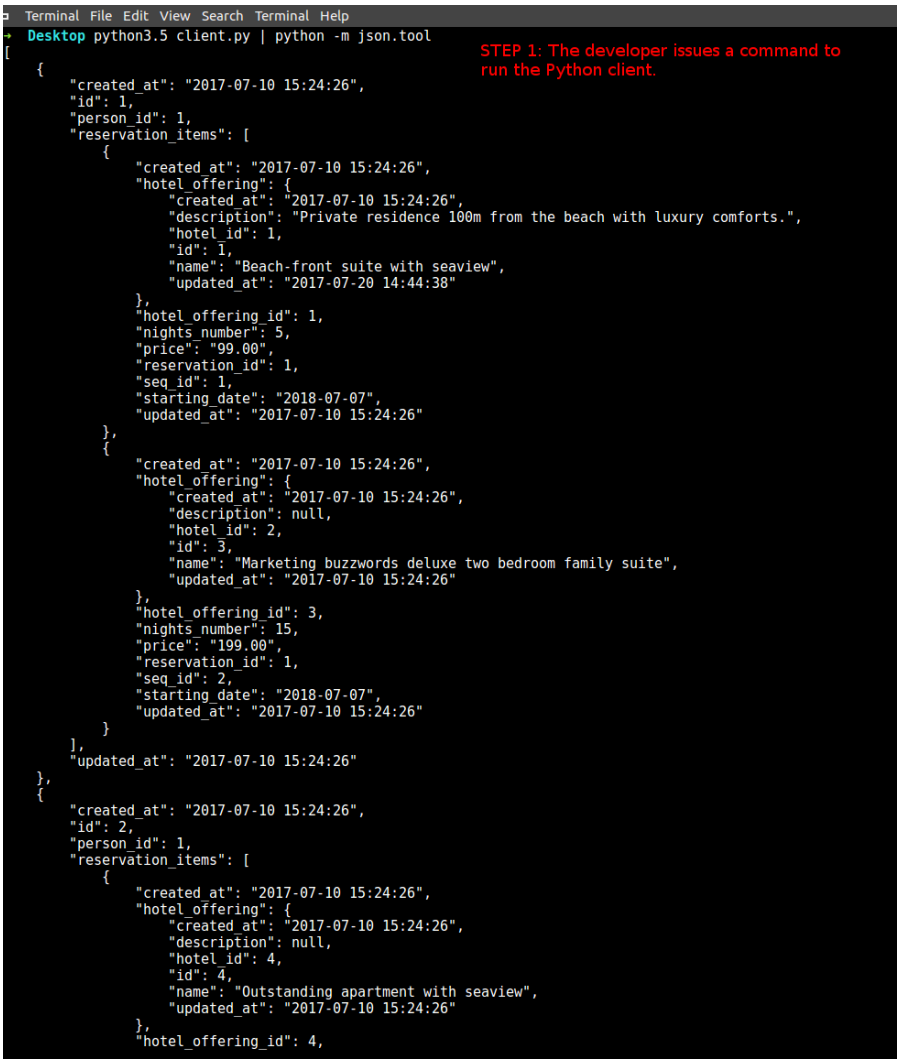


Figure 20: The use case 6 process: The output of an HTTP GET request to the /reservations endpoint, presented in a Linux terminal.

5 CONCLUSION

In this thesis, I showed that a single data model for Travel can be used to satisfy the needs of many industry-specific software applications. I presented the Travel's structure and stakeholders with their roles and definitions. I presented the software that is used and required in modern Travel organizations in order to operate properly and efficiently. I programmed a Reservations Engine module and two client applications to verify that a single data model can be used across many platforms or businesses.

Previous work had individually and isolatedly tried to categorize components of Travel industry and define a specific data model, but this thesis has as an objective to constitute a single point of reference in Travel software design and architecture.

Further work could be focused on standardizing these findings and/or creating open source software libraries that will serve as a good starting point for the development of travel software.

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