Gaining Competitive Advantage By Exploiting Internet Of Things (IoT) Technology

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Abstract: - Internet of Things (IoT) refers to the billions of physical devices around the world that are now connected to the internet, collecting and sharing data. The common managerial and theoretical concern is to build IoT applications momentum, in order to bolster possible weaknesses and stimulate their adoption by individuals. This research explores the influence of IoT applications in hospitality industry. Since IoT applications are considered to add value to hotel guests, their influence, from a potential guest's perspective, over a hotel's primary activities and operations is examined. Hotels, by adding value to their service provisions, could achieve higher customer satisfaction and loyalty levels, conferring a sustainable competitive advantage. Resourced-Based View model was used, because it concentrates on how a hotel's key resources can create value for its customers to meet their needs, which in turn enhances its ability to gain competitive advantage. For current research purposes, a questionnaire was created and distributed to evaluate whether a hotel's IoT applications are associated with choice and guests' preference of an IoT enabled hotel. Findings revealed that all studied IoT applications are hotel services enhancement instruments. Prospective guests' preference of an IoT enabled hotel over another one, provides support that IoT applications drive guests' satisfaction and loyalty, by recognizing it as value for money and reason for revisits.

Key-Words: - Internet of Things (IoT); hotel IoT applications; hotel guest satisfaction; competitive advantage; Resource-based View (RBV) model

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1 Introduction

The past decade has seen a spectacular development of the Internet worldwide. "Smart people" built the "smart artifacts" to live a "smarter life". "Things" have changed, thus changing our interaction with them. The Internet of Things (IoT) is the concept of connecting any device to the Internet and to other connected devices. It is a giant network of connected things and people – all of which collect and share data about the way they are used and about the environment around them.

In hospitality and tourism industry, adopting technological innovations can prove to be of a great importance for achieving competitive advantage. Technological innovations adoption can create smarter destinations by facilitating improvement and restructuring processes for tackling challenges such as seasonality and overcrowding [15]. The main purpose of this study is to investigate guests' perception of a hotel's IoT applications provision on primary activities and operations, through "smart" environments and systems, with a view to reaching a competitive advantage. Results will help managers and practitioners to define whether integrating IoT applications in a hotel can be thought as an effective path for enhancing the quality of provided services and total customer perceived value. Thus, prospective hotel guests' intentions towards and expressed preferences for or against these relatively new technology functionalities are examined.

In literature IoT concept and its connection to hospitality and tourism industry is defined revealing

that IoT can contribute in upgrading the whole tourism industry by informatization and intellectualization in a wider sphere. The Resource-Based View model is chosen to a) explain how innovative technologies adoption reinforce a hotel's services quality enhancement and consequently increase guests' experience satisfaction and b) reflect on IoT applications added value. Although general features of IoT applications in hospitality were examined by some prior studies, inadequate holistic research has been conducted on specific aspects such as guest's choice of an IoT's enabled hotel over another.

This study will make a considerable empirical contribution to literature concerning the perspective of IoT applications acting value added services in hospitality enhancing guests' satisfaction and loyalty. Additionally, it will add to the knowledge by revealing the possible existence of high and low impact IoT applications levels. Thus, the literature on hospitality will also benefit from a methodological contribution for managing the information resource. Findings could be beneficial to managers of hotels in crafting policies for hospitality scholars, as well as creating strategies for other hospitality stakeholders interested in successful implementation of IoT as a mean of services enhancement.

The study is structured into several parts. The first part is the literature review which includes the theoretical framework on IoT, IoT applications and IoT applications in hospitality and tourism industry, as well as previous work on IoT applications in hotels. The next section explains the Resource-Based View model, the VRIN Analysis, the research questions and hypotheses setting. Research method and results will be presented in subsequent sections followed by discussion and conclusions.

2 LITERATURE REVIEW

We are living in the post-PC era where smartphones, tablets and other 'smart' devices are changing the world around us by making it more interactive and informative. "The IoT integrates the interconnectedness of human culture -- our 'things' -- with the interconnectedness of our digital information system -- 'the internet.' That's the IoT," [2]. The IoT aims to extend the benefits of the regular internet – constant connectivity, remote control ability, data sharing, and so on – to goods in the physical world [17].

An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device, where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

2.1 IoT Applications

Based on what [4] say about the IoT value in various industries, [14] present that "the IoT generate $14,4 trillion in value, the combination of increased revenues and lower costs will migrate among companies and industries from 2013 to 2022." From an industry perspective, there are four industries that make up more than half of $14,4 trillion in value, with manufacturing (27%), retail trade (11%), information services (9%), finance and insurance (9%) to be the leading ones [14].

Referring to [14], they present what Gartner (2014) foresees, that is "the IoT will reach 26 billion units by 2020, up from 0.9 billion in 2009, and will cause impact to the information available to supply chain partners and how the supply chain operates."

Currently, IoT is thoroughly applied and being developed in every area of life and industry. The IoT is the hot trends in the tech and business world. [16] states that, "IoT is a fast-growing constellation of Internet-connected sensors attached to a wide variety of things". There are numerous real-world applications of IoT such as smart homes, wearable devices, smart healthcare, smart buildings, smart city, smart farming, smart appliances and so on, ranging from consumer IoT and enterprise IoT to manufacturing and industrial IoT (IIoT). IoT applications span numerous verticals, including automotive, telecommunications, energy and more.

2.1.1 Hospitality IoT

The IoT technology will play an extremely important role in the development of smart tourism industry in general and the hotel sector in particular. IoT can contribute in upgrading the whole tourism industry by informatization and intellectualization in a wider sphere. Research conducted in China express ideas and experience on the technological structure of IoT and its implementation to 'smart' industries, has contributed on deeper understanding of IoT concept from the perspective of sensor network of things and helped to introduce this technology on the global stage and international strategic plans [10].

Cloud computing and IoT technology are significant components smart tourism can focus on, so as to "apply intelligent perception of all kinds of tourism information, like tourist resources, tourism economy, tourism activities, tourism participants, among others to realize the acquisition and adjustment of real-time tourism information through mobile Internet or Internet terminal equipment" [10]. IoT technology can be considered as the core carrier of the smart tourism information system. Through IoT technology, systems can identify the real-time positioning of visitors and automatically point them at the resort map, which can lead to facilitate an exchange of information through alarms and messages. Such example can totally be indicative of how IoT is going to be used in a hotel resort [10].

An increasing number of hotels tend to adopt IoT, with the expectation that new ICT-based technologies and processes will result in enhancing companies' operations and consequently customer service levels. ICT-based products and processes help hotels enhance operating efficiency and improve the service experience, as well as to provide a secure access to global markets [22]. The time that takes for a firm to accept, adopt and use the new technology is called adoption propensity. A firm with high level of adoption propensity will adopt the new technology much earlier than its competitors, which also means that at the same time it is a firm which takes risks. "The firm's adoption propensity is fueled by its attitude towards and belief in innovativeness as a source of competitive advantage." [18].

In the hotel industry, the geographical location is considered to be a major determinant for its operations and profitability. More specifically, a hotel's geographical location indicates the profile of its guests, the size of the market and the level of competition. These three factors play a significant role in hotel's adoption propensity of ICTs, as well as they are closely related to what hotel expects about the added value that ICTs can provide to its customers, and additionally to what it believes about expansion of the target market through ICTs [18].

As the hospitality industry is characterized of high competitiveness, it is obvious that hotel companies tend to implement ICTs innovations so as to improve their image, their customer perceived quality, and consequently to achieve brand loyalty. So, in accordance with the innovativeness, it is essential for hotels to pay much attention to their customer-based brand equity in order to remain competitive in their market [19].

It is supported and recognized that providing with the highest quality of services and aiming to highest customer satisfaction are two of the most crucial factors, in order for the hotel to add value to its product, and subsequently, gain increased levels of customer loyalty and retention. "Faced with intense competition in the marketplace, it is imperative for hotels to tailor hotel services to the changing needs and lifestyles of customers with a view to increasing customer loyalty and retention." [13]. IoT technological application can elevate the competitive advantage of a service organization such as a hotel business by helping the hotel's employees to develop their capability to offer their best services to the customer [13].

2.2 IoT Hospitality Applications

There are many research papers that argue towards the importance of smartification of destinations, hotels, restaurants, entertainment and transportation. According to [22] and [10], a smart tourism central management platform can be successfully achieved through many applicable examples with the most indicative to be "[…] integrated electronic ticketing system, tourist flow monitoring, analysis system of scenic spots, vehicle monitoring system, tour guide management system of travel agents, digital room service and operation management system of hotels, and destination marketing system" [10].

In smart tourism development, the application of IoT mainly includes intelligent hotel management system, scenic spot intelligent ticketing system, intelligent remote video monitoring system, intelligent tour guide system and intelligent travel agency system [22]; [10]. [7] proved that the IoT technology enhances the convenience of tourism. Tourist destination selection, tourist routes planning, hotel bookings, and integration management of tourist attractions could be included in the IoT information system.

[6] attempted to design a real time positioning system based on "received signal strength indication" (RSSI) ranging and the IoT technology. Test results showed that this design could identify real time positioning of visitors and automatically mark them on the resort map, which could facilitate an exchange of information (e.g., alarm messages). [23] established a model of tourism commodity informatization through actual investigation and survey on the key processes of tourism commodities. As a result, a web-based traceability system was designed using two-dimensional code, RFID, active server page (ASP), net module development, and so on.

3 Resource-Based View Model and VRIN Analysis

Resource-Based View (RBV) model theory aims to explain competitive advantage and in turn integrated performance among firms. It sets as of the highest priority the relationship that occurs between the customers' value with the competitive advantage and the superior performance of the business. As a result, the business that aims to achieve competitive advantage focuses on increasing its guests' satisfaction and consequently its profitability, by providing more quality services compared to its competitors. Moreover, in the RBV model, the company utilizes its key resources and capabilities, in order to meet its customers' needs and improve its ability to obtain sustained competitive advantage [8]. "Adapting a resource-based approach towards management requires a shift from focusing on products and product development to concentrating on resources and resource development." [1]. This means that the company that aims to achieve competitive advantage by creating the highest possible value for its customers should follow strategies that are mainly based on its resources.

All the above can be summarized into the phrase that the RBV can describe and represent each company as a unique combination of resources. However, this does not necessarily mean that all of a company's key resources participate equally in providing with sustained competitive advantage. They should be carefully assessed and those resources which can enclose specific characteristics like value, rareness, inimitability and non-substitutability, should only be considered for creating advantage to the company [3]. Thus, there is need to identify the factors that can be used in order for the business to have a clearer picture of how its customers value business key resources as well as to decide which of them can enhance the value of customer experience from the offered service.

In the RBV model of strategic management, competitive advantage is closely related to company's internal characteristics, to its resources. Since business resources are mobile and heterogeneous in long term, in order company's resources to be considered as strategically important for the achievement of competitive advantage, they should also combine the characteristics of value, rareness, inimitability and non-substitutability too (VRIN), [20].

In the case that all the above characteristics occur simultaneously in a resource, then, this resource can be used to ensure company's sustained competitive advantage. This type of analysis is called VRIN analysis and it can be used in supporting way with the RBV model in order to explain which of the resources are suitable for the company's sustained competitive advantage [3]; [20].

Hotels need to organize and develop their strategies in an effort of achieving superior performance against their competitors. To measure the performance of the hotel businesses, there are traditional measurement tools, such as financial statements that evaluate the efficiency of tangible assets of the business, like their beneficial flows to the company, as well as the accurate determination of historical costs. Although these balanced performance measurement systems can provide a clear enough picture of the business position, nevertheless, it is demanded more attention to be paid towards approaches that can also assess the intangible aspects of a firm's performance. To this point of view, only through focusing on its key resources and capabilities, as concentrated in the VRIN analysis attributes, a hotel will enhance its performance and gain sustained competitive advantage, as it has been supported by the theory of RBV model.

4 RESEARCH QUESTIONS AND HYPOTHESES

The value chain analysis enriched with the RBV model, are used in order to answer the research questions (RQs) presented below. The first Research Question argues on whether the use of IoT innovative technology applications can be regarded as an effective factor for a hotel to enhance the quality of provided services. This question is closely related to the value chain theory, where it is supported that, from the customers' perspective, business value chain enhanced activities can lead to value-added products and services. Thus, recognizing high rated products and services could result in higher guests' satisfaction levels and consequently, enhancement of company's competitiveness by establishing a competitive advantage. Additionally, by setting the second Research Question, it is investigated whether, guests-wise, specific IoT applications are equally valuable for the hotel's various functionalities.

Businesses, such as hotels, operating in hyper competitive industries, focus on achieving the highest customer satisfaction possible, investing in customer trust and loyalty, simply because highly satisfied guests are more likely to revisit. To do so, managers need to understand guests' intentions and

preferences towards hotels that use IoT applications and whether they can be in favor of loyalty and trust. On the whole, the third Research Question focuses on whether guests are expected to express a preference on hotels offering IoT applications or not. The fourth Research Question, while taking into consideration the previous three research questions, is based on value chain and the RBV theory and aims at providing a more generalized inference on whether using IoT applications can be efficient way for a hotel to gain competitive advantage.

- RQ1: Can the use of IoT applications be regarded an effective factor for a hotel to enhance provided services quality?
- RQ2: Guests-wise, are IoT applications equally valuable for the hotel's various functionalities?
- RQ3: Do guests express their preference towards hotels that use IoT applications?
- RQ4: Is the use of IoT applications an efficient way for a hotel to gain competitive advantage?

Four hypotheses, stemming directly from Research Questions, serving as requisites of them, were formed. The 1st Hypothesis refers the development of a hotel's own IoT applications for delivering IoT technology mediated services. The 2nd hypothesis investigates whether guests evaluate some hotel IoT applications as more important and efficient than others. The 3rd Hypothesis investigates whether IoT applications positively impact guests' accommodation experience and satisfaction. The 4th Hypothesis assumes that, additionally to customer satisfaction, IoT applications will increase the possibility of returning guests.

H1: There is the need for hotels to design "smart" applications for their services.

H2: Guests evaluate some of the hotel IoT applications as more valuable than others.

H3: The use of IoT applications in a hotel positively affects guests' accommodation experience. (guests' satisfaction)

H4: Guests prefer to return back to hotels that employ IoT applications for service provision. (guests' intention for repeated visit)

The current research predicates its Research Questions and Hypotheses on some assumptions. More specifically, the IoT applications of a hotel's functionalities are indicative, as they are applied in the upper primary representative activities of a hotel's value chain. These applications are connected only to the hotel's operations and marketing components, since, customer-wise, they can add value to the integrated services provision, as guest involvement is direct and the consumption of them is immediate. No IoT applications were proposed for hotel's support activities, because of their far below significance levels of direct value creation for guests. As a result, since the purpose of the current research is to investigate the influence of IoT applications in hotels from a guest's point of view, the chosen IoT applications which hotels can obtain to develop a 'smart' environment were front-desk and reception, billing, in-room, F&B, guest relations, conferences and group, as well as marketing services like surveys, where guest participation is significant, Table 1.

Table 1. *Hotel's IoT applications*

Check in & Check out services	
Mobile Check-in/out	through hotel's mobile application
Smartphone as Room Key	e.g. after checking in, guests can approach their smartphone to the door of the room, where a sensor "recognizes" the specific guest and the door opens automatically
Billing services	
Auto Billing	e.g. whatever guests can purchase at the hotel is added to their bill through their smartphone
Bill Check	e.g. guests will be able to control their bill, during their stay, through hotel' s mobile application
In-Room facilities and services	
"Smart" Rooms	e.g. guests can enjoy the preferable conditions of the room environment, such as temperature, humidity, lighting, music, as "smart" devices in the room can be programmed according to guests' standards throughout their stay
"Smart" Mini-Bars	e.g. sensors in mini bars can inform hotel staff about the appropriate and timely refilling according to guests' consumption and needs
Food & Beverage (F&B) services	
Auto Restaurant Reservations	e.g. guests can make restaurant reservations at the hotel through their smartphone
Auto Tracking and Ordering	e.g. through their smartphones, when guests are around hotel's bars or restaurants area, they can be informed about any available seats and if so, they can be sent the menu and order online
Target Promotions	e.g. special offers and promotions can be sent to guests through the hotel's smartphone application according to their consumption history
Guest Relations services	
Auto Last-Minute Booking	e.g. if guests want to book a room in hotel the last moment they arrive at specific place, they can search about any availability and proceed with the booking through hotel's mobile application
Late Arrival services	e.g. if guests arrive late at night at hotel, the hotel can be informed through the application
Daily Activities Schedule	e.g. every day guests can be informed about possible activities that are going to take place at the hotel or around it, regarding their interests
Social Networks	e.g. guests can rate and share their stay experience of the hotel and its services, while possible new guests can find out what to expect
Events, Meetings, Conferences services	
Event Alarm and Location	e.g. alarm is sent to speakers and attendants of a conference, meeting or event, reminding of the specific time and directions to place they should attend
Group Tracking	e.g. everyone in a group is warned about the schedule of activities or events they have to participate
Guest surveys	
Service surveys	e.g. surveys are sent through hotel's smartphone application allowing guests to rate a service provided by hotel staff
Overall Survey	e.g. survey sent through hotel's smartphone application allowing guest to rate their overall stay at the hotel

4 METHODOLOGY

Considering previous research investigating the IoT relationship with hospitality and tourism industry [12]; [21], methodology was designed based on a model congruent to our general objectives, which enclose mainly the achievement of high-quality services and increased levels of guests' satisfaction for gaining competitive advantage. Resourced-Based View model was chosen, because it concentrates on how the key resources of a hotel, create value for its customers and how this value creates a value proposition enhancing the hotel's competitive advantage. A method of descriptive statistical analysis was adopted, where frequencies, means, variance, standard deviation and independency tests were calculated. Variable

correlations were reported and the level of a hotel's IoT applications influence on guests' opinions towards their accommodation experience was examined through a regression model. R i386 3.4.3 program (version 3.4.3, 2017) was used for statistical computing.

4.1 Survey Instrument and Sample

The questionnaire consisted of 26 questions grouped two sections (Appendix) and an introduction, which briefly presented research's goal. In one section, nominal scales were used to collect respondents' demographics which were thought to reveal significant information about the survey sample population. The other included questions about guests' opinion towards a hotel's IoT applications, with a five point Likert scale ranging from "Strongly Disagree" to "Strongly Agree". The original English questionnaire was reviewed for content validity by a university member of International Hellenic University, Greece, specializing in marketing research, according to the recommendations of [11]. Last, the reviewed questionnaire was back and forth translated into Greek to ensure translation equivalence [5].

An intercept method was followed in Greek public locations that are considered to be busy (e.g. shopping malls, bus and train stations, public parks). The respondents were chosen based on a sampling schedule. Multiple timescales were created to secure random selection, and sampling hours were adjusted different for working days and weekends. Timescales, places, and individuals were randomly selected. The sample population for this research was past guests and potential future ones of a 5-star hotel, where IoT technology is possible to be applied. Individuals were first asked whether they had been guests in a 5 start hotel in the past and only those who declared "yes" could participate the survey. Finally, the self-administered instrument was delivered to 500 individuals, who satisfied all parameters, from 01st August 2021 to 30th September 2021 and a total of 315 completed questionnaires were collected, from which 286 were usable.

5. RESULTS

5.1 Respondents Profile

55.10% of the respondents were female and 44.90% were male. 53.06 % were in the age group of 26 to 45 years old, 15.65 % younger than 25 years old, 19.05% were from 46 to 60 years old and 12.24% are 61 years old or older. Concerning their travel preferences, those who prefer to travel with friends and family share almost equal percentage and together they count for approximately 84% of total responses (41.50% and 43.54% separately). The remaining 14.96% is divided to 7.48% who travel with business or work colleagues, 2.72% who prefer to travel alone and 4.76% to other. The vast majority of respondents (78.91%) choose to visit a five-star hotel for their holidays and relaxation, 16.33% for business and 5.06% for educational or other purpose, e.g. a conference.

5.2 Research Questions and Hypotheses validation

According to frequency distributions, respondents' overwhelming majority (84.35%) possess, as expected, a smartphone or tablet and use smartphone applications (81.63%). The high rate of smartphone ownership and use of applications validates the contention of H1 about the necessity of a hotel to develop smartphone applications for applying IoT's proposed functionalities.

Question 3, was divided into subcategories, illustrating each IoT application type, regarding the hotel's most common activities. Respondents were asked to indicate their level of agreement towards the proposed hotel's IoT applications. Applications mean values were used to underpin their importance. Applications' mean value over 3 is considered positive, as it is above the neutral point. For those whose mean value exceeds the value of 3.75, representing a value of over 75% in the 1 to 5 scale used, is of the highest significance for guests. Along with mean values, variance and standard deviation, as measures for revealing possible gaps and differences in values occurring between sample responses of a variable, were calculated. Minor difference variations translate to narrower values of variance and standard deviation; hence, the mean values are by far more representative in describing sample responses.

Figure 1 shows that all suggested IoT applications exhibit mean scores between 3,748 and 4,061 (>3.75), meaning that they are all above the neutral point of agreement (>3). The ones with the highest mean values along with standard deviation and variance less than 1 were auto restaurant reservation, daily activities, smart rooms and auto last-minute booking, thus the answer for H2 is provided, by indicating which IoT applications potential guests tend to consider as more valuable and therefore must be prioritized by hotel managers for resource development.

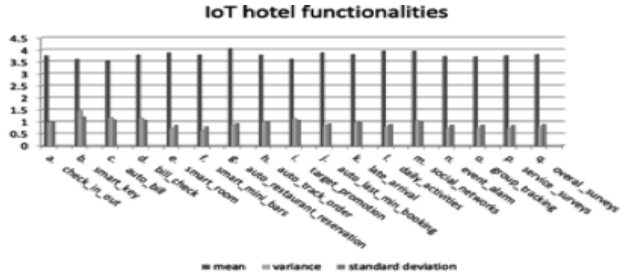

Figure 1. IoT applications' Means, variances & standard deviations

Question 4 examined guests' intention to choose a hotel that incorporates IoT applications. Respondents, when planning their upcoming holidays, were asked to express their preference between "Hotel X" - a 5* category hotel in the resort area A, where an average double room rate is at 150€/night in all-inclusive base – and "Hotel Y" - also a 5* category hotel in the same resort area A, where an average double room rate is at 160€/night in all-inclusive base, with the difference that time it offers all the IoT's functionalities proposed. Table 1 shows that 72.11% of respondents prefer Hotel Y, while only 27.89% chose Hotel X, supporting H3 and H4.

Table 1. Frequency distributions between Hotel X and Hotel Y

Variable	n (=315)	f (=1)	f% (=100)
q4 (hotel_with_iot)	**315**	**1.0000**	**100.00**
Hotel X	106	0.2789	27.89
Hotel Y	209	0.7211	72.11

Seeking for a connection among an IoT enabled hotel's guests' choice and use of smartphones and apps, Table 2 and Figure 2 reveal that the segment choosing to stay in an IoT enabled hotel is composed by the significant percentage of 69.40% for total population of smartphone owners and of 66.00% of the smartphone apps users.

Table 2. Contingencies between Hotel preference with smartphone ownership and use of applications

Hotel with_IoT	smart_phone			smart_app		
	Yes	No	total	Yes	No	Total
Hotel X	15,00%	12,90%	27,90%	15,60%	12,20%	27,80%
Hotel Y	69,40%	2,70%	72,10%	66,00%	6,20%	72,20%
Total	84,40%	15,60%	100,00%	81,60%	18,40%	100,00%

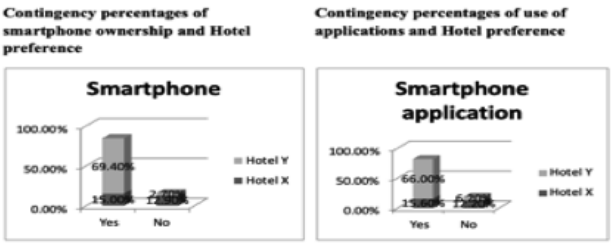

Figure 2. Contingency percentages between hotel preference with smartphone ownership and use of applications

H3 and H4 were additionally examined through questionnaire's question 5, by investigating prospective guests' agreement level, as to whether they consider an IoT enabled hotel as value for money, as well as how possible it is to choose the same IoT enabled hotel for a future visit. According to Table 3, for value for money dimension, the mean value is 3.796, the variance is 0.684 and standard deviation is 0.827, exhibiting that the mean response of the sample is above the neutral point and even higher than the level of 3.75. In combination with low variance and standard deviation (<1) values, the mean value represents the average opinion of over 75% of sample population, signifying that the average respondent considers a hotel's IoT applications as value of money. As far the dimension of returning guests, the mean value of 3.571, along with a variance of 0.630 and a standard deviation of 0.79 (Table 3), indicates the existence of prospect future visits.

Table 3. Statistic Summaries of guests' attitude toward an IoT enabled hotel

Variable (5-point Likert scale)	mean	variance	sd
q5. (guest_opinion)			
a. iot_value_of_money	3,795918	0,6840928	0,8270990
b. guest_return_to_ioT_hotel	3,571429	0,6301370	0,7938117

To reveal possible dependencies among the research's variables, independency t-test was conducted. Table 4 illustrates the independency cases occurring among variables and more specifically the ones dependent to the mean values of guest perception about the value of the IoT enabled hotel (q5a) and the probability of returning to the same IoT enabled hotel (q5b).

Table 4. t-test independency between the smartphone ownership and value for money/ probability of returning to the same hotel-enabled hotel (q5a) and the probability of returning to the same IoT enabled hotel (q5b).

ioT_value_of_money by smartphone		
mean	Yes	No
	3.959677	2.913043
t.test independency of ioT_value_of_money by hotel_with_iot		
t = -7.3808, df = 36.598		
p-value = 0.000000009469	(with 95 percent confidence interval)	
guest_return_to_ioT_hotel by smartphone		
mean	Yes	No
	3.750000	2.608696
t.test independency of ioT_value_of_money by hotel_with_iot		
t = -8.3541, df = 34.657		
p-value = 8.1e-10	(with 95 percent confidence interval)	

When examining whether mean value of value for money/probability of returning to the same hotel is independent to smartphone ownership responses, a 95% probability of statistical significance arises, where smartphone ownership and value for money are not independent, as p-value is less than 5%. Thus, it is accepted that value for money depends on smartphone ownership, meaning that smartphones owners perceive the IoT enabled hotel more valuable than those who are not. Accordingly, smartphone ownership seems to affect the mean value of a potential revisit, as p-value t-test is less than 0.05, meaning that smartphones owners exhibit a more positive attitude towards revisiting the same IoT enabled hotel. Table 5 shows that means of both value for money and probability of returning to the same IoT enabled hotel depend on smartphone ownership, use of applications and guests' intention to choose an IoT enabled hotel, whereas gender is independent.

Table 5. t-test independency between smartphone ownership and value for money/ probability of returning to the same IoT enabled hotel

ioT_value_of_money by smart_app		
mean	Yes	No
	3.966667	3.037037
t.test independency of ioT_value_of_money by hotel_with_iot		
t = -6.1009, df = 40.519		
p-value = 0.0000003248	(with 95 percent confidence interval)	
guest_return_to_ioT_hotel by smart_app		
mean	Yes	No
	3.783333	2.629630
t.test independency of ioT_value_of_money by hotel_with_iot		
t = -7.9531, df = 37.196		
p-value = 0.000000001527	(with 95 percent confidence interval)	

t-test independency between variables q5 with q6

ioT_value_of_money by gender		
mean	Female	Male
	3.802469	3.787879
t.test independency of ioT_value_of_money by hotel_with_iot		
t = 0.10424, df = 127.75		
p-value = 0.9171	(with 95 percent confidence interval)	
guest_return_to_ioT_hotel by gender		
mean	Female	Male
	3.592593	3.545455
t.test independency of ioT_value_of_money by hotel_with_iot		
t = 0.3561, df = 137.61		
p-value = 0.7223	(with 95 percent confidence interval)	

t-test independency between variables q5 with q4

ioT_value_of_money by hotel_with_iot		
mean	Hotel X	Hotel Y
	3.097561	4.066038
t.test independency of ioT_value_of_money by hotel_with_iot		
t = -6.7092, df = 59.984		
p-value = 0.000000007829	(with 95 percent confidence interval)	
guest_return_to_ioT_hotel by hotel_with_iot		
mean	Hotel X	Hotel Y
	2.926829	3.820755
t.test independency of ioT_value_of_money by hotel_with_iot		
t = -7.0876, df = 72.976		
p-value = 7.174e-10	(with 95 percent confidence interval)	

The assessment of proposed IoT applications influence on value for money and probability of returning to the same IoT enabled hotel, was tested through a correlation matrix. Table 6 shows correlation (about 0.6) between value for money and probability of returning to the same IoT enabled hotel with some of the IoT applications. The two regression models examining the relation of IoT applications towards value of money (model 1) and guest probability of revisiting the same IoT enabled hotel (model 2) respectively, were found significant.

Table 6. Correlation matrixes between value for money/ probability of returning to the same hotel to IoT functionalities

IoT's hotel functionalities correlation with iot_value_of_money					
	check_in_out	smart_key	iot_value_ofmoney		
check_in_out	1.0000000	0.6197180	0.6337635		
smart_key	0.6197180	1.0000000	0.5758698		
iot_value_of money	0.6337635	0.5758698	1.0000000		
	auto_bill	bill_check	iot_value_of money		
auto_bill	1.0000000	0.7575045	0.4689535		
bill_check	0.7575045	1.0000000	0.4677493		
iot_value_of money	0.4689535	0.4677493	1.0000000		
	smart_room	smart_mini_bar s	iot_value_of money		
smart_room	1.0000000	0.6758951	0.4271974		
smart_mini_bars	0.6758951	1.0000000	0.3981523		
iot_value_of money	0.4271974	0.3981523	1.0000000		
	auto_restaurant_ reserv	auto_track_ order	target_promotion	iot_value_of money	
auto_restaurant_reserv	1.0000000	0.7296890	0.5496936	0.6342308	
auto_track_order	0.7296890	1.0000000	0.4937029	0.5939884	
target_promotion	0.5496936	0.4937029	1.0000000	0.4307182	
iot_value_ofmoney	0.6342308	0.5939884	0.4307182	1.0000000	
	auto_last_min_book ing	late_arrival	daily_activities	social_networks	iot_value_of money
auto_last_min_Booking	1.0000000	0.7040911	0.4421996	0.4996844	0.5695064
late_arrival	0.7040911	1.0000000	0.5167424	0.4555281	0.3961273
daily_activities	0.4421996	0.5167424	1.0000000	0.5111804	0.4221680
social_networks	0.4996844	0.4555281	0.5111804	1.0000000	0.5356185
iot_value_of money	0.5695064	0.3961273	0.4221680	0.5356185	1.0000000
	event_alarm	group_tracking	iot_value_of money		
event_alarm	1.0000000	0.8175788	0.3528610		
group_tracking	0.8175788	1.0000000	0.4620313		
iot_value_of money	0.3528610	0.4620313	1.0000000		
	service_surveys	overall_surveys	iot_value_of money		
service_surveys	1.0000000	0.9223621	0.3639167		
overall_surveys	0.9223621	1.0000000	0.3546741		
iot_value_of money	0.3639167	0.3546741	1.0000000		

IoT's hotel functionalities correlation with guest_return_to_iot_hotel					
	check_in_out	smart_key	guest_return_ to_iot_hotel		
check_in_out	1.0000000	0.6197180	0.5713188		
smart_key	0.6197180	1.000000	0.4236702		
guest_return_to_iot_hotel	0.5713188	0.4236702	1.0000000		
	auto_bill	bill_check	guest_return_to_iot_ hotel		
auto_bill	1.0000000	0.7575045	0.5059591		
bill_check	0.7575045	1.0000000	0.5599847		
guest_return_to_iot_hotel	0.5059591	0.5599847	1.0000000		
	smart_room	smart_mini_bar s	guest_return_to_iot_ hotel		
smart_room	1.0000000	0.6758951	0.3944933		
smart_mini_bars	0.6758951	1.0000000	0.2436550		
guest_return_to_iot_hotel	0.3944933	0.2436550	1.0000000		
	auto_restaurant_rese rv	auto_track_orde r	target_promotion	guest_return_to_iot_ hotel	
auto_restaurant_reserv	1.0000000	0.7296890	0.5496936	0.6334171	
auto_track_order	0.7296890	1.0000000	0.4937029	0.5233866	
target_promotion	0.5496936	0.4937029	1.0000000	0.4199379	
guest_return_to_iot_hotel	0.6334171	0.5233866	0.4199379	1.0000000	
	auto_last_min_book ing	late_arrival	daily_activities	social_networks	guest_return_to _iot_hotel
auto_last_min_booking	1.0000000	0.7040911	0.4421996	0.4996844	0.5742648
late_arrival	0.7040911	1.0000000	0.5167424	0.4555281	0.5411735
daily_activities	0.4421996	0.5167424	1.0000000	0.5111804	0.4536601
social_networks	0.4996844	0.4555281	0.5111804	1.0000000	0.5449054
guest_return_to_iot_hotel	0.5742648	0.5411735	0.4536601	0.5449054	1.0000000
	event_alarm	group_tracking	guest_return_to_iot_ hotel		
event_alarm	1.0000000	0.8175788	0.3379192		
group_tracking	0.8175788	1.0000000	0.4175025		
guest_return_to_iot_hotel	0.3379192	0.4175025	1.0000000		
	service_surveys	overall_surveys	guest_return_to_iot_ hotel		
service_surveys	1.0000000	0.9223621	0.3884253		
overall_surveys	0.9223621	1.0000000	0.3860937		
guest_return_to_iot_hotel	0.3884253	0.3860937	1.0000000		

F-ratio was calculated to prove the relative importance of the regression models (if p-value <= 0.05. then the regression is appropriate). Tables 7 and 8 reveal that both models are significantly appropriate.

Table 7. Regression model_1

iot_value_of_money - regression
Residual standard error: 0.5599 on 129 degrees of freedom
Multiple R-squared: 0.5604. Adjusted R-squared: 0.5025
F-statistic: 9.674 on 17 and 129 DF. **p-value: 5.769e-16**

Table 8. Regression model_2

guest_return_to_ioT_hotel – regression
Residual standard error: 0.5531 on 129 degrees of freedom
Multiple R-squared: 0.6048. Adjusted R-squared: 0.5528
F-statistic: 11.61 on 17 and 129 DF. **p-value: < 2.2e-16**

Contingency tables were created by combining the findings of the demographical characteristics with the respondent preference of a hotel with IoT functionalities or not, Table 9. From the respondents with a preference to Hotel X there is an almost equal distribution among man and woman. From the respondents with a preference to Hotel Y women tend to achieve greater rates than man. Concerning age, young people (up to 45 years old) exhibit a much more positive attitude towards an IoT enabled hotel (Hotel Y) than older ones. Also, irrespective of travel preferences and purpose of staying in five-star hotel, majority of respondents choose Hotel Y over Hotel X, in general.

Table 9. Contingency Tables

Two-way tables between guests' intention to choose an IoT enabled hotel with

smartphone ownership and use of applications

hotel with_iot	smart_phone			smart_app		
	Yes	No	Total	Yes	No	Total
Hotel X	15.00%	12.90%	27.90%	15.60%	12.20%	27.80%
Hotel Y	69.40%	2.70%	72.10%	66.00%	6.20%	72.20%
Total	84.40%	15.60%	100.00%	81.60%	18.40%	100.00%

Two-way tables between guests' intention to choose an IoT enabled hotel with gender and age

Hotel with_iot	gender			age				
	F	M	Total	Up to 25	26-45	46-60	61 or older	Total
Hotel X	13.60 %	14.30 %	27.90%	2.10%	9.50%	7.50%	8.80%	27.90%
Hotel Y	41.50 %	30.60 %	72.10%	13.60 %	43.50 %	11.60 %	3.40%	72.10%
Total	55.10 %	44.90 %	100.00 %	15.70 %	53.00 %	19.10 %	12.20 %	100.00%

Two-way tables between guests' intention to choose an IoT enabled hotel with travel preference

Hotel with iot	travel_preference					
	alone	with friends	with familly	with business /work collegues	othe r	Total
Hotel X	0.70 %	6.10%	15.60%	2.00%	3.50 %	27.90%
Hotel Y	2.00 %	35.40%	27.90%	5.40%	1.40 %	72.10%
Total	2.70 %	41.50%	43.50%	7.40%	4.90 %	100.00%

Two-way tables between guests' intention to choose an IoT enabled hotel with travel purpose

Hotel with_iot	travel_purpose				
	for holidays/ relaxation	for business/ work	for educational purpose	other	Total
Hotel X	23.80%	2.00%	1.40%	0.70%	27.90%
Hotel Y	55.10%	14.30%	2.00%	0.70%	72.10%
Total	78.90%	16.30%	3.40%	1.40%	100.00%

Table 10 shows the two regression models, where Model 1 shows that the most statistically significant IoT functionalities concerning the perception of potential guests about value of IoT in hotels are auto check in and out and auto last-minute booking. Model 2 shows that the most statistically significant IoT functionalities that loaded more in relation to revisiting guests were auto check-in and out, smart room and smart mini-bars (their estimates Pr(>|t|) <= 0.05). That is, even though proposed IoT functionalities are perceived as significant from potential guests they posse different importance weightiness.

Table 10. Regression models

Regression Model 1

iot_value_of_money - regression					
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.39141	0.31248	1.253	0.21261	
check_in_out	0.21933	0.07151	3.067	0.00263	**
smart_key	0.07400	0.05848	1.265	0.20803	
auto_bill	0.04059	0.07821	0.519	0.60468	
bill_check	*-0.11837*	0.08981	*-1.318*	0.18981	
smart_room	0.13522	0.08444	1.601	0.11173	
smart_mini_bars	0.05988	0.08778	0.682	0.49636	
auto_restaurant_reservation	0.04841	0.09980	0.485	0.62848	
auto_track_order	0.11983	0.07241	1.655	0.10039	
target_promotion	0.04231	0.06359	0.665	0.50699	
auto_last_min_booking	0.25663	0.09034	2.841	0.00523	**
late_arrival	*-0.14188*	0.07450	*-1.904*	0.05909	-
daily_activities	*-0.08278*	0.08002	*-1.035*	0.30284	
social_networks	0.08440	0.07784	1.084	0.28027	
event_alarm	*-0.05610*	0.11840	*-0.474*	0.63643	
group_tracking	0.15846	0.12219	1.297	0.19697	
service_surveys	*-0.04999*	0.15393	*-0.325*	0.74590	
overal_surveys	0.10829	0.14119	0.767	0.44449	
Residual standard error: 0.5599 on 129 degrees of freedom					
Multiple R-squared: 0.5604. Adjusted R-squared: 0.5025					
F-statistic: 9.674 on 17 and 129 DF. p-value: 5.769e-16					

Regression Model 2

guest_return_to_ioT_hotel – regression					
	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.54419	0.31631	1.720	0.08775	
check_in_out	0.17217	0.07239	2.378	0.01885	*
smart_key	*-0.10568*	0.05920	*-1.785*	0.07659	
auto_bill	0.00800	0.07917	0.101	0.91967	
bill_check	0.04152	0.09091	0.457	0.64861	
smart_room	0.22500	0.08547	2.632	0.00951	**
smart_mini_bars	*-0.19020*	0.08886	*-2.141*	0.03419	*
auto_restaurant_reservation	0.12434	0.10102	1.231	0.22062	
auto_track_order	0.07591	0.07330	1.036	0.30231	
target_promotion	0.03855	0.06437	0.599	0.55036	
auto_last_min_booking	0.10961	0.09144	1.199	0.23285	
late_arrival	0.14364	0.07542	1.905	0.05905	-
daily_activities	*-0.02926*	0.08100	-0.361	0.71847	
social_networks	0.04863	0.07880	0.617	0.53818	
event_alarm	*-0.12641*	0.11985	*-1.055*	0.29348	
group_tracking	0.16488	0.12368	1.333	0.18485	
service_surveys	*-0.08339*	0.15581	-0.535	0.59346	
overal_surveys	0.16215	0.14292	1.135	0.25866	
Residual standard error: 0.5531 on 129 degrees of freedom					
Multiple R-squared: 0.6048. Adjusted R-squared: 0.5528					
F-statistic: 11.61 on 17 and 129 DF. p-value: < 2.2e-16					

6. DISCUSSION

The current research investigated the influence of IoT in hotel industry, from guest's perspective. H1- need of smart phones and smart apps, in combination with the H2- guest evaluation of the IoT functionalities in hotels', were developed to examine the contention of Research Question 1, about whether the use of IoT is an effective factor for a hotel to enhance the quality of the provided services. Research Question 2 was formed to invest with Research Question 1, aiming to provide a more lucid and balanced picture potential guests' perception towards IoT enabled hotels, through testing the H2.

H1 and H2 were supported, identifying all IoT functionalities as means for enhancing the hotel services that guests can enjoy, though some IoT functionalities were found to be more valuable for guests than others. Considering the high percentages of smartphone owners and users of applications, along with the recognized value of IoT applications in provided services. hotels could concentrate on developing smartphone applications that primarily focus on IoT functionalities rated as more valuable from potential guests.

Research Question 3 is connected with H3, where the results clearly showed the preference of potential guests to choose an IoT enabled hotel with

IoT, supporting H3. That result entails that the use of IoT in a hotel positively affects guests' experience and it was used as background knowledge Research Question 4 about raising the prospect gaining competitive advantage through hotel IoT applications integration. As proposed in H4, embedding efficient IoT in a hotel's provided services adds value to potential guests, resulting to increased customer satisfaction and loyalty. H3 and H4 are supported, demonstrating potential guests' recognition of value for money and probability of revisiting an IoT enabled hotel.

The variables dependencies reveal that gender-neutral, potential guests' perception of value for money from IoT functionalities and likelihood of revisiting the same IoT enabled hotel depends on smartphone ownership, use of smartphone applications and preference of an IoT enabled hotel. By investigating the influence of IoT in hotel services, correlation between the proposed IoT functionalities and value for money/probability of revisiting the same IoT enable hotel were examined, resulting in a statistically acceptable correlation. Regression models were significantly appropriate; however, data adjustment was not ideal. as multiple R-squared was quite low, since the relation between perspective guests' value for money recognition of IoT functionalities and the probability of guests' revisit were not ideally linear.

It total, after answering all Research questions there is the need to combine results with RBV theory. Since IoT functionalities have been found effective and valuable in hotels' providing services (RQ1. RQ2), they can contribute in enhancing the quality of customer service and consequently add value to potential customer. IoT enabled hotels could adjust their customer-based value chain to their guests' needs and preferences, achieving higher satisfaction levels and developing customer loyalty. These two distinct capabilities could in turn lead to the creation of competitive advantage, as suggested in RQ3 and RQ4.

Following the RBV model approach, the most attractive IoT functionalities should be received as top priority for the purpose of providing the highest possible value to customers, mainly based on key resources. Special attention must be paid on the resources that can be developed to add value to hotel's value chain and lead to competitive advantage. Auto check-in and out, auto restaurant reservation, auto track and order and auto last-minute booking should be technologically elevated to improve hotel's key resources and capabilities, such as enhanced quality of services, higher levels of customer trust, extensive and accurate knowledge about customer needs and preferences.

7. LIMITATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Current research's first limitation is its geographical constraint. The survey included only Greek citizens without considering any differences posed by other cultures. Also, the IoT functionalities proposed in the current research focus on hotel's primary activities and operations. They are designed as operational and marketing activities of the hotel's value chain, such as reception (check-in and check-out), billing, room (smart room facilities), food and beverage (reservations in hotel's restaurants and bars), guest relation (late check-in/out, last minute booking, recommendations for daily activities, social media), marketing and sales (target promotions. special offers), evaluating (specific and overall surveys) and convention (alarm for the speakers, group tracking) services. These services are selected as indicative and they are not the only ones that a five-star hotel could provide.

Future studies could expand the results of the current research to a wider geographical area, for instance Balkan countries, or throughout Europe, even in a global level as the hotel sector enables the term of globalization. Moreover, additional research for examining IoT functionalities that can occur in supporting activities of value chain could be implemented, for instance proposing ways in which IoT can be used to enhance the structural, technological, financial and human assets of a hotel.

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