The Internet of Things

Developing a Sustainable Competitive Advantage in the Hotel Industry

Diogo André Gomes Guerra

Advisor:

Prof. Paulo Cardoso do Amaral

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ABSTRACT - ENGLISH

Title: The Internet of Things Developing a Sustainable Competitive Advantage in the Hotel Industry

Author: Diogo Guerra

The Internet of Things (IoT) is a technology that allows objects to be connected to the internet, enabling them with communication capabilities (with other objects and with people). By 2020 there will be over 50 billion things/objects connected to the internet, meaning this technology will completely revolutionize the world as we know it.

This dissertation´s goal, is to analyze the strategic potential of the IoT in the hotel industry. In this view, the research problem this dissertation faces is to ascertain if a hotel may create value through the IoT, and if that value creation may lead to the development of a sustainable competitive advantage.

In order to achieve this dissertation´s goal, a set of IoT´s functionalities are proposed and linked to a value activity, in a Hotel´s Value Chain. Then, through a survey, answered by 418 respondents from 44 nationalities, it is ascertained that IoT creates value and increases guest loyalty, and also, the most attractive IoT´s functionalities are identified.

Then, through an analysis conducted to the most attractive IoT´s functionalities (identified in the survey), it is ascertained that these functionalities allow a hotel to develop two resources: 1) High Quality Customer Service, and 2) Guests´ Tacit Knowledge.

Further on, by applying the RBV model, it is ascertained that Guests´ Tacit Knowledge is a resource that has value, it´s rare, imperfectly imitable and non-substitutable, which means that it may help a hotel developing and implementing value-creating strategies, that may last in time.

It is concluded, then, that IoT has potential to help a hotel creating value, through the resource Guests´ Tacit Knowledge, and it may use that value creation to develop a sustainable competitive advantage.

ABSTRACT - PORTUGUESE

Title: The Internet of Things Developing a Sustainable Competitive Advantage in the Hotel Industry

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A Internet of Things (IoT) - ou a Internet das Coisas - é uma tecnologia que permite a conexão de objectos/coisas à internet, permitindo assim que os objectos/coisas possam comunicar entre si e com pessoas. Em 2020 vão existir mais de 50 biliões de objectos/coisas ligados à internet, o que significa que esta tecnologia vai revolucionar totalmente o mundo como o conhecemos.

O objectivo desta dissertação é analisar o potencial estratégico da IoT na indústria hoteleira. Neste prisma, o problema de investigação, da presente dissertação, é aferir se um hotel consegue criar valor com a IoT, e se essa criação de valor pode levar ao desenvolvimento de uma vantagem competitiva sustentável.

De modo a atingir o objectivo desta dissertação, são propostas algumas funcionalidades da IoT, e posteriormente ligadas a uma actividade, numa Cadeia de Valor de um hotel. De seguida, através de um questionário, respondido por 418 pessoas de 44 nacionalidades, é possível aferir que a IoT pode criar valor e aumentar a fidelização de clientes, por outro lado, assim, são também identificadas as funcionalidades da IoT mais atractivas.

Através da análise das funcionalidades da IoT mais atractivas (identificadas através do questionário), é possível aferir que estas funcionalidades permitem que um hotel possa desenvolver dois recursos: 1) Serviço ao Cliente de Alta Qualidade, e 2) Conhecimento Tácito dos Hóspedes.

Com o modelo RBV, é, então, possível analisar que o Conhecimento Tácito dos Hóspedes é um recurso valioso, raro, imperfeitamente imitável, e não substituível, pelo que pode ajudar um hotel a desenvolver e implementar estratégias de criação de valor, sutentáveis.

É assim concluído que a IoT tem potencial para ajudar ajudar um hotel a criar valor, através do recurso Conhecimento Tácito dos Hóspedes, e essa criação de valor pode ser usada para desenvolver uma vantagem competitiva sustentável.

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I - INTRODUCTION

> "Because competitive advantage is increasingly found in knowing how to do things, rather than in having special access to resources and markets, knowledge and intellectual capital have become both the primary bases of core competencies and the key to superior performance" (Lubit, 2001).

In the hotel industry the above statement is especially true, once the experiential, intangible, and heterogeneous inherent characteristics of the Industry (Oh et al., 1997) make it a knowledge-intensive one (Kahle, 2002). More than the brand and the location, knowing the guests is an imperative to satisfy them and according to Minghetti and Coletti (2002) "enhanced customer satisfaction and retention lead to increased customer loyalty, occupancy rates and revenue per available customer".

Hotel managers may focus on developing strategies around technology because technology applications, which assist them in leveraging the knowledge available about their guests, can be a way to build a sustainable competitive advantage (Minghetti & Coletti 2002). On the other hand, Piccoli (2008) argues that hotels have not been using Information Technology (IT) strategically. This means that there is a great opportunity here for those players who can manage to use IT strategically (Piccoli, 2008) as this will differentiate them from their competitors.

This dissertation is about the Internet of Things (IoT) and its propensity to create value in the hotel industry. The IoT is a new technology which, by embedding sensors, with processing power and internet connection, into "things", adds a new dimension to the way people communicate with things, and to the way things communicate between themselves (Bandyopadhyay & Sen 2011).

The challenge this dissertation faces is to prospect if the Internet of Things (IoT) is able to create value in the hotel industry, and if that value creation may lead to the development of a sustainable competitive advantage.

In order to gain insight over the main challenge, the following research questions are proposed for this research project:

1) **Is there any impact of the IoT in a hotel´s value chain?**

2) **Which IoT functionalities do customers value the most?**

3) **Does IoT have the potential to help hotel companies´ in the development of a sustainable competitive advantage?**

In order to answer the research questions, an analysis is conducted so as to find out if the IoT has potential to create value for hotels. With this in mind, the methodology chapter starts by proposing a Value Chain (Porter 1985) for the Hotel Industry, being this the starting point for an analysis of the impact of IoT in a hotel´s Value Chain. Then, a model consisting of an inventory of the possible functionalities of the IoT, on the most guest-centered activities (Operations, Marketing and Sales and Service) of the value chain, is developed. This model aims to analyze how these functionalities may impact a hotel´s value chain. The functionalities derived from this model are, further, used in a survey, to inquire customers about the value they see in a hotel providing such IoT functionalities.

Then, after identifying the most attractive IoT´s functionalities to the guests (through the survey), a strategic analysis of those IoT´s functionalities, is performed. This analysis aims to find out what resources can a hotel develop, with such IoT´s functionalities. The resources, identified through the analysis, are then analyzed through the RBV model, in order to find out if they can be a source of a sustainable competitive advantage.

The theoretical background needed to answer the research questions is developed in the state of art. The chapter starts by presenting the literature review related with the IoT and the Value Chain framework, as a way to understand the impact of the IoT in a hotel´s value chain. Still in this chapter, a review of the literature available about the Resource Based View model is performed, in order to understand how strategic resources that lead to a sustainable competitive advantage are analyzed.

Aiming at providing the tools needed to analyze the creation of value in hotels through the IoT, this dissertation starts by providing an overview of the theory about the IoT, the Value Chain and the RBV model. Then, the chapter "Strategic Impact of IoT in the Hotel Industry" is developed, with the goal of analyzing what functionalities can the IoT provide, and how those functionalities can be linked to a value activity in a hotel´s value chain. Moreover, a Survey is developed and conducted to 418 people, enabling, this way, the identification of the most attractive IoT´s functionalities for guests, and also providing insights about IoT´s value-creation potential. Once it has been established which IoT´s functionalities are more attractive for guests,

an analysis is performed, in order to understand what strategic resources can a hotel develop, with those functionalities.

Finally, in the conclusion chapter, the RBV model is used to discuss if hotels are able to leverage the IoT´s functionalities, that customers value the most, in order to create a sustainable competitive advantage.

II - STATE OF ART

This chapter aims to provide an overview of the necessary theoretical subjects that are necessary to answer the research questions.

The review of the most relevant academic literature available about the IoT, the Value Chain and the RBV model is, then, performed throughout the chapter. The review of the literature on the latter subjects, aims to provide a better understanding of the technology, as well as the necessary tools to make a strategic analysis of its impact in the hotel industry.

2.1 THE INTERNET OF THINGS (IoT)

This section presents the research conducted on the academic material about the IoT. It includes some IoT´s definitions, as well as the needed hardware to implement an IoT network and the type of functionalities that can be derived from the IoT.

Then, an analysis of two hotels that have invested on the IoT is conducted, in order to gain insight of possible applications of the IoT in the hotel industry. The hotels analyzed are: the Seattle 1000 and Hotel Peninsula Tokyo.

2.1.1 IoT DEFINITION

The idea of the IoT has more than a decade of existence and was first developed by the MIT Auto-ID Labs (Ma, 2011). Back then, IoT´s usage was coupled mainly with RFID and its product-tracking applicability in supply chains (Gama et al. 2012).

But the IoT has evolved from such an RFID-centric approach, to a vision that encompasses the IoT as a society where a multitude of different objects are connected ubiquitously (Gama, Touseau & Donsez 2012). Cisco Internet Business Solutions Group, for instance, reinforces this view by stating that the IoT is the point in time when more things than people are connected to the internet. This connection is achieved by embedding tiny sensors and transmitters into a wide array of objects, which enables those objects with processing power and with a unique identification, allowing them to be connected to the internet (López et al. 2012). Further on, the IoT not only allows things to communicate between themselves, but also creates new ways for people to communicate with things (Bandyopadhyay & Sen, 2011).

Basically, the IoT consists of an overlay and interconnection of the physical and virtual world (Ma, 2011), through the creation of wireless networks of objects (Nazarov, 2010) where things/objects have an unique identification, are connected to the internet and have processing power that allows them to sense and respond to changes in their environments (refer to appendix 1 for an example of the evolution and possible applications of IoT)

According to Ma (2011), IoT is leading the third wave of the information technology industry´s revolution and it is already pointed out, by developed nations, as one of the most important strategic pillars for promoting economic development and technology innovation. Cisco Internet Business Solutions Group argues that in 2010 there were already 12.5 billion things connected to the internet, and this number is expected to grow to 50 billion in 2020 (as shown in figure 1).

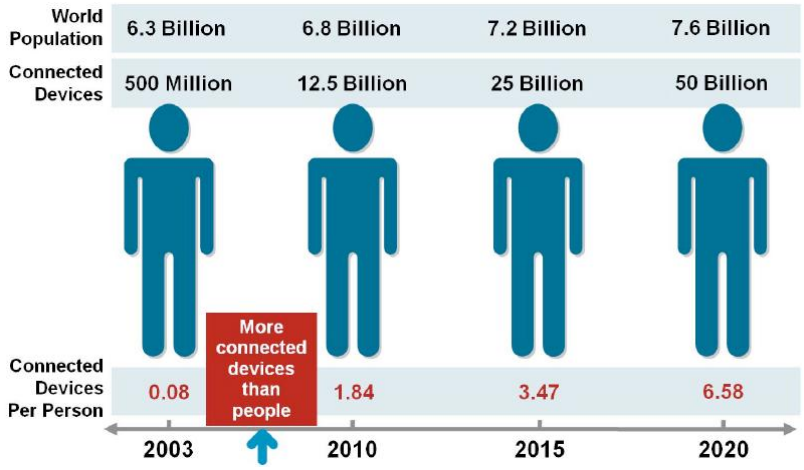


Figure 1: Evolutio of IoT

Source: Cisco Internet Business Solutions Group, 2011

In an IoT network where objects are communicating with other objects and with people, about changes in their environment, the amount of information generated is very extensive and immediately accessible (Bandyopadhyay & Sen, 2011), which means that the IoT has potential to impact every value chain (Fleisch, 2010), meaning that the resulting IoT applications have potential to create new business models in any industry (Chui et. all, 2010).

2.1.2 IoT ARCHITECTURE

In order to explain how IoT works, its main characteristics should be the first thing to refer. According to Ma (2011) in an IoT network, all objects must have an unique identification, they must be interconnected as autonomic network terminals and they must become intelligent in order to communicate with other objects and people in the network.

Having in mind the achievement of an IoT network with such characteristics (as the ones mentioned in the previous paragraph), the layered architecture represented in figure 2 must be developed (Atzori et al., 2010 cited in Bandyopadhyay & Sen, 2011). The two layers at the bottom have the goal of gathering data from the objects in the network, and the two on the top are responsible to make an use of that data in applications, while the internet layer provides the means for the communication between the bottom and top layers (Bandyopadhyay & Sen 2011).

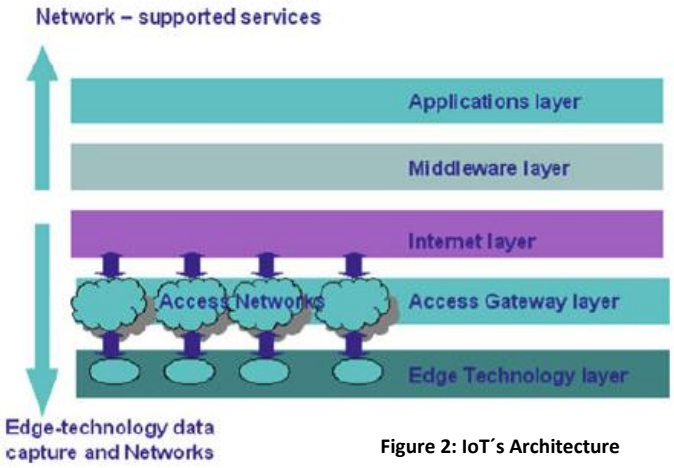


Figure 2: IoT´s Architecture

Source: Bandyopadhyay & Sen

The multi-layered architecture of IoT makes it a very complex subject, which is why it can´t be addressed merely as a single technology (Ma & Zhang, 2011). Actually the development of an IoT network is only possible by intermediary of several enabling technologies (Atzori et al., 2010).

On the following sections, an analysis of the technologies needed to develop an IoT network, is provided. These technologies are related with the identification, sensing and communication properties, without which the IoT can´t work.

2.1.2.1 ENABLING TECHNOLOGIES

In order to build an IoT network, the first thing to do is to provide objects with an unique identification, making it possible, this way, to track and identify an object without ambiguity (Bandyopadhyay & Sen 2011).

RFID (radio frequency identification) is the most important technology to enable automatic identification and tracking of objects in an IoT network (López et al., 2012). An RFID system is composed by a tag (a small chip with a small radio antenna), attached to an object, that transmits information, through an RFID reader, to backend applications or servers (Ranasinghe et al., 2005). While the RFID tags give the object an unique identification, the reader detects their position (Atzori et al., 2010). Although very important to connect the physical objects to the virtual world, as explained in the aforementioned paragraph, RFID still can´t provide the sensing, processing and network capabilities to make the objects smart, with the ability to respond and communicate, the changes in their environment, with other objects and people in the network (Kortuem et al., 2010).

Sensor technologies have the ability to counteract RFID´s sensing inability (López et al., 2012), because networked sensor systems can gather information about the environment surrounding the objects (Beigl et al., 2004). Sensor networks are composed by a number of nodes communicating in a wireless fashion (Atzori et al., 2010), providing the end user with a better understanding of the environment (Akyildiz et al., 2002). The sensors are very small wireless devices, powered with a battery (energy efficient), with the goal of transmitting the data in the sensors, establishing, this way, a WSN - Wireless Sensor Network (López et al., 2012).

Since the billions of sensors that may compose the IoT need unique IP addresses, deployment of IPv6 is crucial due to its expanded address (Bandyopadhyay & Sen 2011). IPv6 is also a suitable protocol for large sensor networks, due to its auto-configuration capabilities (Durvy, et al. 2008)

RFID and sensor technologies are key elements in an IoT network and a recent trend has been the integration of sensors into RFID tags (López et al., 2012). DASH7, developed by the DASH7 Alliance, is a new wireless sensor networking technology for wireless sensor networking (WSN). According to the DASH7 Alliance, the DASH7 technology provides the lowest power, longest range wireless networking technology available anywhere.

DASH7 sensor technology is intended for low-bandwidth digital communications, and as it operates at around 433 megahertz, it is globally accepted in any region of the world. DASH7 is also designed for low power communications, even lower than Zigbee and Bluetooth (two other WSN protocols), making it perfectly compatible with RFID tags, which are mostly passive as their energy is provided by the radio waves emitted by their readers (Shneider, 2010). Also, according to the DASH7 Alliance, DASH7 requires only 10% of the power of Zigbee (a comparison between DASH7 and other WSN technologies is presented in Appendix 2)

DASH7 not only supports the integration of RFID tags, but also supports sensors and IPv6, and unlike other active RFID technologies it allows tag-to-tag communication. Which means DASH7 makes it possible to put together the main technologies needed to build an IoT network, as it allows for identification and tracking of objects (RFID tags) and allows sensing and communicating throughout the network (sensor technologies). Another important aspect of DASH7 is that its signal can penetrate through walls and range up to two kilometers, according to the DASH7 Alliance (Dash7 Alliance, 2012).

2.2 THE VALUE CHAIN FRAMEWORK

This section aims to provide a conceptualization of the Value Chain framework, which is used to develop the first model of the methodology so as to find out how IoT´s functionalities can impact a Hotel´s value chain.

2.2.1 THE VALUE CHAIN CONCEPT

The Value Chain framework was developed in 1985 by Michael Porter (Armistead & Clark, 1993) and has remaineds as the paradigm framework to understand/analyze how firms create value (Stabell & Fjeldstad, 1998). The value chain´s core concept is that a product goes through a series of activities, within the firm, in order to be produced and delivered to the customer (design, production, marketing, delivery and service), and as it goes though this activities it gains value and costs, which means that a profit is generated when value overcomes costs (Hergert & Morris, 1989 cited in Armistead & Clark, 1993).

Porter (1991) argues that a firm is a collection of discrete and interrelated activities (assembly of products, leads, processing orders, etc), and the value chain analysis allows firms to identify where strategically important activities lie and what is the impact of such activities, in terms of

cost and differentiation, for the firm (Hergert & Morris, 1989). In this view, the value chain is a tool that allows firms to analyze all its activities and their interactions, which in turn helps firms to examine sources of competitive advantage (Porter, 1985).

As argued by Herhert & Morris (1989) the value chain can also be used as a strategic planning tool, as it (1) allows firms to identify sources of competitive advantage, by pointing out the activities over which the firm has proprietary access to scarce resources; (2) it emphasizes the interrelationships and linkages between activities, and these linkages and interrelationships are important for creating competitive advantage; (3) it helps firms in formulating generic strategies such as cost leadership, differentiation and focus.

2.2.2 GENERIC CATEGORIES OF THE VALUE CHAIN

According to Porter (1985), there are nine generic categories of activities that compose every firm´s value chain. These activities are described as value activities that are physically and technologically distinct (Hergert & Morris, 1989) and together they help firms creating valuable products to its customers (Porter, 1985).

As Porter (1991) argues, the two levels that compose the value chain, and by which the nine generic categories are dispersed, are the Primary Activities, which are activities directly related with the production, marketing and delivery of the product to the customer; and Support Activities that aim at providing the inputs or factors needed to perform the Primary Activities. Each of the nine generic categories can then be disaggregated into a set of discrete activities (Porter, 1985). Figure 3 depicts the Value Chain as proposed by Porter (1985)

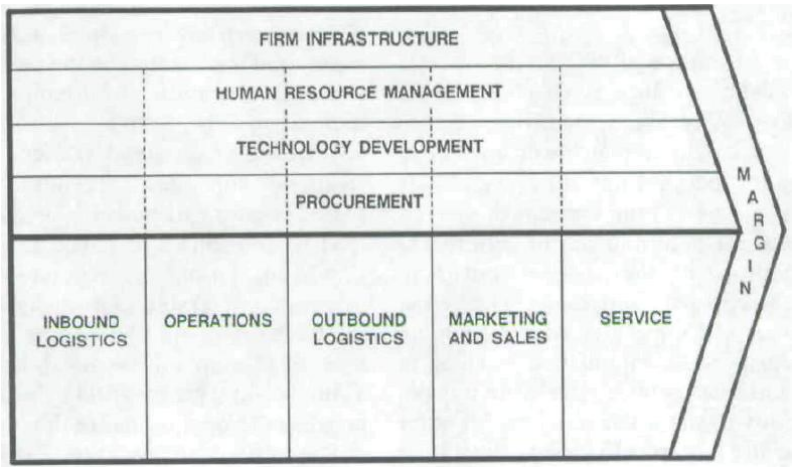


Figure 3: Value Chain

Source: Porter (1985)

The activities in the first level of figure 3, depicted horizontally, constitute the five generic categories of primary activities, which according to Porter (1985: 39-40) are:

- **Inbound logistics,** activities associated with receiving, storing, and disseminating inputs to the product.
  Examples of Inbound Logistics´ activities: material handling, warehousing, inventory control, vehicle scheduling and returns to suppliers.

- **Operations,** activities associated with transforming inputs into the final product form.
  Examples of Operations´ activities: machining, packaging, assembly, maintenance, testing, printing and facility operations

- **Outbound Logistics,** activities associated with collecting, storing, and physically distributing the product to buyers
  Examples of Outbound Logistics´ activities: finished goods warehousing, material handling, delivery vehicle operation, order processing, and scheduling.

- **Marketing and Sales,** activities associated with providing a means by which buyers can purchase the product and inducing them to do so.
  Examples of Marketing and Sales´ activities: advertising, promotion, sales force, quoting, channel selection, channel relations, and pricing.

- **Service,** activities associated with providing service to enhance or maintain the value of the product.
  Examples of Services´ activities: installation, repair, training, parts supply, and product adjustment

Further on, in figure 3, vertically depicted, are the four generic categories that compose the support activities, which according to Porter (1985) are:

- **Procurement,** activities related with the acquisition of inputs used in the value chain.
  Examples of Procurement´s activities: purchasing of raw materials and consumable items, machinery and buildings.

- **Technology Development,** range of activities that aim to improve the product and the process.
  Examples of Technology Development´s activities: research, product design, media research, servicing procedures and support of IT/IS.

- **Human Resource Management,** activities related with recruiting, hiring, training, developing and compensating all types of personnel.
  Examples of Human Resource Management´s activities: determine the skills and motivation of employees and the cost of hiring and training.

- **Firm Infrastructure,** set of activities that aim to support the entire value chain.

Examples of Firm Infrastructure´s activities: general management, planning, finance, accounting, legal, government affairs, and quality management.

According to Porter (1985), the value of each category of the Primary Activities for a firm depends on the industry. For a services´ firm, as a hotel for instance, outbound logistics may be insignificant and operations may be the most valuable category. The same happens with Support Activities, as each category can be split into a set of distinct value activities that vary between industries.

The support activities are depicted in layers (as shown in figure 3) because they are performed in parallel and have an impact in all primary activities, (Stabell & Fjeldstad, 1998).

Further on, the margin, represented at the right edge of the value chain in figure 3, represents the total value derived from the performance of all the value activities in the chain (Porter, 1985; Stabell & Fjeldstad, 1998).

According to Porter (1985) in each category, activities can still be defined as direct, indirect or quality assurance. Direct activities are directly present in the creation of value for the customer (e.g.: check-in/out); Indirect activities assure that direct activities can be performed continuously (e.g.: room cleaning); and quality assurance activities aim to assure the quality of all other activities (e.g.: monitoring).

2.2.3 COMPETITIVE ADVANTAGE (Porter, 1991)

Porter (1991) argues that competitive advantage is built when a firm performs some value activities at a lower cost than its competitors, or in a unique way that enhances the value to the customer. Hence, in order to identify a competitive advantage, firms should analyze its value activities through the use of the value chain (Stabell & Fjeldstad, 1998), and then a strategy must be defined so as to figure out how the value activities should be configured and linked, in order to build a competitive advantage (Porter, 1991).

Thus, Porter (1991) states that the discrete activities are the basis for creating competitive advantage, however Prajogo et. al (2008) argue that not all activities have the same importance in the development of a competitive advantage. Which is why critical activities, those with high potential impact on cost reduction or differentiation, must be identified, as these are the key activities to build a competitive advantage (Hergert & Morris, 1989).

2.3 THE RESOURCE-BASED VIEW MODEL

This section aims at presenting the review of the available literature on the Resource Based View (RBV) theory. In order to accomplish that, first a brief overview of the model is presented, followed by a conceptualization of its main elements, including the definition of "firm resources" and "sustained competitive advantage", ending with an introduction to the VRIN analysis.

2.3.1 AN OVERVIEW OF THE RBV MODEL

The focus of the strategic management field in the way firms develop sources of sustained competitive advantage has started has started in the 1980´s (Porter, 1985). Two main frameworks have been developed to analyze how firms develop such advantages, one of them had to do with the internal and external analysis of the firm (also known as SWOT), that suggests that a firm should analyze its internal strengths and develop strategies upon them in a way that enables the firm to enjoy its external opportunities and neutralize external threats, which would, then, lead to a sustained competitive advantage (Barney, 1991). Another one is more focused on a firm´s opportunities and threats, derived from its competitive environment that gives rise to high levels of performance, better known as Porter Five Forces, (Barney, 1991). The focus of these frameworks, however, may make it hard to understand how a sustainable competitive advantage is built, because according to Barney (1991) it disregards the fact that firms within an industry may be heterogeneous regarding the resources they possess, and it considers that a firm´s resource that leads to a competitive advantage is highly mobile across its competitors, translating in an unsustainable competitive advantage.

The RBV model assumes that a firm may possess a set of resources and capabilities that are both heterogeneous and imperfectly mobile across other competing firms (Newbert, 2008), giving that firm the ability to develop a competitive advantage (based on those heterogeneous and immobile resources and capabilities) that is sustainable over time (Barney, 1991). Thus, the RBV model is an extremely important framework to understand how a firm develops a competitive advantage and whether or not it is able to sustain it over time (Eisenhardt and Martin, 2000).

Once the function of the RBV model has been explained, briefly, in the previous paragraphs, it is necessary, now, to explain some of its main concepts: resources, capabilities and, Sustainable Competitive Advantage, which are presented above.

2.3.1.1 RESOURCES, CAPABILITIES AND SUSTAINABLE COMPETITIVE ADVANTAGE

Regarding resources, Barney (1991) citing Porter (1981) argues that a firm´s resources are internal strengths that act as the foundations for a firm do build its strategies. Thus, resources are all the tangible (e.g.: technological resources, human capital, machinery, etc.) and intangible (e.g.: knowledge, brand name, customer loyalty, etc.) assets (Maijoor and Witteloostuijn, 1996), that are controlled by a firm and over which a firm may develop its strategies (Daft, 1983 cited in Barney, 1991), which means that resources may be a major source of sustainable competitive advantage (Powell, 1992 cited in Maijoor and Witteloostuijn, 1996).

Further on, Amit and Schoemaker (1993) refer to "capabilities" as "the firm´s capacity to deploy Resources". More specifically, capabilities are information based resources developed due to interactions between resources (Amit and Showmaker, 1993), such as the firm-specific´s tacit knowledge.

It may also be useful to provide a distinction between competitive advantage and sustainable competitive advantage, for clarification purposes. According to Barney (1991) a competitive advantage is achieved by a firm, when the latter is implementing a value creating strategy, that is not being implemented by anyone else in the market. On the other hand, a firm builds a sustainable competitive advantage when (apart from being the only one in the market currently implementing a value creating strategy) a competitor may replicate the same strategy, afterwards, but it is unable to replicate its benefits (Barney, 1991).

Regarding the Hotel Industry, Dev et al. (2002) argue that there are 22 resources most likely to help a hotel building a competitive advantage, and these resources may be combined and form 5 main capabilities that may lead to a competitive advantage which are: 1) organizational competence (competing capabilities, such as empowerment, operating procedures and reservation systems), 2) quality competence (capabilities needed to provide high quality service and ensure guest satisfaction), 3) customer competence (capabilities that enable the hotel to develop customer loyalty), 4) entry competence (hotel´s capabilities to choose a good location and entry a certain market), and 5) physical competence (capabilities to improve hotel´s facilities).

Concerning the aforementioned paragraph, customer service is a very important resource, with potential to generate a sustainable competitive advantage (Ray et al.,2004), and needed to

develop "quality competence" and "customer competence" capabilities (as referred in the previous paragraph).

Further on, as not all firm´s resources have the potential do develop a sustainable competitive advantage, a framework is needed to identify which firm´s resources are heterogeneous and immobile, which is the VRIN analysis(Barney, 1991), explained below.

2.3.2 THE VRIN ANALYSIS

The VRIN analysis provides a framework to help firms identify to what extent a resource is valuable, rare, inimitable and non-substitutable (Eisenhardt and Martin, 2000). Further on, if a firm´s resource is valuable and rare, then the firm can develop a competitive advantage, then if that same resource is also inimitable and non-substitutable the firm can develop a sustainable competitive advantage (Newbert, 2008).

To better understand the VRIN analysis, each of the VRIN attributes are explained in the following paragraphs.

Valuable - in order for a firm´s attribute to be considered a resource (although it may be rare, inimitable and non-substituable) it, first, must be valuable. A valuable resource allows firms to develop and implement value-creating strategies that allows them to take advantage of market opportunities or to neutralize market threats (Barney, 1991).

Rare - a valuable resource is said to be rare, if that resource is owned only by a single firm (Barney, 1991), or if the number of firms with access to that resource is less than needed to form a perfect competition market (Hirshleifer, 1980 cited in Barney, 1991). If a firm develops and implements a value-creating strategy, based in a valuable and rare resource not owned by a large number of competing firms, it can achieve a competitive advantage.

Imperfectly Imitable Resources - Barney (1991) states that firms with valuable and rare resources are strategic innovators (first movers), once those firms can develop and implement strategies that other firms can´t. On the other hand, in order for these valuable and rare resources to enable a firm to build a sustainable competitive advantage they must also be imperfectly imitable. Which means, that it is necessary that other competing firms (that do not own such resources) can´t have access to such resources (Barney, 1991), or that the benefits for the following companies, who implement strategies based on those resources, aren´t as big as they are for the first firm (Peteraf, 1993).

According to Barney (1991) in order for a firm resource to be imperfectly imitable, at least, one of the following criteria must be met: 1) the firm obtains a resource due to "historical conditions, 2) there is a "causally ambiguous" link between a firm´s resource and sustainable competitive advantage, 3) the resource that generates a sustainable competitive advantage is social complex. In the following paragraph, each criteria is explained in more detail.

- **Unique Historical Conditions -** Barney (1991) states that a firm that has acquired and exploited a valuable and rare resource due to time and space issues, over its history, is in possession of an imperfectly imitable resource, because other firms, who didn´t follow the same path through history, don´t have access to those time-and-space-dependant resources. Which means that a firm with access to a time-and-space dependant resource is able to develop and implement a value-creating strategy that other competing firms won´t be able to replicate (Barney, 1991). An example of such resource might be a firm (such as a hotel company) that builds a hotel in a location that is a lot more valuable some time after the construction of the hotel (Barney, 1991).

- **Causal Ambiguity** - When a firm doesn´t understand, or imperfectly understands, the reason why it has a sustainable competitive advantage, it is said that there is a causally ambiguous link between a resource and that firm´s sustainable competitive advantage, which means that a firm is in the possession of an imperfectly imitable resource (Barney, 1991). If a firm doesn´t fully understand which resource or combination of resources led to its sustainable competitive advantage, then other competing firms that are trying to copy that firm´s advantage, won´t be able to do it, as they won´t be able to go beyond an imperfect understanding of which resources, or combinations between them, are enabling that firm to build a sustainable competitive advantage (Barney, 1991).

- **Social Complexity -** When a firm is in possession of a resource, that leads that firm to a competitive advantage, fruit of a very complex social phenomena that makes it impossible for other competing firms to imitate that resource, it is said that the firm is in possession of an imperfectly imitable resource (Barney, 1991). Because, although other competing firms may understand what resource is enabling a firm to build a competitive advantage, they are unable to replicate, in the same way, that resource, due to the social complexity of the resource (Barney, 1991). For instance, physical technology by itself is an imitable resource (once every firm can have access to the same technology), however if a

firm exploits that technology more completely than other firms, due to social complex resources such as knowledge, learning, culture and so on, this firm will be able to build value creating strategies that other firms (with the same technology) won´t, this way building a sustainable competitive advantage.

Non-Substitutability - when a firm´s value creating strategy is based in a given resource and there is no other resource that may allow the implementation of that same value creating strategy, it is said that the firm is in possession of a non-substitutable resource (Barney, 1991). However, if there is a strategically equivalent resource to the one owned by that firm, which may be used to develop and implement the same value-creating strategies, but the equivalent resource is both rare and imperfectly imitable, then the firm´s resource is still non-substitutable (as other firms won´t be able to acquire it) and the firm has the ability to develop a sustainable competitive advantage (Barney, 2001).

Once the RBV model and the VRIN analysis has been explained, it is possible to show the illustrative framework that relates resources´ heterogeneity and immobility, with the VRIN attributes and sustainable competitive advantages, which is presented, according to research conducted by Barney (1991), in figure 4. This framework is useful help a firm analyze if a resource has potential to help that firm building a sustainable competitive advantage.

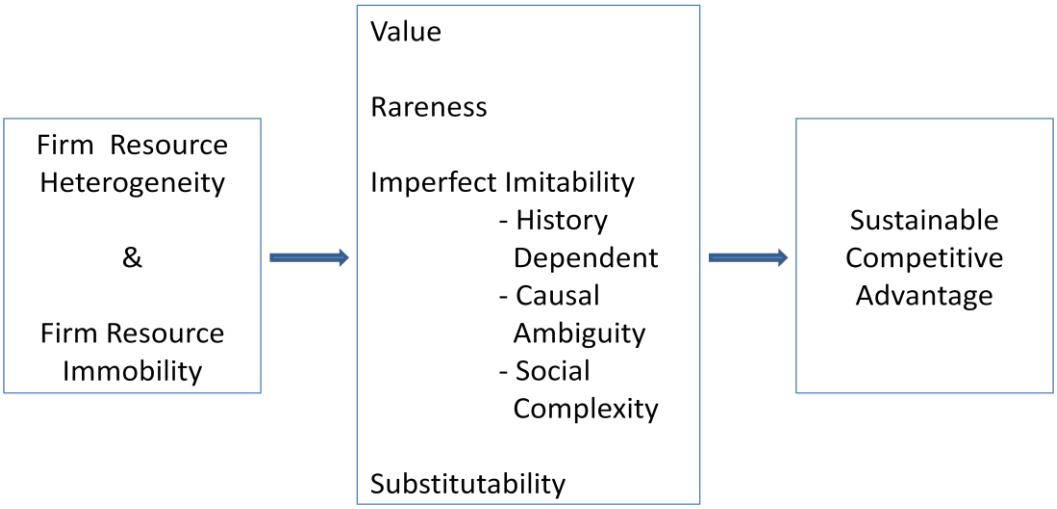


Figure 4: RBV Framework

Source: Barney (1991)

As Barney (1991) argued, not all firm´s resources have potential to lead to a sustainable competitive advantage. In the last years, such resources have become even scarcer due to the

development of hypercompetion, which has caused tacit knowledge as one of the primary sources a firm can have to develop a sustainable competitive advantage (Lubit, 2001; Amit and Schoemaker, 1993; Peteraf, 1993; Winter 1987 cited in Nonaka and Krogh,2009). Hence, the concept of tacit knowledge is explained, in more detail, in the following paragraphs.

2.3.3 THE CONCEPT OF TACIT KNOWLEDGE

Nonaka (1991) argues that in such an uncertain economy there is only one resource that can, trully, lead a firm to a sustainable competitive advantage, which is "knowledge". However, the increasing competition, across markets, has been decreasing the kind of special/rare knowledge with potential to help firms building a sustainable competitive advantage (Lubit,2001). Hence, a firm needs a type of knowledge that is hard for other competing firms to imitate, and that allows that firm to develop new knowledge, fast, whenever the market requires it (Lubit,2001).

The type of knowledge that encompasses the characteristics, mentioned in the previous paragraph, is the "Tacit Knowledge" (Nonaka, 1991). In order to understand the concept of tacit knowledge it may be useful to summarize, first, its antonym, the "explicit knowledge", which is formal and easy to communicate and share (Nonaka, 1991), once people are consciously aware about it and can easily put it into words, meaning it can be spread across other competing firms (e.g.: inventory management, total quality management, and so on) and, thus, it can´t provide a firm that owns it, with a sustainable competitive advantage (Lubit, 2001).

Tacit knowledge, however, is very hard to formalize and to be put into words, making it hard for other competing firms to copy it (Lubit, 2001). This happens because tacit knowledge is deeply embedded in actions, routines, values, ideals, procedures and emotions (Nonaka et al. 1996, 2000a, b, cited in Nokata and Krogh, 2009). People acquire tacit knowledge unconsciously, which is why this kind of knowledge encompasses information that is difficult to express or share (Lubit, 2001). Also, once people experience tacit knowledge as intuition (Lubit, 2001), it is apparent that the cognitive dimension is an important part of tacit knowledge, as it consists of the mental models, beliefs and perspectives, that shape the way people perceive the world around them, making it hard for them to articulate that kind of information (Nonaka, 1991).

Moreover, acquiring tacit knowledge requires a large amount of experience in an activity, preferably by watching other people applying their tacit knowledge, either while performing a routine or addressing problems (Lubit, 2001; Nonaka, 1991). Hence, Lubit (2001) argues that

tacit knowledge has four categories: 1) know-how, 2) mental models, 3) ways of approaching problems, and 4) organizational routines.

"Know-how", has to do with skills (such as swinging a golf club) which can´t be fully explained in words, because people know how to do something but can´t explain how they do it (Lubit, 2001). "Mental models" are related with the way we shape the world around us, how we make sense of the masses of data that encompass us, so we can make sense of a given situation and provide a response, such as the way we evaluate a person´s personality, or judge risk (Lubit, 2001). The "ways of approaching problems" refers to the decision trees people use to approach problems, which affect the solutions we might select (Lubit, 2001). As for "organizational routines", this category is associated with the regular and predictable behavior patterns, under which a firm´s tacit knowledge is stored, allowing the firm to intuitively know in what data to focus on and provide better customer response (Lubit, 2001).

Over the present state of the art chapter, it has been provided the conceptualization and presentation of the main topics needed to answer this dissertation´s research problem. First, it has been presented the IoT technology, which is useful, for the next chapter, to propose a model of an IoT network at a hotel. It has also been introduced the DASH7 sensor´s technology, which - due to its signal´s long range, up to 10 years battery life and worldwide accepted frequency - is proposed, in the next chapter, as a solution to build a hotel´s IoT network. Since, in order to answer the research question, it is useful to understand the impact of IoT in a hotel´s Value chain, the Porter´s Value Chain framework has also been analyzed. Further on, as the aim of this dissertation is to find out if the IoT can help hotels building a sustainable competitive advantage, the RBV model has been also conceptualized, which is a useful framework to understand if the IoT has potential for that or not. The literature review of the RBV theory provided insights that firm´s resources with potential to build a sustainable competitive advantage are getting scarcer due to hypercompetition, therefore it has been presented the concept of "tacit knowledge". A type of knowledge that is hard for other firms to imitate, it might have value, it might be rare and non-substitutable (VRIN attributes), which means it has potential to help firms building a sustainable competitive advantage.

In the next chapter, the aforementioned frameworks and concepts are used to: 1) propose a building model of an IoT network at a hotel, 2) come up with a set of possible IoT´s functionalities and provide an impact proposition of IoT in a hotel´s value chain, 3) develop a survey do find out what are the most valuable IoT´s functionalities, and 4) apply the RBV model

to analyze if the most attractive functionalities have potential to help hotel building a sustainable competitive advantage.

III - STRATEGIC IMPACT OF IoT IN THE HOTEL INDUSTRY

The current chapter aims at addressing the research problem that this dissertation faces. In this view, the chapter starts by developing an assumption that regards the utilization of IoT in a hotel.

Then, a value chain for the hotel industry is proposed, based in a value chain developed by Angeli (1998), in order to understand what functionalities can derive from an IoT network, in a hotel. Further on, so as to make a proposition of the impact of IoT in a hotel´s value chain, a model, where all IoT´s functionalities are inventoried and linked to a discrete activity in the value chain, is developed.

Further on, an impact analysis of each IoT´s functionalities is conducted, in order to understand how relevant they are for a hotel´s value creation process.

3.1 PROPOSED BUILDING MODEL OF AN IoT NETWORK

As mentioned before, the information needed to understand how an IoT network can be implemented in a hotel, as well as the functionalities that might derive from it, is lacking. Hence, an assumption is developed, considering the information provided in the State of Art, about the IoT and its functioning.

For this dissertation, the major goal with an IoT network is the creation of smart environments/spaces (or a smart hotel) and self-aware things (e.g.: mini-bars, room locks, acclimatization, etc.), creating a new way for guests to interact with the hotel and its workers. In order for Things to become context aware, sense, communicate, interact and exchange data with other things and people in the network, those things must be embedded with micro sensors. As explained in the State of Art, DASH7 would meet this need, especially given that it works in the globally accepted frequency of 433 MHz, its signal can penetrate through concrete and range to a distance of up to 250 m, and it has a battery life of up to 10 years, making it superior to other alternatives like Zigbee and Bluetooth.

It is proposed, then, that DASH7 sensors are embedded in objects and spaces all over the hotel, from the products in the rooms´ mini-bars to the room doors, wirelessly interconnecting the objects between each other and connecting them to the internet, collecting several types of information about the guests.

In order to maximize the potential of the IoT network at a hotel, the embedment of sensors would be in following spaces and objects:

- **Public spaces**
  - Hotel lobby/reception
  - Restaurants and bars
  - Pool area
  - Conference rooms
  - Hallways
- **Rooms**
  - Mini bars
  - Products inside the mini bars
  - all over the room (to control lights, TV, A/C)

Once it is necessary for things to communicate between themselves and with people in the network, and also to provide a set of functionalities to the guest, it is proposed that the development of an IoT Architecture (Bandyopadhyay & Sen 2011) may be as it is shown in figure 2 (in the stat of art chapter).

The first layer of an IoT network (Bandyopadhyay & Sen 2011) is the "edge technology layer", which is responsible for providing things, in the network, with an unique identification, to enable the collection, processing and storage of information from those things, and also to provide them with sensing and communication capabilities. In order to accomplish this, the first thing to do is to deploy the DASH7 sensors into the things and spaces previously mentioned, which may compose a hotel´s IoT network, building, this way, a Wireless Sensor Network, that allows things in the network to communicate between themselves. DASH7 sensors, once deployed in the reception, for instance, can detect a given guest through their smartphone. Further on, if a DASH7 sensor is deployed into a pool sun bed, it can provide that sun bed with an unique identification and provide its location in real time. The information gathered by DASH7 sensors, then, needs to be handled, and the first stage of its handling starts in the "access gateway layer". Then, there is the need for an "internet layer", which allows things to be connected to the internet, and also to act as an intermediate between the aforementioned layers and the top layers of the architecture (explained below).

The "middleware layer" is responsible for managing the information coming from the hardware layer (the two layers mentioned in the previous paragraph) so it can be used further, in the "application layer". The "middleware layer", thus, may be where a hotel´s PMS (Property Management System) is integrated into the IoT network, which is useful once a hotel´s PMS is also used for data mining (guest relations, marketing, and so on), as it is where all the guest´s

information is recorded, traditionally. Once the information is ready to be used, in activities such as performing functionalities for IoT users (guests), the "application layer" takes its part, being responsible for delivering a set of functionalities towards the guests.

Once the previous paragraphs have explained how the "things and objects" in the IoT network communicate between each other, it is, now, useful to propose a way for guests to integrate and interact with the IoT network (this is, to be able to enjoy the IoT´s functionalities). In this view, a Smartphone application can be developed, providing the guest with an unique identification and providing also a bridge for IoT´s functionalities. The development of a Smartphone application makes sense because the use of Smartphones amongst tourists is growing, as we can see through MPI´s Future Watch 2011 Survey, which concludes that 80% of business tourists use smartphones in their jobs and will be looking for hotels that provide them with Smartphone apps that enhance their experience. The same applies for Leisure Tourists who, according to a PhoCusWright survey, in 2011, were more “online” than ever as on average they had 2.7 Web-enabled devices (smartphones, tablets and laptops). Also according to a Morgan Stanley Research (cited in Ingram, 2010), Mobile users will surpass Desktop Internet users by the end of 2013 (as shown in appendix 3).

3.2 IoT´S IMPACT PROPOSITION IN A HOTEL´S VALUE CHAIN

This section aims at analyzing what functionalities can be derived from the IoT network proposed in the previous assumption, and how such functionalities impact a hotel´s value chain. In this view, figure 4 shows a value chain for the hotel industry (Angeli, 1998 cited in E-business Watch, 2002).

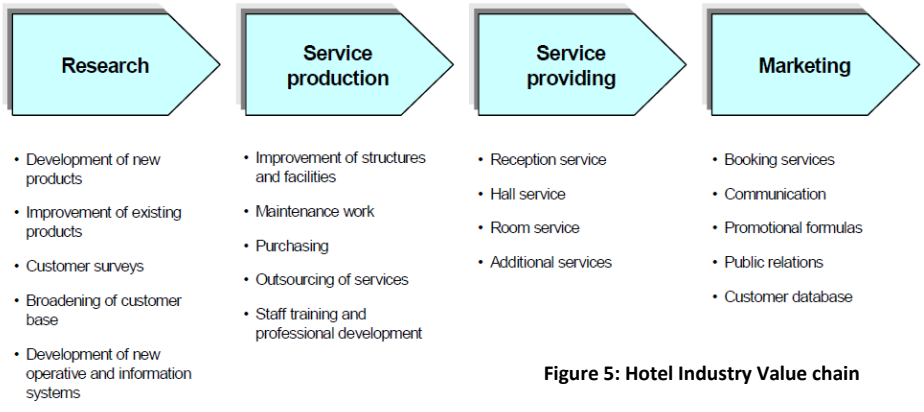


Figure 5: Hotel Industry Value chain

Source: E-Business Watch, 2002

The aforementioned value chain, however, is not in accordance with Porter´s Value Chain framework, which is the one chosen to develop the model that allows the development of an

analysis to IoT´s impact in a hotel´s value chain. Therefore an adaptation is done, using the literature about the value chain, in the state of art. Discrete activities related with Outbound/Inbound Logistics, Service and Infrastructure are not mentioned in the value chain depicted in figure 4. The process is, then, to consider that all discrete ativities (in figure 4) that are related with providing the service/product to the guest, are nested under the Operations´ category, because this category entails the transformation of inputs into outputs (Porter, 1985) and in the hotel industry the output is a service and the inputs include all the acitivities needed to provide that service, such as a check-in. Further on, the discrete activities (in figure 4) related with attracting guests to the hotel and acquiring new ones (through promotions, booking channels, development of new products, and so on) are placed under the Marketing and Sales´ category, because according to Porter (1985) the funtion of Marketing and Sales is to get the customer to buy a product, in this case a room at the hotel and all its services.

Considering the aforementioned paragraph, the value chain depicted in figure 5 is accomplished, following Porter´s framework.

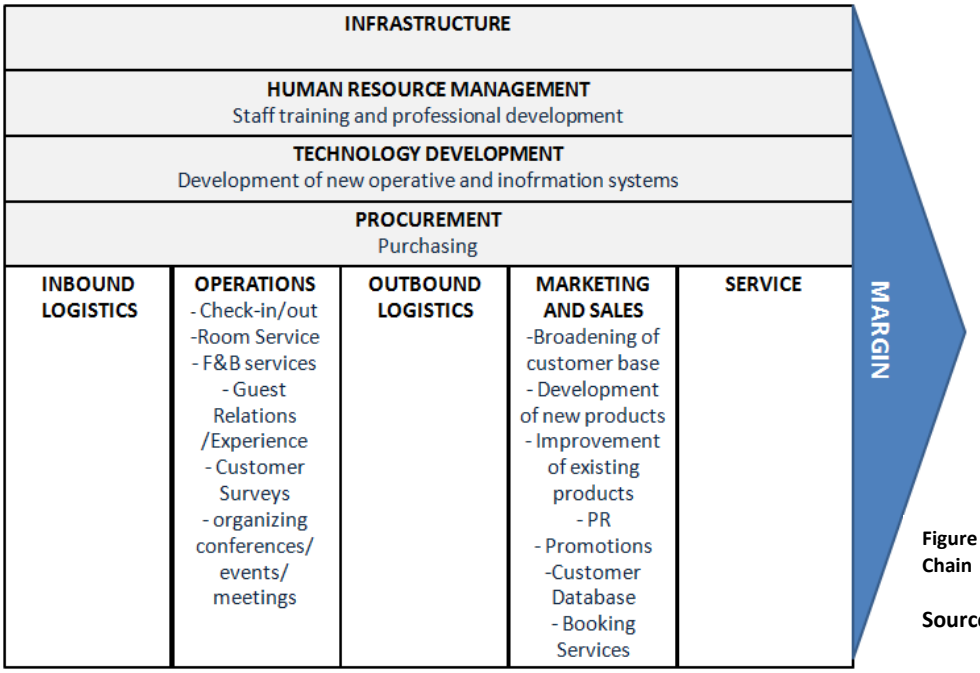


Figure 6: Hotel Industry Value Chain

Source: Own source

The process now is to make an inventory of the possible functionalities of IoT that can be applicable to each discrete activity showed in figure 5. With this in mind, the following table is developed.

GENERIC ACTIVITY	DISCRETE ACTIVITY	IoT´s FUNCIONALITIES
OPERATIONS	Check-in and Check-out	1) Automatic check-in/out 2) Smartphone as Room Key
	Customer Surveys	3) Service surveys. e.g.: surveys sent through the smartphone app allowing guests to rate a service provided by hotel staff 4) Overall Survey. e.g.: survey sent through the smartphone app allowing guest to rate their overall stay at the hotel
	Billing	5) Auto Billing. e.g.: all purchases at the hotel are added to a guest´s hotel bill through their smartphone 6) Bill Check e.g.: guests will be able to control their bill, during their entire stay, through the smartphone app
	F&B Services	7) Target Promotions. e.g.: sent to the smartphone app according to guest´s consumption history 8) Auto Tracking and ordering. e.g.: the barman is warned when a specific guest seats down on a sun bed by the pool and can ask them, through the smartphone app what they´d like to have 9) Auto Restaurant Reservations e.g.: allows guests to make reservations for a restaurant at the hotel through their smartphone and also choose the table they´d prefer
	"While-in-Room" services	10) Smart Mini-Bars e.g.: when a guest takes a coca-cola out of the mini-bar for more than a given amount of time, the cost is automatically billed to the guests hotel account. 11) Smart Rooms e.g.: possibility to trace a guest´s "while-in-room" profile. For instance, if a guest lowers the TV volume whenever they receive a call, from that moment on every time the guest receives a call the TV volume will be lowered automatically.

GENERIC ACTIVITY	DISCRETE ACTIVITY	IoT´s FUNCIONALITIES
OPERATIONS	Events/Conferences /Meetings	12) Event Alarm and Location e.g.: an alarm is sent to a speaker that doesn´t show up in the conference room, 10 minutes before the start of the event where he/she should start speaking 13) Group Tracking. e.g.: everyone in the group may have their location (at the hotel) available to other group members
	Guest Relations/Experience	14) Daily Activities Program e.g.: according to a guest´s profile, activities in the hotel or in its surroundings may be directed towards the guest´s smartphone app every morning when they leave the room 15) Social Network e.g.: Allowing guests to rate and talk about the hotel and its services, allowing other guests to know what to expect 16) Late Arrival services e.g.: if a guest´s flight is delayed and they arrive late at night, as soon as the guest lands the application will warn the Hotel so that a transfer can be provided and a meal prepared 17) Auto Last Minute Booking e.g.: if a guest is landing at Heathrow and didn´t book any hotel, they will be asked if they want to book a room with Hotel ABC as soon as they land in the airport

Table 1: Model of IoT´s Functionalities

Source: Own source

In what regards the previously depicted model, the following considerations are taken:

- No IoT functionality is proposed to a hotel´s value chain support activities (figure 6), mainly, because it is considered that primary activities have more potential in creating value for the guest;

- The activity "Promotions" is depicted in the value chain of figure 6 as a Marketing and Sales´ Generic Activity, however, in the model (depicted in table 1) ,"Promotions" is placed under the F&B Services´ discrete activity (Operations). This is done because with

the IoT, a hotel can provide Target Promotions directly to its clients, when before these promotions were only possible (and not in the same way) through guests´ data analysis from the Marketing Department;

- The remaining Marketing and Sales´ discrete activities (broadening of customer base, development of new products, improvement of existing products, PR and Customer Database) are not linked to any IoT functionality, but IoT still may have impact in those activities (e.g.: through the IoT´s functionality Overall-Surveys, it is possible for instance to improve existing products)

3.2.1 IoT´S FUNCTIONALITIES DESCRIPTION

The current section aims at providing an analysis of the impact of IoT in a hotel´s value chain. Hence, each IoT functionality, derived from table 1, is analyzed, focusing on the changes it brings to the value activity, to which it´s being applied.

- **IoT´s Impact in Check-in/out**

1 and 2) Auto Check-in and Smartphone-as-Room Key

The check-in is a very important activity, once it´s the first physical contact that guests have with the hotel. Hence, hotel companies allocate some efforts in developing new ways to enhance and innovate this activity.

The person responsible for processing the guests´ check-in is the receptionist, who must know everything about the hotel and its services. The goal of the check-in is to welcome the guests, ask for some data (e.g.: ID, passport, credit card, and so on), register them in the hotel´s property management system (PMS), to inform them about hotel´s services and answer all the questions they might have, and also to assign them a room and provide them a room key (usually a key card).

Depending on the type of guest (e.g.: leisure tourist, business tourist), and the type and category of the hotel, there are different forms of checking-in.

Business tourists, those for whom the main reason of the travel is for business purposes or conferences/meetings, want quick and easy check-in processes. A quick check-in is especially important when it concerns a big group attending a conference/meeting (e.g.: 200 people). In this kind of events guests arrive all at the same time, making it very hard for receptionists to perform the check-in for all the 200 people, translating, usually, in a long waiting time for check-in. Further on, the waiting time is not only inconvenient for the group, it is also inconvenient for

other guests (e.g.: leisure tourists) who are not in the group and have to wait for all those people to check-in.

Another problem during the check-in is the rooms´ availability. An available room is a room that is clean and free (without any guests on it). The information about the cleaning status of the room is provided by the housekeeping, and usually this information is inserted into the PMS whenever a housekeeper finishes cleaning the room (e.g.: by dialing a number in the room´s phone). Sometimes this doesn´t happen, because housekeepers forget to dial the number as they finish cleaning the room, which then translates into one less available room (virtually) when receptionists are checking the room availability through the PMS. With an IoT network this could be solved if housekeepers carried a sensor with them, because this way whenever a housekeeper closes the room door (which happens after the room is cleaned) the sensors in the room would automatically update the room´s status to "clean", in the PMS.

Another situation where a room is available physically but not virtually, happens when a receptionist doesn´t virtually check-out a guest from a room (virtual check-out is the act of inputting in the system that the guest has liquidated his bill and has therefore checked-out, meaning the room can then be cleaned).

Regardless the reason, the resulting outcome of a physically available room, being virtually unavailable is the following:

- bad service towards the guest, as it could take more time to assign a room to the guest;
- loss of revenue, which can happen when a receptionist is faced with a walk-in guest (a guest without a reservation looking for a room) and doesn´t sell any room because there isn´t any (virtually) available

An automatic check-in would solve these problems. As first, a guest would download the Hotel´s smartphone application, right upon booking their stay, then the guest could instantly input his/her data into the application (e.g.: the data that is asked for during the check-in). Then, when the guest is arriving at the hotel, as soon as they enter the hotel lobby, a message is sent to the guest´s smartphone, welcoming them and confirming the details of the reservation (e.g.: type of room and check-out date). Further on a room would also, automatically, be assigned to the guest, according to the guest´s preferences and also the room availability (which is possible because the hotel´s property management system can be connected to the IoT network).

After the check-in is done, instead of providing a Key Card to the guest, the smartphone will work as the guest´s room key during their entire stay. Key Cards are usually set up, to open a specific room, during the check-in, when a room is attributed to the guest, and as this process is manual, sometimes receptionists attribute the Key Card to the wrong room number, which translates in a guest coming down to the reception right after the check-in, already with a complaint. With the "Smartphone-as-Room Key" functionality, this would be avoided, because the assignment of the room would be automatic, considering the guest´s preferences and room availability. Then, to open the room, the guest only needs to approach the smartphone to the room door, which will, then, open automatically. This is also useful, since guests keep losing key cards very often.

- **IoT's Impact in Customer Surveys**

A survey, if well developed, is a useful tool for hotel companies, as it allows them to better understand their guests, their needs, and their perceptions about the service it was provided, towards them, during their stay. Which in turn gives hotel companies the opportunity to improve hotel products and services, and also to develop new ones.

Above all, surveys are important to help hotels to better understand their guests, their needs and what hotel areas need improvement, which is necessary to increase guest´s loyalty, and according to Marit et al. (1996), hotel managers have troubles in identifying which areas and services, in a hotel, are more valuable and important, or in need of development, for the guests. This happens because traditional surveys make it hard for hotel managers to know what factors guests value the most when evaluating their experience at a hotel (Marit et al., 1996).

3 and 4) Auto Service and Overall stay surveys

Guests´ surveys are usually meant to inquire about a guest´s overall stay. They are, usually, performed in paper and guests answer them by hand. In the hotel industry, surveys are, usually, conducted during the check-out, or placed in guests´ rooms in the day prior to check-out.

There are some problems, though, concerning guests filling surveys by hand, mostly because handmade surveys make it hard to process the data inside them, especially when regarding big hotels with high occupancy rates, which means high volumes of surveys to process every day. Another problem is the lack of accuracy on guests´ answers, due to the fact that surveys are conducted only on the last day of a guest´s stay, which causes answers to be based, mostly, on the guest´s last days at the hotel and not on their entire stay. There´s still another issue, mostly

regarding the fact that an "overall stay survey" inquires about guests´ satisfaction over their experience at the hotel, in general, disregarding all the services and experiences that happened during the entire stay, making it harder for hotel companies to understand, sometimes, why guests weren´t pleased with their stay, or why they were overwhelmed with the hotel.

With an IoT network and a smartphone application this problem may be avoided. First, guests can choose, through their smartphone app, whether they´d like to be inquired about services provided towards them throughout their stay, or they can choose not to be inquired every time they are provided with a service and simply volunteer to rate a service as they wish. Regardless the situation, due to the sensors spread throughout the hotel and the guests´ smartphones, guests may be tracked every time they are being provided with a service, at the hotel (e.g.: dinner at a hotel´s restaurant), and as the service ends, guests may be asked or ask to rate the service, through the smartphone app.

"Overall stay surveys" can be done differently also, as instead of providing these surveys during guests´ last day at the hotel and asking them to fill it by hand, the survey is sent to the guests´ smartphone, after the check-out.

The functionalities mentioned in the previous paragraphs make it possible for hotel companies to know more accurately and automatically why guests are happy or unhappy with the services being provided towards them. They make it also possible to know which services´ at the hotel are adding, or not, value to the guests´, allowing hotels to identify improvement opportunities, and gaps in customer service that need to be solved.

- **IoT´s Impact on Billing**

In hotels, usually, it´s during the check-in that the billing process begins. As a guest is checking-in, a bill/account is created, in the PMS, linked to the room number attributed to the guest, and during their stay, every time a guest from that room purchases a service at the hotel, they just have to provide their room number, so that the bill from that purchase may be added to their room account. The expenses are all paid during the check-out.

5) Auto-Billing

Some problems arise, regarding the billing process mentioned above, mainly because the guest, may make a mistake and provide the wrong room number. The aforementioned process also creates a need for guests to sign every bill (in paper format) as a way to confirm, upon check-out, what they have really paid, which means that there is an abundance of paper flowing

throughout the hotel and it also creates a sort of fatigue, from the guests´ side, as they have to sign and confirm their room every time they make a purchase.

An IoT network, through sensors spread all over the hotel, eliminates the need for guests to provide their room number and a signature in every purchase they make, throughout their stay. Which is possible because the smartphone identifies the guest and the room where they´re staying. Then, every time a guest is about to purchase something, such as a cocktail at the pool bar, the sensors in the pool bar can identify that guest and the respective room, and also identify which product has the guest acquired (due to sensors in the bottles), making it able to add that expense, automatically, to the guest´s hotel bill.

6) Bill Check

This functionality would allow guests to, constantly, check their expenses throughout their entire stay at the hotel. But more importantly it would allow more accurate target promotions. For instance, if a guest is staying in the hotel for a fortnight and in the first days of the stay, he/she consumes a drink in a hotel bar around 17h00, from then on, sensors can track the guest, and their consumption information, (through the smartphone) whenever they pass near an F&B venue (at the hotel) around 17h00 and invite them, through the smartphone app, to have a drink (in the nearby F&B venue) with a discount or an offer for another drink.

- **IoT´s Impact in F&B services**

The F&B (Food and Beverages) Department is the second big source of revenues at a hotel, right after the Rooms Division Department, mainly because guests spend a lot of time out of their rooms and a lot of that time can be spent inside hotel premises, such as near a pool, a lounge, or in conference room, which are places, designed, to be near an F&B Venue (e.g.: restaurants, bars, lounges, and so on).

7) Target Promotions

Promotions are a way for hotels to incentivize guests´ consumption, but also to increase loyalty and perceived value of the service. But it´s usually hard for hotels to provided promotions, tailored, for each guest, as well as it is hard to know when to provide a promotion. Usual promotions, used by hotels, work by delivering guests a coupon, upon check-in, with a discount for a dinner at one of the hotel´s restaurants.

Through an IoT network, more precisely due to the "Bill Check" and "Auto-Billing" functionalities described previously, it is possible to track guests, through the smartphone application, when

they´re sitting/walking around any F&B venue, and then, according to their consumption history, they can receive targeted promotions for that particular venue. For instance, if a given guest has been coming to the hotel for a couple of years, and already has, during the current stay, a significant amount of expenses in F&B venues, that guest can be offered a drink or a meal whenever they´re passing by a hotel restaurant/bar.

8) Auto Tracking and ordering

When guests arrive at an F&B venue (e.g.: a restaurant, a bar, the pool area with a pool bar, and so on) the first thing they want is to see the menu and then order. In big hotels, usually, the ordering process is very long, which translates into a bad service for the guest and maybe even in lost sales, because guests may get tired of waiting and leave.

Due to sensors spread throughout the hotel, it is possible to track a guest, through the smartphone, whenever they sit/walk around an F&B venue. After a guest is tracked in a given F&B venue, the menu for that venue can be automatically provided to the guest (through the smartphone application), or also a waiter can be sent to exact guest´s location to help him finish the order.

In the pool area, guests are usually sitting on their sun beds, and most of the times they don´t want to get up to go to the pool bar and ask for their orders. Therefore, sensors embedded in the sun beds can recognize a guest from the moment they sit down, through the smartphone application. Then the guest can make the order through the smartphone app, and after the order is done, a message can be sent to the pool-bar´s POS (point of sale) with the client´s order and indicating the location of the sun bed where the guest is sitting.

9) Auto Restaurant Reservations

This is a relevant functionality for regular/loyal guests, because when hotels are nearly overbooked, there is a certain difficulty to ensure a table at a particular restaurant for regular guests. Due to sensors spread around F&B venues it is possible to track a regular guest passing by a given restaurant, where the guest has had meals during previous stays at the hotel. It is also possible to know which table the guest had preferred previously.

As an example of the functionality´s properties, a scenario where the hotel has a 98% occupancy rate is considered. In this scenario, there is a regular guest (who has been coming to the hotel for a couple of years) passing by their favorite hotel restaurant. The sensors near that restaurant can detect the guest, through the smartphone, and also the guest´s history of eating at that

restaurant in previous stays. As the restaurant is nearly booked for the following days, the guest is asked, through the smartphone, if they want to make a reservation and also what table would they prefer.

- **While-in-Room services**

10) Smart Mini-bars

Mini-bars are an item present in hotel rooms with the goal of increasing convenience to the guests. If it weren´t for the mini-bars, guests would have to go to an F&B venue (at the hotel) every time they want a snack or a drink, which sometimes can be inconvenient for guests.

The billing process for products consumed from the mini-bars is, usually, done by hand. Basically there is a Room Service´s team responsible for checking, every day, all mini-bars. During a mini-bar check at a room, this team checks what was consumed, and if a product was consumed, its respective cost is then added to the guest´s hotel account. Sometimes, this can be an inaccurate billing procedure, as the F&B team responsible for checking the mini-bars may forget to add an expense or may add an expense to a guest´s account that didn´t occurred. The check-out day is the most problematic case, regarding mini-bar expenses, as guests may consume products from the mini-bar, during the night before check-out, and the F&B team, usually, only checks mini-bars during the morning. Which means that if guests don´t report those consumptions to the receptionists, upon check-out, the hotel won´t be able to charge them, after they leave the hotel, without guests´ authorization.

The deployment of sensors on the mini-bars allows the automatic addition of a product´s cost to a guest´s hotel account, for every time that a guest removes a product from the mini-bar (for more than a previously defined amount of time). The sensors can also detect when a mini-bar needs to be refilled, and communicate that information, automatically to the room-service´s team. This allows the hotel to keep constant tracking of what the guests are consuming, in real time, allowing responsible areas, like the F&B Department, to achieve a much better daily planning of stock needs and to provide a better service towards the guests.

11) Smart Rooms

Due to sensors spread throughout the room, it´s possible to build a "while-in-room profile". This profile can include, for every guest, their preferences/habits/patterns of behavior for when they´re staying in the room. For instance if a guest is watching TV and when the phone rings they turn the TV volume down, the sensors can acquire this information and associate it to that

guest (through the smartphone app), which means that every time the phone rings the TV volume can be lowered automatically.

The aforementioned example isn´t the only possibility, as there are other sensors throughout the room, allowing the room to learn, and forecast, the guests´ moves and reactions to changes in the room environment (as the one explained before). For instance, if a guest turns on the A/C every time they enter the room, this information can be acknowledged and from then on, when sensors throughout the hotel detect the guest coming up to the room, these sensors can communicate with the sensors in the room, which in turn can activate the A/C.

This functionality, can also allow for housekeepers to be warned, automatically, whenever a guest leaves a room, in the morning, which is a sign that the room can be cleaned.

From then on, this "while-in-room profile" can be stored for future stays at the hotel, even if it is at a different room, because this information is communicated between the whole network at the hotel, and will always be attached to that specific guest, because of the unique identification that the smartphone app provided to that guest.

- **Events/Conferences/Meetings**

Events vary on size, depending on the hotel structure, but are usually attended by big groups, and are, mainly, organized by companies and in 2010, alone, there were more than 5000 meetings in hotels worldwide, according to ICCA (International Congress and Convention Association). They usually consist on corporate man and women who travel with the purpose of attending a business event, related to their company (e.g.: Siemens annual meeting) or their field (e.g.: a journalist attending the lunch of a new BMW model).

The most important trend is that these Tourists are getting more technological. According to MPI´s Future Watch 2011 Survey, 80% of business tourist use smartphones in their jobs. Further on, they also pointed out that these Tourists will be looking for hotels that provide them with apps that enhance their experience, like real time distribution of conference information and “social networking” capabilities between the members of the event.

12 and 13) "Event Alarm and Location" and "Group Tracking"

Usually, companies and other meeting organizers, make someone (from the organizing entity) responsible for coordinating the meeting, and when meetings are big, the coordination of the group might be something hard to coordinate.

The "Event Alarm and Location" functionality aims at helping the coordination of speakers and attendants during the meeting. Due to sensors spread towards the hotel and conference rooms it is possible to track a speaker (through the smartphone), in the hotel, and warn them when their turn to speak is close, so the speaker can get to the right conference room on time. The same applies for attendants, who can be tracked by hotel sensors and be warned (through the smartphone) whenever a meeting is about to start, and also informed about the conference room where they´re supposed to be, because sometimes during the same meeting, elements from the same company attend different conferences at different conference rooms.

In meetings, usually, participants do a lot of activities together, ranging from meals to networking activities outside the hotel, which means that if a meeting has 400 participants, these 400 participants need to be coordinated at the same time and in a proper manner to follow the event´s schedule. The "Group Tracking" functionality would make it possible to track everyone attending a given meeting, at the hotel, allowing meeting coordinators to organize every activity in a smoother way, and also for participants to locate their colleagues.

- **Guest Relations/Experience**

The Guest Relations´ Department main goal is to ensure the best experience and service towards guests, during their entire stay at the hotel, in order to increase their satisfaction, because a satisfied guest is very likely to become a loyal guest (Fornell, 1992; Halstead & Page, 1992, cited in Marit et al., 1996) and loyal guests are a way to increase, proportionally, a hotel´s profitability (Marit et al., 1996) and also to increase sales to new customers due to word-of-mouth referrals (Reichheld & Sasser, 1990 cited in Marit et al., 1996).

14) Daily Activities Program

One of the functions performed by the Guest Relations team is to let the guests know about every activity that is going to happen, in the hotel and its surroundings, and that may be of guests´ interest. Which may be complicated as in order to reach every single guest and their particular interests in a daily basis would imply that each member from Guest Relations knows every guest and its interests.

The "Daily Activities Program" functionality aims at addressing each guest individually with a tailored offering. First, as guests download the smartphone app, they can input some information about their activities´ preferences (e.g.: what kind of events, what kind of music bands, what kind of sports, what kind of thematic cuisines, and so on). Then, upon a guest´s

check-in, sensors spread throughout the hotel can download that information into the network and the PMS. This way, every time a guest gets out of the room, in the morning, sensors in the room hallway can detect the guest leaving the room, through the smartphone, and send a tailored activities program to the guest´s smartphone. This list would entail only activities, happening at the hotel, that are interesting to the guest, based on their preferences.

15) Social Network

The "Social Network" functionality aims at providing a platform where not only guests can communicate between themselves, but also things/spaces, in the hotel, can communicate with guests, in order to increase each guest´s experience at the hotel. Therefore this functionality can be split into two features which are: Guests´ Updating and Things´ Updating.

Due to sensors spread, throughout the hotel, in things/spaces like the snooker tables, the pool, the pool´s sun beds, the public computers, and so on, it is possible for guests to receive updates, through the smartphone, about these things´ status (Things´ Updating feature). For instance, the functionality may allow the guests to know when the pool reaches a certain temperature, or to constantly check its temperature. Further on, if a guest is arriving the pool area and is looking for sun beds, sensors in sun beds can detect which sun beds are free and inform the guest about the location of a free sun bed, through the smartphone. Also, if a guest is in the bar and is waiting for the computers or the snooker tables to be free, the guest doesn´t have to be constantly checking their availability as once they are free, sensors can detect that information and update it in a kind of news feed wall.

The Guests´ Updating feature aims at enhancing each guest´s stay through other guest´s experiences. First, upon check-in, guests can choose whether they´d like to take part on the "Social Network" functionality during their stay or not (this question is asked through the smartphone), if their answer is positive they can still choose if they want their identity to be revealed or maintained anonymous. Then, throughout their stay, guests can have all sort of experiences at the hotel, as they can go to a Greek Theme Night at one of the hotel´s restaurants, they can try out one of the new dishes at another hotel restaurant, they can attend a standup comedy show at the hotel, and so on. As guests go through these activities they can rate how satisfied or not they were with them, through the "Auto Service Survey" functionality mentioned previously, and if they do rate those activities they can then choose if they want to post their ratings and comments to the network. As sensors detect that information in the system, they can track other guests who might be walking near the place where the rated

activities happened and provide those ratings and comments to those guests or just warn them about the rating update, through their smartphones.

16) Late Arrival services

Hotels usually have specific check-in and check-out hours, and as guests travel through different transportation means the arrival times at the hotel aren´t always as planned.

The "Late Arrival Services" functionality aims at providing a good service for those guests whose flight is delayed and arrive very late at the local airport. If a guest is arriving at the airport after midnight, because their flight has delayed, not only is already passed a hotel´s check-in time as hotel´s restaurants may be closed. Therefore, as the guest turns their Smartphone on, the smartphone app may detect that the guest is at the airport and provide the guest an option to call a transfer to the hotel, if the guest opts to do it, a message is sent directly to the reception, where a receptionist can see it and then request a transfer for that guest. In the meanwhile this information is also sent to the hotel´s IoT network and, as the hotel restaurants are closed, a menu from the Room Service is sent to the guest´s smartphone, who can then choose what they´d like to have, ready, when the guest enters the room. After the guest chooses a meal, this information is sent directly to the Room Service´s team, who can then start preparing the meal and place it in the guest´s room, right after the guest enters the hotel.

17) Auto Last Minute Booking

Some people may have some needs for a last minute travel, or for some reason are traveling but have forgotten to book a hotel room. Therefore the "Auto Last Minute Booking" aims at addressing this people's needs.

So as to illustrate how this functionality works, it is considered a scenario where a guest, who has downloaded Hotel ABC´s smartphone application (either because it has stayed at hotel ABC before or for other reason), is arriving at a local airport and didn´t book any hotel room. As soon as the guest lands and turns the smartphone on, the smartphone application may detect that the guest doesn´t have any reservation with Hotel ABC and consequently send that information to be acquired by the Hotel´s IoT network, and if there is room availability (this information is available due to the connection between the network and the PMS) a message is sent to the guest, through the smartphone app, asking whether or not they´d like to book a room, if the guest opts to do it, this information is automatically sent to the hotel network and, if needed, sensors in the hotel can warn the Housekeeping team to clean a room for that guest.

The current chapter starts by proposing a model to build an IoT at a hotel, where it is also suggested that a smartphone application is developed, mainly due to the high number of tourists who have a smartphone. Then a Value Chain, based on the analysis conducted in section 2.2 (state of art) for the hotel industry is presented (figure 6), and a model (table 1) is developed where an IoT functionality is proposed and linked to each value activity of the value chain in figure 6. Further on, the conducted analysis of each IoT functionality from the model (table 1) enables a better understanding of how the IoT might impact a hotel´s value chain.

Next chapter, focuses on the development of a survey that has the goal of ascertaining if IoT is valuable for potential guests or not.

IV SURVEY ANALYSIS

Until now, in the previous chapters, a Value Chain for the hotel industry has been presented, a model was developed where a set of IoT´s functionalities where proposed, and each IoT functionality has, then, been linked to a value activity (in the value chain) in order to understand its impact in that Value Chain activity. However, it is also necessary, to understand how the market sees and values a hotel, that could provide the IoT´s functionalities, previously mentioned in the model of table 1. Because if guests don´t see value (one of the VRIN attributes) in the services that may be provided through these functionalities, then IoT won´t have potential to provide a Hotel with a sustainable competitive advantage. Thus, a survey - based on the model represented in table 1 and the proposed model for building an IoT network - is developed.

4.1 PROPOSED MODEL FOR BUILDING THE SURVEY

The model proposed to build the survey is based on three hypothesis, which are related with 1) the assumption regarding the development of a smartphone application, 2) identification of the IoT´s functionalities, from the ones proposed, that people would like to see at a hotel, and 3) with the need to ascertaining if IoT provides hotels with potential to create value for guests. Hence, the three hypothesis, under which the survey questions are developed, are the following:

H1) It is relevant to develop a smartphone application;

H2) There are IoT´s functionalities highly valuable for the guests;

H3) IoT influences guest loyalty.

Once the major goals of the survey had been identified, it is now possible to develop the questions, in detail, to be presented in the survey.

Regarding H1, the question made is:

- **"Do you have a Smartphone?",** is the first question of the survey. This question is necessary due to the proposed model for building an IoT network at a hotel, presented at the beginning of the chapter, where it has been suggested that a Smartphone application could act as the intermediary that could connect the guest to the hotel, and through which all IoT´s functionalities could be provided. The smartphone application has been proposed because the number of tourists who use smartphones is already very significant

(leisure tourists have on average 2.7 web-enabled devices, and business tourists value hotels who can provide them with apps that can enhance their experience), and the aim of this question is to provide an a close estimate on the number of people who have a smartphone. If the average number is significant, it sustains the assumption (and the hypothesis) that a smartphone application should be developed. In order to ascertain that, the question is presented to the respondents as a simple "yes" or "no" question, as this are the only two options of answering.

Further on, in order to validate H2, the question to be asked is:

- **"Rate each functionality according to the value it would bring in enhancing your stay",** this question encompasses all the functionalities proposed in the model of table 1, and aims at providing an understanding of which are the most attractive IoT´s functionalities for guests. In order to analyze that, all IoT´s functionalities, proposed in the model of table 1, are presented to the respondents, each with at least one practical example. To each functionality, respondents are asked to provide a rating from 1 (it wouldn´t enhance a guest´s stay at all) to 6 (it would definitely enhance a guest´s stay).

Moreover, so as to validate H3, two questions are developed, as follows:

- **"In an hypothetical scenario, where you have two similar 5* Hotels, located next to each other, which one would you choose?"**, the goal of this question is to have a better understanding of what is the extent to which IoT allows a hotel to practice a higher price than its competitors, by providing them the proposed IoT´s functionalities. In order to understand that, respondents faced with a scenario where they have to choose between two identical hotels: 1) Hotel A, with a room rate of 130€ per night, and 2) Hotel B, with a room rate of 140€ per night but with all the IoT´s functionalities proposed in the model of table 1.

- **"Would a Hotel that provides you with such IoT´s functionalities increase the likelihood of you coming back to the Hotel?"**, the goal of this question is to provide a better understanding of what is the extent to which the IoT´s functionalities, proposed in the model of table 1, can influence a hotel´s guest loyalty. Here respondents have to consider the functionalities they rated in question 2 and answer the question according to a scale from 1 (IoT wouldn´t make any difference) to 6 (I would come back for sure due to the IoT functionalities).

In addition, some demographic answers aiming to provide consistency to the survey, are also asked to respondents, as follows:

- **"What is your gender?",** this question provides respondents with two answering choices, from which they have to choose one: 1) Male, and 2) Female.
- **"What is your age?",** here respondents are able to provide information about their age, through the following options: 1) under 18, 2) 18-24, 3) 25-30, 4) 31-40, and 5) over 40.
- **"What is your nationality?",** in this question respondents are asked to provide their nationality, in an open text box.

Once, the questions that make part of the survey have been developed, next section presents the Survey´s results.

This survey allows, through a sample of potential guests, the better understanding of the potential of IoT to create value for hotels that implement it. Further on, it also provides information about IoT´s value, which is the first attribute a resource must possess in order to become a potential source of sustainable competitive advantage.

4.2 SURVEY´S SAMPLE REPRESENTATION

This section´s goal is to characterize the sample of people who answered the survey. Thus the focus is on presenting some demographic data about the respondents who took the survey.

First, the survey is developed in the Google Docs platform, and conducted to 418 people, using the Facebook and the Amazon Mechanical Turk, as means to distribute the survey link.

From the 418 respondents

- 56.9% of the respondents are males, and 43.1% are females.
- 70% of respondents have ages between 18 and 30 years old (41% between 18-24, and 30% between 25-30) and also that 27% are over 31 years old.
- 73% of them are from India (32%), Portugal (17.9%) and USA (23.4%), and in total there were 44 nationalities represented.

From the data provided above it is possible to say that the the sample is quite relevant: 1) the size of the sample is significant, 2) amongst the 44 represented nationalities there are three that are more significant which are India (due to its size, it is an important market for most of businesses), USA (Headquarters to some of the biggest hotel chains in the world like Marriott,

Starwood, Ritz Carlton and Accor), and Portugal (country where this dissertation is being developed), 3) 27% of respondents are over 25 years old (which represents the type of people that already have an income).

Once, the sample has already been represented, an analysis to the respondents´ answers, is presented in the following section.

4.3 SURVEY´S RESULTS - EMPIRICAL PROOF OF IoT's VALUE-CREATION POTENTIAL

The following are the results obtained from the 418 respondents who answered the survey:

Q1) Do you have a Smartphone?

From the 418 respondents, 310 said they have a smartphone, which represents more than 70% of the sample. This number is considered very high, which is why it strengthens the argument of developing a smartphone app, especially since it has been seen, in the beginning of the chapter, that the usage of smartphones will increase exponentially in the following years (appendix 3).
This high number of respondents who have a smartphone, is also in accordance with the data (in section 3.1) showing that, on average, leisure tourists carry with them 2.3 web-enables devices (like smartphones).

Q2) Rate each functionality according to the value it would bring in enhancing your stay

In this answer, it is assumed that a functionality with an average score of over 4.5, is attractive, because this represents a value of over 75% in the 1 to 6 scale used, thus it requires that respondents see significant value in an IoT functionality in order to score it over 4 points. this question enables, this way, the identification of the most attractive functionalities, which are: target promotions (4.51 points), the social network, auto last-minute booking and auto check-in (all with 4.52 points), daily activities program (4.53 points), auto restaurant reservations (4.55 points), auto billing (4.60 points), smartphone=room key (4.71 points), late arrival services (5.0 points) and bill-check (5.07 points).

The aforementioned functionalities are the ones to be analyzed, in order to find out if a hotel can use them to develop a resource that might lead to a sustainable competitive advantage.

Q3) In an hypothetical scenario, where you have two similar 5* Hotels, located next to each other, which one would you chose?

Here respondents were faced with a scenario where they had to choose between two identical 5* hotels, being that one of those hotel provides the IoT´s functionalities rated in the previous question, and other doesn´t.

From the 418 respondents, 298 (more than 70%) chose Hotel B, which shows that they would pay 10€ more for a hotel that could provide those IoT´s functionalities. Hence, it is very likely, that a hotel can practice higher prices (than its similar competitors) due to the IoT, and guests are willing to pay that higher price.

Q4) Would a Hotel that provides you with such services increase the likelihood of you coming back to the Hotel?

Here respondents had to consider the IoT´s functionalities they rated in question 2, and rate, through a scale of 1 to 6, the likelihood of them coming back to a hotel that could provide them such IoT´s functionalities.

The average of the responses was 4.67 points, which means that on average there is a probability of near 75% of a guest coming back to a hotel that provided the previously mentioned IoT´s functionalities. It is also important to mention that 64% of the respondents answered with 5 (34.7%) and 6 (29.7%), which may be a sign that guests´ loyalty towards a hotel with IoT, will increase significantly.

Further on, all the tables and graphics used to analyze the survey results, are provided in Appendix 4.

4.4 SURVEY´S DISCUSSION

Since it has been referred, both in the State of Art and at the beginning of the current chapter, IoT is still an emerging technology, especially regarding its use in the hotel industry, which is why the proposition of a model for implementing an IoT network at hotel, has been developed through an assumption, at the beginning of this chapter (on section 3.1).

Further on, a model has been developed, proposing, for each Hotel´s Value Activity, an IoT functionality, in order to come up with a combination of IoT´s functionalities that may have an impact on a hotel´s value chain, and, thus, on a hotel´s value creation process. The developed survey, hence, aims at providing quantitative data, from the respondents, in order to sustain some of the assumptions made about the IoT (namely the development of a smartphone application), but above all it provides helpful insights to validate the hypothesis under which the

survey is developed. The validation of these hypothesis is important to answer two of the research questions (needed to answer the main research problem) this dissertation faces:

RQ1. Is there any impact of the IoT in a hotel´s value chain?

RQ2. Which IoT functionalities do customers value the most?

The first hypothesis needing validation is **H1) It is relevant to develop a smartphone application,** because if this hypothesis isn´t confirmed, then it is not possible to develop the proposed IoT network and IoT´s functionalities, by other words the remaining hypothesis won´t also be confirmed. Trough the survey, it is ascertained that over 70% of the respondents have a smartphone (which is in accordance with the data, relative to the use of smartphones by tourists, provided in section 3.1), thus it is possible to consider that it is relevant to develop a smartphone application.

Regarding RQ1, it is relevant to validate **H3) IoT influences guest loyalty**, because if IoT does influence guest loyalty it may indicate that IoT has an impact in a hotel´s Value Chain (RQ1).Before validating H3, it is important to mention that it is possible to link to each value activity (figure 6) an IoT functionality - which per se means that IoT has potential to impact a hotel´s value chain -, and in order to prove that, the model represented in table 1, provides a set of sixteen IoT´s functionalities, each linked to a value activity.

Then, in order to understand if the IoT´s functionalities (table 1) have, really, impact in a hotel´s value chain - in other words, if IoT creates value - it is necessary that the market sees value in a hotel that may provide such IoT´s functionalities. Taking this is mind, in the survey, respondents are asked, through two questions, if the referred IoT´s functionalities have any impact on their loyalty towards an hotel that provides them that.

The first question, needed to validate H3) is **"In an hypothetical scenario, where you have two similar 5* Hotels, located next to each other, which one would you choose?"**, which shows that 71.3% of respondents, when faced with two identical five star hotels, are willing to pay 10€ more for the hotel that provides them the referred IoT´s functionalities. From this result, it is ascertained that IoT may allow a hotel to increase its average room rates. As an example, in the considered scenario (if Hotel B had 100 rooms and considering room revenues only) hotel B could earn an extra 36500€ per year.

The second question is **"Would a Hotel that provides you with such services increase the likelihood of you coming back to the Hotel?"**, which presents an average of 4.67 points,

showing that the probability of a guest coming back to a hotel with IoT, is over 75%, which indicates a high degree of loyalty.

Further on, when looking only at the people who chose Hotel B, the likelihood of them coming back to the hotel is 85% (average of 5.11 points). So, not only more than 70% of the 418 respondents would pay 10€ more for a hotel with IoT, but also, there is a probability of 85% of those guests coming back to the hotel again. Thus, H1 is validated, meaning that IoT has potential to impact guests´ loyalty, because it creates value, and, thus, it has impact on a hotel´s value chain.

Regarding RQ2, it is through **H2) There are IoT´s functionalities highly valuable for the guests**, that it can be answered. In order to do that, it is assumed that every IoT functionality with an average score over 4.5 points, is considered highly attractive, hence it is ascertained what IoT´s functionalities, potential guests, value the most and like to see at a hotel, which are: 1) target promotions 2) the social network, 3) auto last-minute booking, 4) auto check-in, 5) daily activities program, 6) auto restaurant reservations, 7) auto billing, 8) smartphone=room key, 9) late arrival services, and 10) bill-check. Thus, with the aforementioned results, the second research question is answered and the H2 is confirmed.

From the aforementioned IoT´s functionalities, it is also possible to ascertain that potential guests are looking mostly for enhancements in Guest Relations activities (refer to model in table 1), mainly because all the IoT´s functionalities proposed to this value activity (social network, daily activities program, auto last-minute booking and late arrival services) have been highly rated by the respondents. Another statement that can be done, is that guests are looking for easier ways to pay for services at a hotel, once the IoT´s functionalities related with Billing Activities (Bill-check and auto billing) have also been highly rated by respondents.

In summary, the survey has been developed and conducted to 418 people, which enabled the validation of the three proposed hypothesis: H1) It is relevant to develop a smartphone application, H2) There are IoT´s functionalities highly valuable for the guests, and H3) IoT influences guest loyalty.

With the validation of the aforementioned hypothesis, it was possible to ascertain that IoT has potential impact a hotel´s value chain, by creating value to guests (increasing customer loyalty), and also what are the most valuable IoT´s functionalities for guests, this way answering RQ1 and RQ2, respectively.

Hence, next chapter analyzes how a hotel can create value through those IoT´s functionalities, and if that value creation can be sustained, thus, leading to a sustainable competitive advantage, which is the research problem this dissertation tries to answer.

V - IoT´s POTENTIAL TO GENERATE A SUSTAINABLE COMPETITIVE ADVANTAGE

This chapter´s main goal is to discuss the potential that IoT may have, in enabling a hotel to build a sustainable competitive advantage. Therefore, the most attractive IoT´s functionalities, derived from the previously explained survey, are analyzed, in further depth than they were in section 3.2. This analysis focuses mostly on the ability of a hotel being able to use the referred IoT´s functionalities, to develop a resource that might lead to a sustainable competitive advantage. After the resource has been identified, the RBV framework is applied, in order to verify if the resource encompasses the VRIN attributes, that a resource must possess in order to have potential to become a source of sustainable competitive advantage.

5.1 STRATEGIC ANALYSIS OF THE MOST ATTRACTIVE IoT´s FUNCTIONALITIES

From the seventeen proposed IoT´s functionalities (refer to model depicted in table 1), the most attractive ones, according to the 418 survey respondents, were only ten (with an average score of over 4.5 points). An analysis is, then, conducted, in the following paragraphs, with the goal of ascertaining what kind of strategic resources can a hotel develop through those IoT´s functionalities.

Due to insights from the RBV section in the State of Art chapter, the analysis focuses mainly on the propensity those IoT´s functionalities may have in developing two resources: 1) Customer Service, and 2) Tacit Knowledge, because these resources are pointed out to have high strategic potential, especially in the hotel industry, a very knowledge intensive industry where knowing the guest is the most important resource a hotel might have.

IOT FUNCTIONALITY	RESOURCE
Target Promotions	Tacit Knowledge and Customer Service
Social Network	Tacit Knowledge and Customer Service
Auto Last-Minute Booking	Customer Service
Auto Check-in	Customer Service
Daily Activities Program	Tacit Knowledge and Customer Service
Auto Restaurant Reservations	Customer Service
Auto Billing	Tacit Knowledge and Customer Service
Smartphone = Room Key	Customer Service
Late Arrival Services	Customer Service
Bill Check	Tacit Knowledge and Customer Service

Table 2: What resources can be developed through each IoT functionality

Source: Own source

Table 2 (depicted above) represents the resources that may be developed through each IoT functionality. Regarding the tacit knowledge, it is considered that the IoT´s functionalities with potential to develop it, are : 1) target promotions, 2) social network, 3)daily activities program, 4) auto billing, and 5) bill check. These IoT´s functionalities, are also considered to have potential to increase/develop high quality customer service, because by having this kind of knowledge about guests, a hotel can provide the latter with a high quality service. Moreover, these five IoT´s functionalities are highly related between each other, and its propensity to develop tacit knowledge about guests, depends on the interaction between them, which explained in the following paragraphs.

Usually it is hard for a hotel to "know" every single guest, and to better understand this statement, the following scenario is considered: a hotel room has four guests, and each of those guests may make different purchases at the hotel´s F&B venues, and participate in different hotel activities, but since the only way for those guests to enjoy those services is to provide their room number, it is very hard for a hotel to know what has been consumed by each of those guests, what are their preferences, and in which activities they had participated in. The hotel

can only associate consuming patterns, tastes, and so on, to all the guests from a given room, and not to every single guest from a given room.

Due to the IoT network and smartphone app, each guest may have their own single identity in the hotel. Further on, through the Auto-billing functionality, it is possible to have access to the consuming patterns of every single guest in the hotel, because every time a guest purchases something (e.g.: a cocktail), in an F&B Venue, they only have to carry their smartphone with them, as the expense is automatically billed to their room account, but indicating which guest from that room has made that consumption. Additionally, the Bill-check functionality enables guests to check their individual hotel bills (and also the total bill of the room to which they are associated), which is possible due to the Auto-Billing functionality that registers every guest´s purchase. Moreover, sensors spread through the hotel, can also detect every guest´s behavioral patterns, tastes, and routines. In this view, a hotel can develop activities that better address their guests´ needs, and promote them - in a tailored fashion - to every single guest, through the Daily Activities Program functionality. And also, they can do it in a way that wouldn´t be possible without the tacit knowledge, gathered through the aforementioned IoT´s functionalities, about every guest.

Additionally, the tacit knowledge generated by the, previously referred IoT´s functionalities, enables the hotel to provide guests, through the Target Promotion´s functionality, with promotions tailored not only to their tastes, but also to match their needs at a given time, or in a given situation. Which is possible due to the tacit knowledge created through the gathering of information, conducted by the IoT sensors, about guest´s patterns, actions, and procedures, enhancing, this way, a guest´s purchasing probability.

Further on, the Social Network functionality, allows guests to have access to the status of hotel´s objects/spaces (e.g.: pool table availability, pool´s temperature, and so on), and to comment on the quality of the services being provided to them during their stay, this way providing a platform for guests to get in contact with other guests and with the hotel itself, but above all it is a way for the hotel to unlock some of the guest´s tacit knowledge (in section 2.3.3 it is referred that tacit knowledge is more easily unlocked through social activities/means). This is a way for a hotel to understand and get to know their guests in an unprecedented way, which is an important opportunity to develop new and tailored services that could better match guests´ needs.

From the analysis of the IoT´s functionalities, mentioned in the previous paragraphs, it is, then, possible to see that they may have potential for developing tacit knowledge because 1) they enable a hotel to know each single guest´s needs and behavioral patterns, 2) the IoT network allows the gathering of tacit information about each guest, and 3) they provide a potential way to unlock that guest´s specific tacit knowledge through the Social Network functionality.

In what concerns the resource "Customer Service", it is considered that, the remaining five functionalities from table 2, have potential to enable a hotel to provide their guests with a high quality customer service, and they are: 1) Auto Last-Minute Booking, 2) Auto Check-in, 3) Auto Restaurant Reservations, 4) Smartphone = Room Key, and 5) Late Arrival Services. The analysis performed in section 3.2.1, provides the arguments that explain why it is considered that the aforementioned IoT´s functionalities, have a high impact in enhancing Customer Service. In summary, these functionalities enhance the Value Activities, to which they are related, and solve problems related with the way those Value Activities are traditionally performed, thus, allowing hotels to enhance the value creation towards its guests.

Through the analysis conducted in the previous paragraphs, it is considered that the most attractive IoT´s functionalities (depicted in table 2) may have potential to help hotels developing two resources: 1) High Quality Customer Service, and 2) Guest´s Tacit Knowledge. Next step is to apply the RBV framework in order to understand if both, or which, of these resources may have potential to help a hotel building a sustainable competitive advantage.

5.2 APPLICATION OF THE RBV MODEL

As illustrated in the State of Art chapter, the RBV model considers that firm´s resources and capabilities are potential sources of sustainable competitive advantage. In this view, the RBV assumes that resources and capabilities, are heterogeneously distributed across firms, and those resources and capabilities may not be perfectly mobile across firms, which means heterogeneity may be sustainable. Further on, not all firm´s resources and capabilities have potential to help firm´s developing a sustainable competitive advantage, in order for that to happen a resource must: 1) have value, 2) be rare, 3) be imperfectly imitable, and 4) be non-substitutable, the so called VRIN attributes.

From, the analysis conducted in the previous section, to the most attractive IoT´s functionalities, it is considered that those functionalities have potential to help hotels in the development of two resources: 1) High Quality Customer Service, and 2) Guest´s Tacit Knowledge. Thus, the aim of this section, is to analyze if both, or which of, those resources encompasses the four VRIN

attributes, needed for a resource to have potential to develop a sustainable competitive advantage. After the VRIN analysis is conducted, an answer to another research question proposed in the Introduction chapter, is provided:

- **Does IoT have the potential to help hotel companies´ in the development of a sustainable competitive advantage?**

The VRIN analysis is performed in the following paragraphs, conducted over the two resources mentioned previously.

5.2.1 VALUE

The first attribute a resource must encompass in order to have potential of becoming a source of sustainable competitive advantage is "Value". A valuable resource allows a firm to exploit market opportunities and/or to neutralize threats, this way, enabling a firm to develop value creating strategies for its customers. In this sense, it is ascertained that:

- Both **High Quality Customer Service (HQCS)** and **Guest´s Tacit Knowledge (GTC),** explore a big opportunity, mentioned in the Introduction chapter, which is that Hotels are not using I.T strategically, meaning that there is a differentiation opportunity for a hotel that manages to do it. The IoT´s functionalities, proposed to develop the referred resources, can provide that, as by exploring them, a hotel can develop resources such as High Quality Customer Service and Guest´s Tacit Knowledge, that in turn may provide hotels with ways to develop value creating strategies, that may enhance customer loyalty.

- Moreover, the value of a resource depends, highly, on how valuable customers see that resource or the strategy that a firm develops through that resource. In this case, the survey conducted to 418 respondents, asked people questions that are somehow related with the resources **High Quality Customer Service** and **Guest´s Tacit Knowledge**, and the value creating strategies that a hotel can build through these resources. For instance, there is a question in the survey, where respondents are faced between two identical 5* hotels next to each other, except one of them offers the IoT´s functionalities (and the services associated to them that increase the quality of the service towards the guest) for 10€ more than the other hotel (who doesn´t). 71% of the respondents said they would pay 10€ more for the hotel who could provide them those services. Further on, the average score of 4.67 points (in the question regarding the likelihood of a respondent coming back to a hotel that could provide those services through the IoT´s functionalities) shows that the IoT has potential to help hotels increase guest loyalty. These questions

don´t make reference, explicitly, to the resources being analyzed (HQCS and GTC), or the value creating strategies that may be associated to them, but both resources are implicitly used in the questions. For instance, when respondents are asked about the value they see in each IoT functionality, they are provided with examples, explaining each functionality individually, but all the functionalities are interconnected, some more than other, and it is this interconnection that allows the creation of Tacit Knowledge and the provision of a better Customer Service- an example is that when respondents are asked to rate the target promotions (which enhances the service towards them) they don´t realize that this IoT functionality is enhanced by the Auto-Bill functionality.

The aforementioned reasons, indicate, that both **High Quality Customer Service** and **Guest´s Tacit Knowledge,** are Valuable resources for a hotel, as they 1) explore the opportunity of hotels neglecting the strategic potential of technology, and 2) the responses from the 418 respondents may indicate, to some extent, that the market sees value in a hotel that may develop these resources (through the means of IoT), showing that a hotel may earn higher revenues, not just by increasing prices but also by increasing customer loyalty, which leads to increased occupancy rates and revenue per available customer.

5.2.2 RARENESS

It is mentioned in the RBV section of the State of Art that when a firm can develop and implement a value creating strategy that no other firm in the market can, that firm is developing a competitive advantage. The reason why other competing firms can´t develop and implement the same value creating strategy, is because those firms don´t have access to the resource, under which the first firm is developing and implementing the value creating strategy. Then, that resource is considered to be Rare. By other words, a resource is Rare when it is possessed by only one firm, or if the number of firms with access to it, isn´t enough to form a perfect competition market.

In order to understand how rare the HQCS and GTK resources might be, it is important to consider the following:

- A hotel is able to develop the resources **High Quality Customer Service** and **Guest´s Tacit Knowledge,** through the IoT technology (more exactly through the interaction between the proposed IoT´s functionalities), which is also a resource,
- Through the conducted research, it is only possible to point out two more hotels that are using IoT (Moskvitch, 2011 and The Hammersmith group, 2010), so far: 1) the Hotel

1000 in Seattle (providing only energy control functionalities and the Smart Mini Bars functionality proposed in Table 1´s model), and 2) the Peninsula Tokyo Hotel (which provides only the Smart Rooms functionality).

With the considerations made in the aforementioned paragraph, it is possible to say that the use of IoT (which enables the development of the HQCS and GTK resources) in the Hotel Industry, is rare, because there are mainly 2 hotels that are using the technology, at the moment, and they are not providing all the IoT´s functionalities proposed in this dissertation. But a technology per se, although it may generate value, it can´t be rare in the long term, as every hotel may have access to it - it is a mobile resource and thus, by itself, it can´t lead to a sustainable competitive advantage - however, the way IoT is explored, can lead to the development of rare resources.

Regarding, now, the High Quality Guest Service (resource), in more detail, since IoT is a rare technology in the industry, IoT can be considered as a Rare resource. Mainly because the resource (composed by the IoT´s functionalities mentioned in Table 2) enables a hotel to provide services to their guests, that currently no other competitor can (even the 2 hotels regarded previously), due to the proposed IoT´s functionalities.

Further on, the resource Guest´s Tacit Knowledge, is also considered to be rare. The rareness of this resource is related to its basic nature, because, as explained in the State of Art chapter, tacit knowledge is a type of knowledge that is hard to put into words, and therefore making it hard to transfer across firms. Which means that the tacit knowledge a hotel may develop, due to the IoT, about, let´s say, Guest A, is not found anywhere else, therefore Guest´s Tacit Knowledge is a rare resource.

It is then concluded that both **High Quality Customer Service** and **Guest´s Tacit Knowledge** are both rare resources. As ascertained in section 2.3.2, when a firm develops and implements a value creating strategy based in a Valuable and Rare resource, it may develop a competitive advantage. The goal now is to analyze if these resources are also Imperfectly Imitable and Non-Substitutable, and if they are, a sustainable competitive advantage can be developed.

5.2.3 IMPERFECT IMITABILITY

In order for a firm´s resource to be imperfectly imitable, other firms, can´t have access to that resource, nor be able to develop and implement value creating strategies with that resource.

Starting with the **High Quality Customer Service,** it is understandable that this resource provides value and it is rare, however other hotels may be able to understand why this resource is valuable, and therefore those competing hotels may also be able to provide a high quality service to its guests. Thus, the HQCS is a valuable and rare resource, but other hotels may copy it, if they have also access to the IoT.

On the other hand, the **Guest´s Tacit Knowledge** can be considered a Rare resource. Because it is very hard to put into words and to formalize, mainly because it is a kind of knowledge that guests (and people in general) aren´t aware about it, thus being very hard for other firms to copy it. The tacit knowledge being mentioned here is related mostly with guests´ behavioral patterns, actions, procedures and buying decisions, made at the hotel, which is information that is gathered by the IoT sensors spread through the hotel, allowing a hotel to have access to knowledge about their guests, in an unprecedented way. Moreover, following the RBV steps of categorizing a resource as imperfectly imitable, it is ascertained that GTK encompasses one of the criteria needed (explained in section 2.3.2) to be considered an imperfectly imitable resource because it is fruit a very complex Social Phenomena, as it has been explained previously.

5.2.4 NON-SUBSTITUTABILITY

A firm´s resource is said to be non-substitutable when there are no other strategic equivalent resources (different resource but with the same strategic potential), that may enable other competing firms to develop and implement the same value creating strategies.

The **High Quality Customer Service,** apart from being, somewhat, easy to copy, is also substitutable, because hotels may have other resources that can also increase customer satisfaction, or whatever value creating strategies that a hotel can build with this particular High Quality Customer Service resource.

Regarding the **Guest´s Tacit Knowledge**, as it has been explained throughout the current chapter, due to the IoT and its functionalities, a hotel may know its guests in a way that they may not even know themselves. Because the information that can be gathered by a hotel about its guests, through the IoT´s functionalities (represented in table 2, which also enable the development of GTK), is implicit information, mainly associated with guests´ intuitive actions, procedures, and so on. This is what enables a hotel to develop tacit knowledge about their guests, and by knowing its guests so well, a hotel may develop and implement value creating strategies that wouldn´t be possible with other resource. Then, as there is no other strategic equivalent resource, that may allow a competing hotel to develop the same value creating strategies, GTK is a non-substitutable resource.

5.3 RBV ANALYSIS´ CONCLUSIONS

Due to the VRIN analysis conducted in the previous sections, it is ascertained that:

- the resource **High Quality Customer Service** has value and it is rare, mainly because it allows a hotel to enhance the value of its services to its guests in a way that no other competitor is currently doing. On the other hand, because it is easy to copy by other hotels and it may have strategically equivalent resources, it can only enable a hotel to develop value creating strategies that can lead to a competitive advantage, which is not sustainable as other hotels may have access to this resource in the long-term.

- the resource **Guest´s Tacit Knowledge**, has value and it is rare - because it enables a hotel to provide guests with valuable services that they want and in a way that other hotels can´t, but it is also imperfectly imitable and non-substitutable, due to its tacit nature. Thus, this resource has potential to enable a hotel to develop and implement value creating strategies, that may lead to a sustainable competitive advantage.

It is then possible, to answer to the last Research Question (that composes the main research problem) proposed in the Introduction Chapter:

RQ3. Does IoT have the potential to help hotel companies´ in the development of a sustainable competitive advantage?

Regarding the analysis conducted in the previous sections, it has been considered that the IoT network (proposed in section 3.1) is able to provide a set of functionalities to guests. From those IoT´s functionalities (table 1), five of them are considered to have potential to help a hotel in

developing Guests´ Tacit Knowledge: 1) target promotions, 2) social network, 3)daily activities program, 4) auto billing, and 5) bill check. Guest´s Tacit Knowledge, is a resource that is valuable, rare, imperfectly imitable and non-substitutable, which, according to the RBV model, means that it is an heterogeneous and immobile resource, across other hotels. This means that a hotel can use the resource GTK to develop value creating strategies with potential to lead the hotel to develop a sustainable competitive advantage. It, is then, possible to consider that the IoT has potential to help hotel companies´ in the development of a sustainable competitive advantage, thus answering RQ3.

The following section addresses the main limitation and challenges the IoT faces, in what regards its development and the consequences of its implementation, such as privacy issues.

5.4 IoT´s CHALLENGES AND LIMITATIONS

As it has been analyzed in the State of Art, IoT is still an emerging technology, and as any emerging technology there are some issues, regarding its development, and some of the propositions considered throughout this dissertation, that need to be addressed. In this view the important issues to consider are addressed as follows:

- **Data Security,** since the IoT may provide functionalities related with the use and access to guests´ sensitive information, industry groups and government regulators may have to define clear rules on data privacy and data security.

- **Economic Challenges,** the building of an IoT network at a hotel may entail a big cost, especially when the price of DASH7 sensors, proposed in this dissertation, is currently of 10$ per sensor. However this price is expected to fall, especially if considering Moore´s Law that states that chip performance doubles every 18 months while prices fall.

- **Technological issues,** as it has been analyzed in the state of art, the IoT is not a single technology, rather it is a mix of several technologies. First, due to the high number of objects/things that need an identification and internet address - and the fact that IPv4 is reaching its full capacity - the deployment to IPv6, which with its expanded address space allows addressing, connecting and tracking things, is needed. Another problem regards the large amount of data gathered by the sensors, which creates the need to develop proper mechanisms with the capacity to manage and mine all this data, in order to use it in useful services. Another issue to be considered, is the management of heterogeneous applications that are needed to provide IoT´s functionalities.

It is apparent that there are concerns and challenges that IoT developers still need to face, but the speed of this development depends also on the users, and in this case, in order for IoT to reach its full potential in the hotel industry, the involvement of hotels in the development of IoT is also necessary.

In the current chapter, the RBV model has been applied over the most attractive IoT´s functionalities, where it has been identified that a an heterogeneous and immobile resource can be developed, which is Guest´s Tacit Knowledge. Through this resource it is considered that a hotel may develop value creating strategies that enhance customer service, and due to the resource´s VRIN attributes, a hotel may develop a sustainable competitive advantage, which answers RQ3.

Once the research questions that compose the main research problem have been answered, next chapter focused on answering the research problem that this dissertation faces.

VI - CONCLUSION

Through the performed analysis on the literature, regarding the development of competitive advantages in the hotel industry, it has been concluded that, knowledge is becoming one of the primary sources a hotel can have (Introduction chapter), in order to achieve superior performance. And, technology is considered to be a valuable strategic resource to make use of this knowledge, but hotels, however, are not using technology strategically (as it is mentioned in the introduction chapter).

Due to the opportunity identified in the previous paragraph, this dissertation focuses on the IoT - an emergent technology that allows objects to communicate between each other and with people - and its use in the hotel industry. In this view, the main research problem this dissertation faces is to ascertain if the IoT has potential to create value in the hotel industry, and if that value creation may lead to the development of a sustainable competitive advantage. Seeking the best possible answer, the research problem is split into three research questions:

RQ1. Is there any impact of the IoT in a hotel´s value chain?

RQ2. Which IoT functionalities do customers value the most?

RQ3. Does IoT have the potential to help hotel companies in the development of a sustainable competitive advantage?

The first step to address the research question, is to conduct an analysis on the literature available about the IoT, which allows to understand, to some extent, how an IoT network may be built, and what kind of functionalities it may provide. Further on, this analysis allowed, also, to identify the DASH7 sensors´ technology, which is regarded as the lowest power, longest range wireless sensor networking technology available anywhere. The remaining State of Art chapter focused on providing insights, from the literature, about the Value Chain Framework (needed to answer RQ1), and the RBV model (needed to answer RQ3).

Through the analysis of the IoT´s literature, a model for building an IoT network has been proposed, in section 3.1, where it is considered the use of DASH7 sensors to build the network, and the development of a smartphone application to connect the guest to the hotel´s IoT network. The development of a smartphone application has been proposed due to the high

number of tourist that already have a smartphone (this data can be found in section 3.1) but also because, from the 418 survey´s respondents, 74% of them said they have a smartphone.

Then, a value chain for the hotel industry has been proposed (figure 6), and a model was developed, linking, to each Value Chain´s activity, an IoT functionality (section 3.2). Moreover, through the survey analysis (Chapter 4), it was possible to ascertain that the IoT creates value for guests, because it increases their loyalty towards an hotel (75% probability of one of the 418 respondents coming back to the hotel), and also the willingness to pay (71% of respondents would pay 10€ more for a hotel with IoT). Thus, the answer to RQ1 is that IoT creates value in a hotel, by changing a hotel´s value activities, which means it has an impact in a hotel´s value chain.

Further on, the survey also enabled the identification of the most attractive IoT´s functionalities (from the ones proposed in the model of table 1), which answered RQ2. Then these IoT´s functionalities were analyzed in order to understand what resources can a hotel develop, through them (Table 2 in section 5.1). From the analysis, two resources are considered possible to be developed by a hotel with those IoT´s functionalities: 1) High Quality Customer Service, and 2) Guest´s Tacit Knowledge.

Then, the RBV model has been applied to both resources, mentioned above, in order to find out their strategic potential. The conclusion (in section 5.3) was that High Quality Customer Service, allows a hotel to develop value creating strategies that may lead to a competitive advantage - because the resource is valuable and rare -, but it in the long term, that competitive advantage is not sustainable - because the resource is not imperfectly imitable and it has substitutes -, which means other competing hotels may copy that resource, or use a strategic equivalent, to build the same value creating strategies, leading a hotel to lose its competitive advantage.

In what regards Guests´ Tacit Knowledge, through the RBV model, it was possible to ascertain that a hotel may use this resource to build value creating strategies that may lead to a sustainable competitive advantage. Because not only the resource is valuable and rare - as it provides a hotel with tacit knowledge about their guests, which allows the hotel to provide an unprecedented service to its guests (based on that knowledge about them) - but also, due to its tacit component, it is an imperfectly imitable resource - tacit knowledge is very hard to put into words and formalize, making it hard to copy- , and it is non-substitutable - there are no other strategic equivalent resources that may allow other competing hotels to create the same value services to the guests.

It is, then, possible to answer RQ3, and the answer is that, IoT allows a hotel to develop a resource (Guests´ Tacit Knowledge) with potential to help hotels in the development of a sustainable competitive advantage.

The research problem this dissertation faces is the following (which is answered in the following paragraph): **Does the IoT have potential to create value in the hotel industry, and may that value creation help a hotel developing a sustainable competitive advantage?**

Through the model proposed in table 1 (section 3.1), it is ascertained that IoT may provide a hotel with functionalities that might have potential to impact a hotel´s value chain, thus IoT may also help a hotel in creating value to the guest. Furthermore, that value creation is to some extent (according to the survey analysis in section 4.4) perceived by the market, in the way that a hotel with IoT may increase its guest loyalty - and an increase in guests´ loyalty means an increase in occupancy rates, and revenue per available room (as it is stated in the introduction chapter). Moreover, that value creation is mainly developed by the Guest´s Tacit Knowledge, a resource built through the following IoT´s functionalities: 1) target promotions, 2) social network, 3) activities program, 4) auto billing, and 5) bill check (as it is concluded in section 5.3). And this resource is heterogeneous and immobile across other hotels, which according to the RBV theory, allows a hotel to develop and implement value creating (and idiosyncratic) strategies, that may last in time.

With the acknowledgement from the previous paragraphs, it is concluded that a hotel can, indeed, create value through the IoT, and use that value-creation to develop a sustainable competitive advantage. Thus, answering, this way, to this dissertation´s research problem.

6.1 FUTURE RESEARCH

As this dissertation thesis focuses on a technology, that is still not fully developed, especially if considering its use the hotel industry, the following research topic s are proposed for future research work, about the IoT:

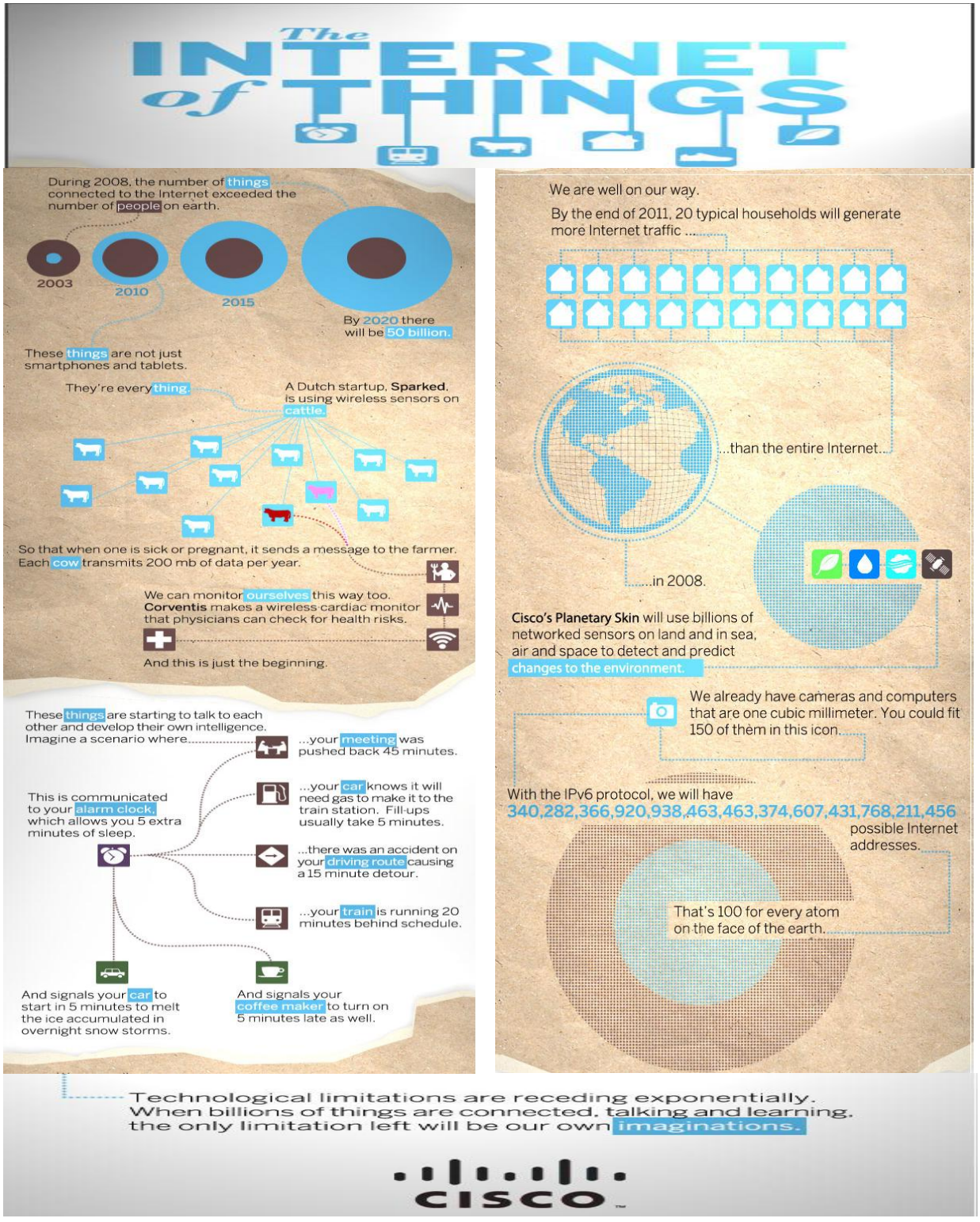
1) **Empirical data to fundament this dissertation´s work,** mainly, future research can be conducted in a more practical way, in order to ascertain if some of the propositions regarded during this dissertation (mainly the proposed IoT network and its functionalities) are feasible;

2) **IoT´s potential to reduce costs,** throughout the development of this dissertation, the potential for IoT to optimize processes and reduce costs in a hotel, has not been approached, mainly because it would involve a thorough financial analysis of big hotel sample. However IoT has potential to reduce costs significantly at a hotel. As an illustrative example, the Auto Check-in functionality may enable a hotel to reduce its reception´s team significantly.

3) **IoT´s potential in other industries,** as it has been analyzed in the state of art, IoT is a technology that will truly revolutionize the world as we know it, and it may have potential to impact every business. Hence, future research may include the strategic impact IoT may have in other industries and businesses, such as in Insurance (evaluate dynamically a driver´s risk through his driving patterns), Medical and Healthcare (remote monitoring of the health status of an individual), Environment Monitoring (control the development of global warming more accurately), and so on.

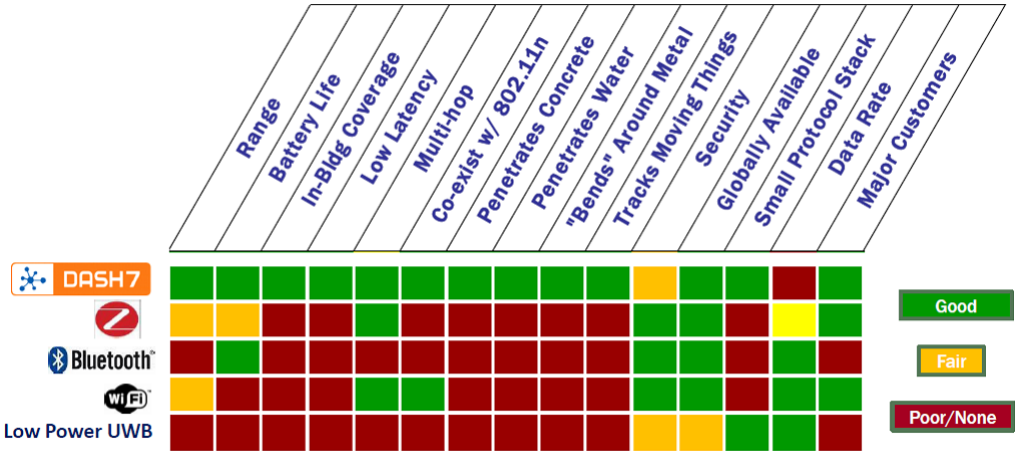
APPENDICES

APPENDIX 1 - AN EXAMPLE OF IoT's POTENTIAL



Source: Cisco Blog, 2011

APPENDIX 2 - WSN TECHNOLOGIES COMPARISSON

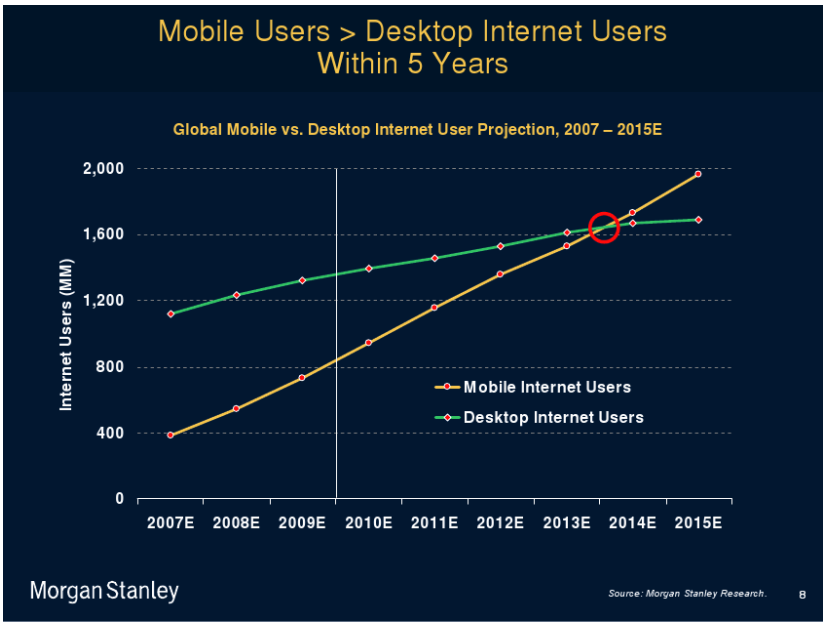


Source: DASH7 Alliance, 2012

	DASH7	ZigBee	Comments
Global Spectrum Availability			At 433 MHz, DASH7 is available in every major trading nation in the world. At 2.4GHz, ZigBee has the benefit of being available in all nations but at the cost of using a frequency that is crowded, unreliable, short-range, and has limited or no ability to penetrate walls, concrete or water.
Customer Adoption			DASH7 has been adopted by major customers like the U.S. Department of Defense to the tune of nearly $1 billion. ZigBee continues to fall short in terms of major customer adoption and unit volumes, hence the growing exodus of ZigBee developers to DASH7.
Interoperability			Due to the existence of major customers that demand interoperability, interoperability is a major focus for DASH7. ZigBee remains focused on finding its first major vertical market win and interoperability is secondary.
Recognition as an International Standard			DASH7 is an internationally-accepted, ISO Standard. Many countries recognize ISO as the only legitimate technology standards-setting body. ZigBee is a specification, not a standard, loosely based on a US-centric IEEE standard that lacks global adoption or support
Application Suitability			DASH7 is designed to provide long battery life and low device costs for bursty, asychronous (BLAST) applications that require multi-year battery life. ZigBee's focus is on applications that can benefit from high data rate or sophisticated routing – weeks of battery life is considered sufficient.
Industry Ecosystem			Both DASH7 and ZigBee have substantial industry ecosystems however the main distinction is that ZigBee's ecosystem is dated and withering while DASH7's ecosystem is new and vibrant.

Source: DASH7 Alliance, 2012

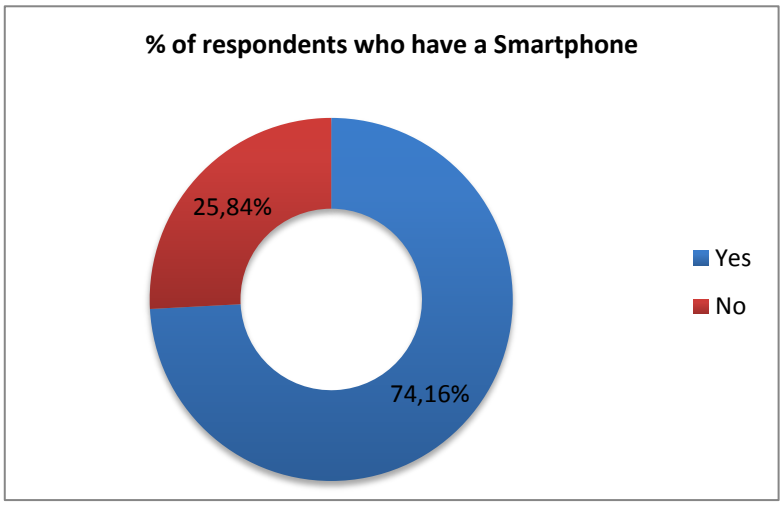
APPENDIX 3 - EVOLUTION OF MOBILE INTERNET USERS



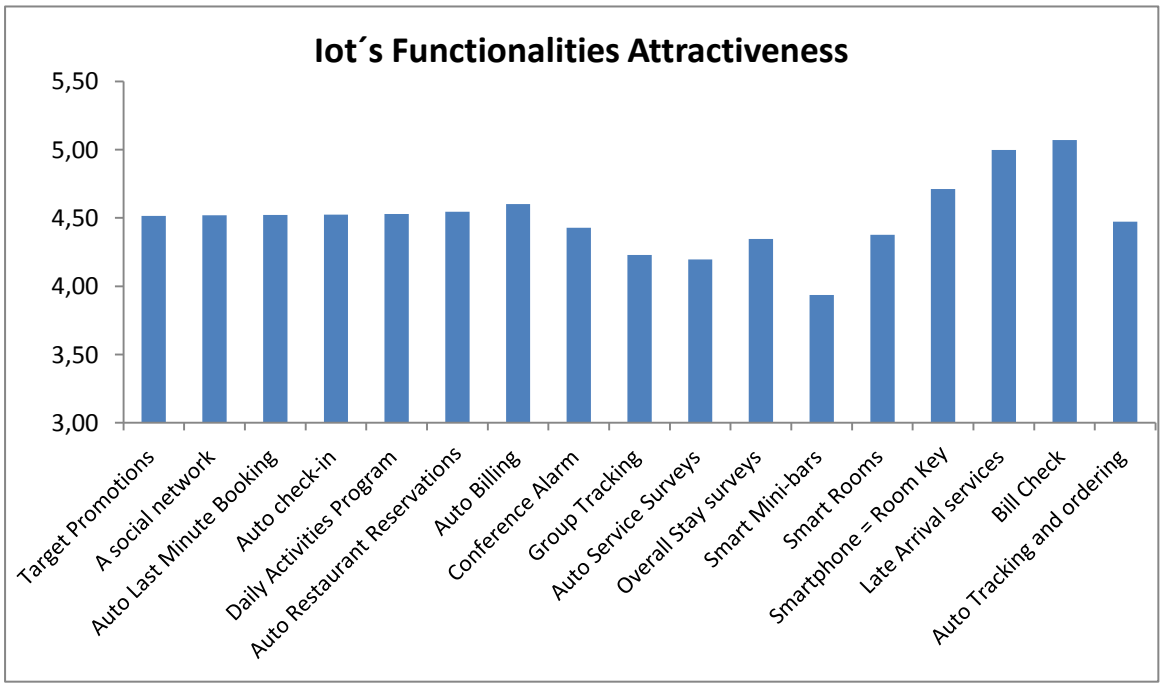
Source: Morgan Stanley Research, 2011

APPENDIX 4 - SURVEY´S RESULTS

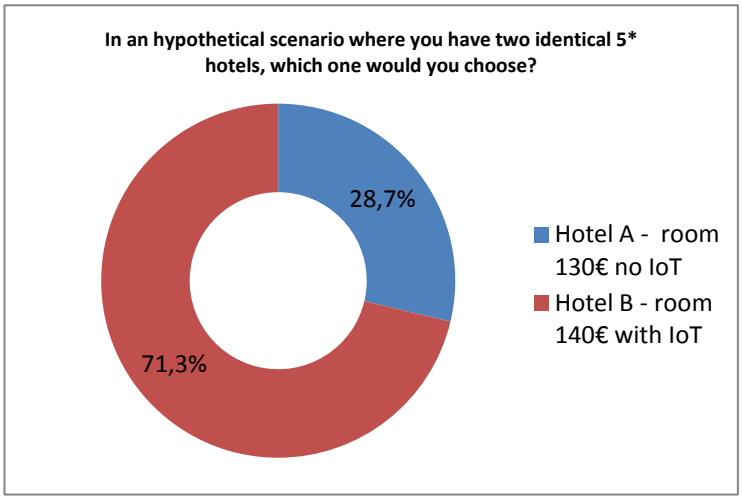
Do you have a Smartphone		
	Absolute Frquency	**Relative Frequency**
Yes	310	74,2%
No	108	25,8%
TOTAL	**418**	**100%**



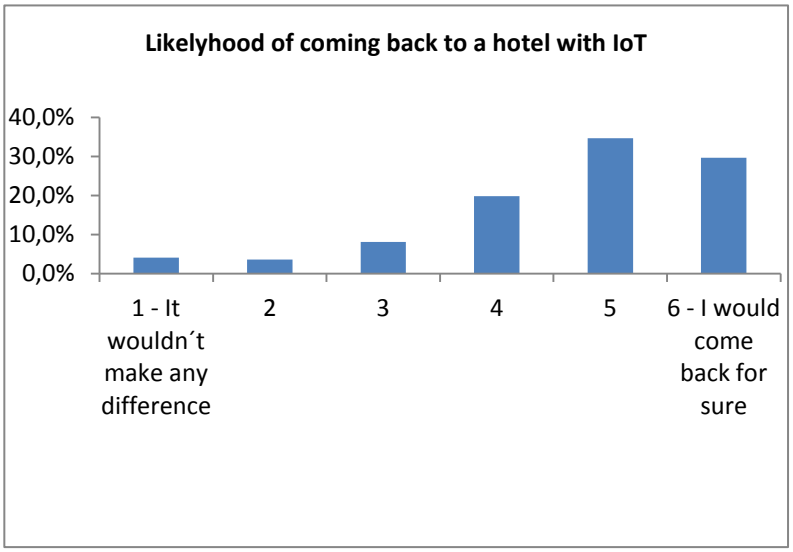
Functionalities attractiveness	
	MEAN
A social network	4,52
Auto Last Minute Booking	4,52
Auto check-in	4,52
Target Promotions	4,51
Daily Activities Program	4,53
Auto Restaurant Reservations	4,55
Auto Billing	4,60
Conference Alarm	4,43
Group Tracking	4,23
Auto Service Surveys	4,20
Overall Stay surveys	4,35
Smart Mini-bars	3,94
Smart Rooms	4,38
Smartphone = Room Key	4,71
Late Arrival services	5,00
Bill Check	5,07
Auto Tracking and ordering	4,47



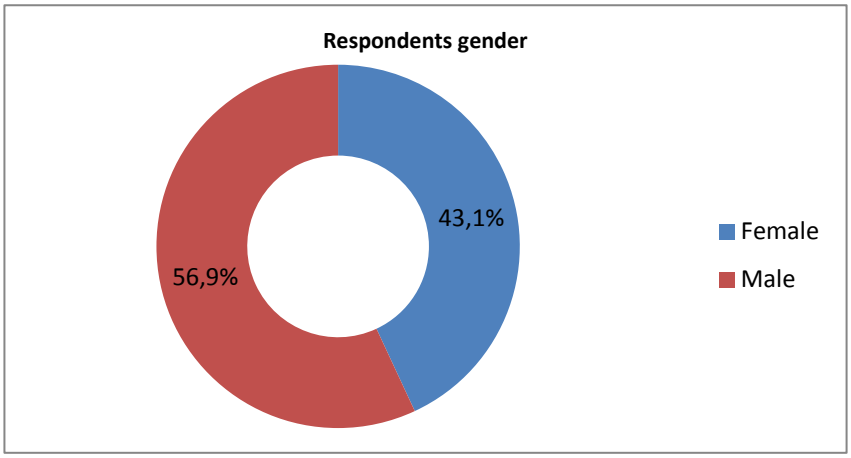
In an hypothetical scenario would where you have two 5* hotels located next to each other which one would you choose	Absolute Frequency	Relative Frequency
Hotel A - room 130€ no IoT	120	28,7%
Hotel B - room 140€ with IoT	298	71,3%
	418	**100%**



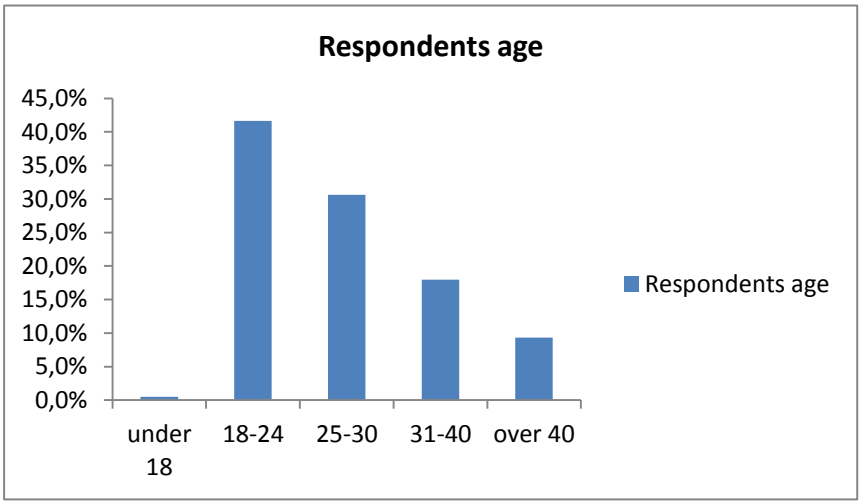
Would a hotel that provides you with the aforementioned IoT services increase the likelihood of you coming back to the hotel	Absolute Frequency	Relative Frequency
1 - It wouldn´t make any difference	17	4,1%
2	15	3,6%
3	34	8,1%
4	83	19,9%
5	145	34,7%
6 - I would come back for sure	124	29,7%
TOTAL	**418**	**100%**
MEAN	**4,67**	



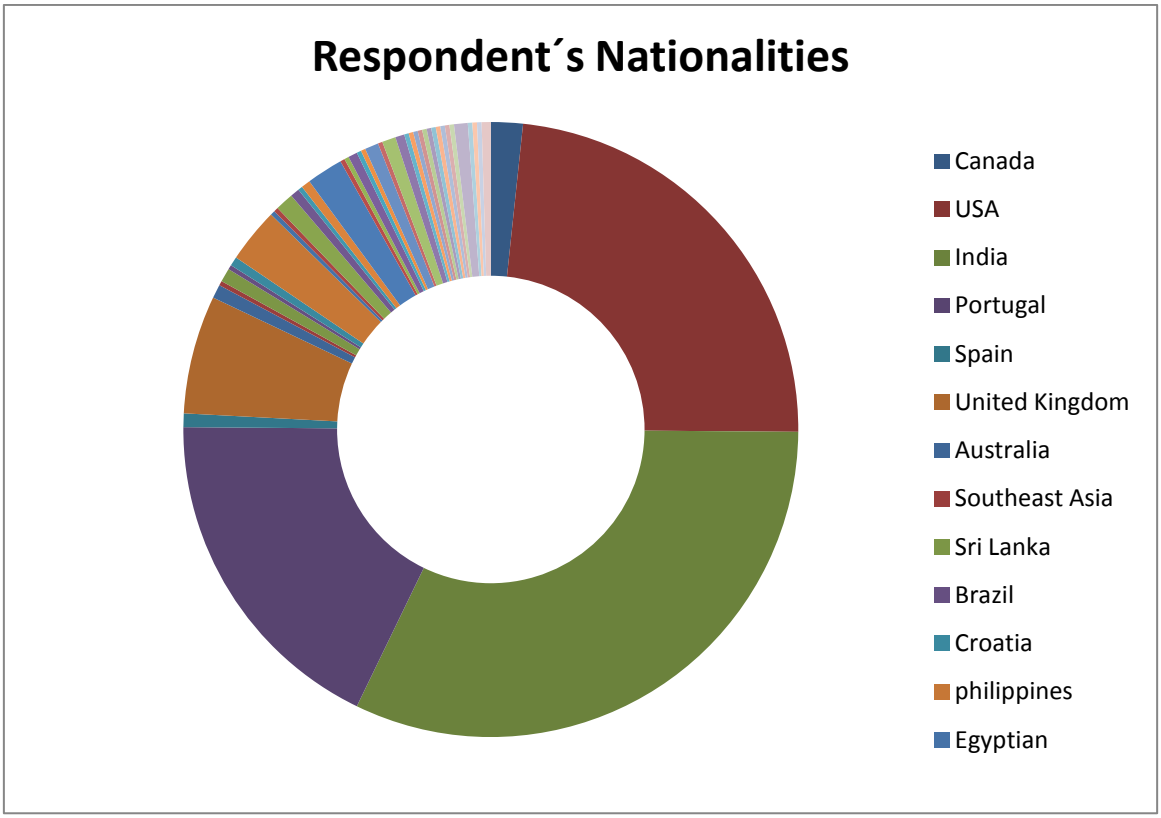
Respondents Gender		
	Absolute Frequency	Relative Frequency
Female	180	43,1%
Male	238	56,9%
TOTAL	**418**	**100%**



Respondents Age		
	Absolute Frequency	Relative Frequency
under 18	2	0,5%
18-24	174	41,6%
25-30	128	30,6%
31-40	75	17,9%
over 40	39	9,3%
TOTAL	**418**	**100%**



Respondents Nationality		
	Absolute Frequency	Relative Frequency
Canada	7	1,7%
USA	98	23,4%
India	134	32,1%
Portugal	75	17,9%
Spain	3	0,7%
United Kingdom	26	6,2%
Australia	3	0,7%
Southeast Asia	1	0,2%
Sri Lanka	3	0,7%
Brazil	1	0,2%
Croatia	2	0,5%
philippines	12	2,9%
Egyptian	1	0,2%
Mexico	1	0,2%
Macedonia	4	1,0%
German	2	0,5%
Lithuania	1	0,2%
Croatia	2	0,5%
Greece	8	1,9%
Nigeria	1	0,2%
Indonesian	1	0,2%
Pakistan	2	0,5%
Austria	1	0,2%
Latvia	1	0,2%
Bangladesh	3	0,7%
China	1	0,2%
Romania	3	0,7%
kuwait	2	0,5%
Netherlands	1	0,2%
Mauritian	1	0,2%
Georgia	1	0,2%
Estonia	1	0,2%
Malaysia	1	0,2%
Malta	1	0,2%
Russia	1	0,2%
Slovakia	1	0,2%
Slovenian	1	0,2%
Swiss	1	0,2%
Poland	1	0,2%
Uruguay	3	0,7%
Ukranian	1	0,2%
Bosnian	1	0,2%
Czech Republic	1	0,2%
France	2	0,5%
TOTAL	**418**	**100%**
Nº of nationalities	**44**	


Respondent´s Nationalities
Canada
USA
India
Portugal
Spain
United Kingdom
Australia
Southeast Asia
Sri Lanka
Brazil
Croatia
philippines
Egyptian

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