Energy Efficiency Management Analysis - Hotel Segment in Greece

Dimitrios Efthymiou

SCHOOL OF ECONOMICS, BUSINESS ADMINISTRATION & LEGAL STUDIES
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Student Name: Dimitrios Efthymiou

SID: 1101180003

Supervisor: Dr. Chris Grose

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List of Abbreviations

EBIT: .......................................................... Earnings Before Income Taxes
EEM: .......................................................... Energy Efficiency Management
EMS: .......................................................... Energy Management System
ESIF: .......................................................... European Structural and Investment Funds
EU: .......................................................... European Union
GDP: .......................................................... Gross Domestic Product
HVAC: .......................................................... Heating, Ventilation & Air Conditioning
IoT: .......................................................... Internet of Things
IP: .......................................................... Internet Protocol
IRR: .......................................................... Internal Rate of Return
ISO: .......................................................... International Standardization Organization
LEED: ...................................................... Leadership in Energy and Environmental Design
NPV: .......................................................... Net Present Value
PPC: .......................................................... Public Power Corporation
ROI: .......................................................... Return of Investment
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Executive Summary

The aim of the current dissertation is the analysis of the Energy Efficiency Management (EEM) in hotel segment in Greece through the answering of a series of research questions and the presentation of a case study regarding a 5-star hotel in Halkidiki, Northern Greece. The goals and objectives of the hotel management, through the implementation of an Energy Management System (EMS), are presented. Moreover, two different approaches for the implementation of the EMS are described through the literature review, where the first accepts the importance and benefits of EMS and the other stands on the barriers that prevent its implementation. Regardless of the intention of hotel owners and managers to implement an EMS in order to increase the energy efficiency, there are a lot of cases that it is a mandatory for them to follow the European Union (EU) and Greek regulatory framework and finally install such a system. Furthermore, the three different layers of the EMS architecture are analyzed presenting also the respective benefits of the usage of each layer. A case study of a 5-star hotel in Halkidiki is used in order to demonstrate the benefits of the implementation of such a system. In addition to that, the data of a questionnaire, that the hotel management has developed, presented and this data in combination with the factors that affect the Return of Investment (ROI) has been taken into account so as a proper EMS to be designed and installed in order to maximize the energy efficiency and minimize the payback period. The Return of Investment (ROI), the Internal Rate of Return (IRR) and the Net Present Value (NPV) were calculated in order to prove the profitability and the attractiveness of the investment. The importance of EMS is not limited only to financial indicators but also to the marketing of the hotel since it is the key factor so as to be green and eco-friendly. Finally, the study includes recommendations regarding the next investments that should be implemented in order the management to increase further the energy efficiency and reduce the unnecessary costs as well as the respective conclusions that are very useful for all the hotel owners that are not obliged to implement such a system and they doubt whether they should do it or not.
1. Introduction

The analysis of EEM in hotel segment is of paramount importance not only for the viability of the hotels themselves but also for the whole country since hotels are the key players of the tourism industry, which is the locomotive of the Greek economy.

1.1 Background

Energy efficiency simply means using less energy to perform the same task which leads to eliminate energy waste. Energy efficiency brings a variety of benefits: reducing greenhouse gas emissions, reducing demand for energy imports, and lowering the respective costs since the impact of energy price fluctuation to overhead of an organization is significant. Hotel Energy Management is the practice of controlling procedures, operations and equipment that contribute to the energy use in a hotel operation. This can include electricity, gas, water or other natural resources. Because hotels can have complicated operations and extensive facilities, they utilize many different types of energy resources.

As globalization and digitalization drive global change, travel and tourism now represents the unifying power of a more connected, informed and outward looking world. During the last 5 years, more than 1.3 billion people per year, travelling abroad. Europe, the world’s leading region in innovation, connectivity and technological advances, is also the world’s largest tourism market (World Tourism Organization, 2019). More specifically, Greek tourism has managed to hit one record year after the other in terms of arrivals and revenues. Greece is now one of the top 15 destinations in the World. It is impressive the fact that during 2018, 33 million visitors were attracted by Greek beauties and stayed in any kind of hotel, contributing around 28% to the nation’s Gross Domestic Product (GDP) (Ikkos A. & Koutsos S., 2019).

1.2 Aims & Objectives

Hotels are one of the most energy intensive facilities, with correspondingly high energy costs. They are ranked among the top five in terms of energy consumption in the tertiary building sector. For a large hotel, the energy cost is between 30% and 35% of the total operation cost and this corresponds to almost 3% of the total turnover. There are many cases in which this may reach even the 8% of the hotel’s turnover. The increased operation costs directly affect the hotel’s financial performance and as this trend grows, jeopardizes the viability of the business since adversely affects the profitability. Thus, the energy efficient practices are of paramount importance for the hotels, since
they can improve the hotel’s financial performance and provide short-term benefits with limited investment. Energy savings of almost 20% can increase hotel’s Earnings Before Income Taxes (EBIT) up to 10%, since among all operating costs, those of energy utilities are the ones of the most controllable (Schneider Electric Brochure for Hotel Solutions).

There is no doubt that the main goal for a hotel is guest’s delight. However, we should take into account also what is the key to excellence for a hotel operator. It is striking the right balance between guest delight and minimized operating costs, such as energy bills since, as it has already mentioned before, affect severely the operational expenditures. Most of the time, on the one hand, hotel’s energy waste is not top of mind for its guests and on the other hand, hotels give very little incentive to adopt energy efficient habits. Thus, it is very hard for the hotel operator to find and retain that balance. Given the main culprits of energy waste, it’s through EEM solutions. The main intention of the management is to focus its activities in the line of reducing operating costs by introducing new EMS that give to the operator the opportunity to check the consumption, analyze the respective data and find solutions in order to reduce the total energy needs and preserve the environment by creating an eco-friendly establishment. Cutting the operating costs increases the profit and allows improved competitiveness in the tourism market.

Over the recent years, tourism industry threatened by the climate change, since there are extreme weather patterns and a rising of sea level. These phenomena are due to the rising of the concentration of greenhouse gases such as carbon dioxide, methane and nitrous oxide which lead to greenhouse effect and global warming. Although recently, the renewable sources of energy have further developed, fossil fuels still play a key role in global energy mix since it is the main source for generating electricity. For this reason, it is of paramount importance, for the tourism industry and especially for the hotel owners, to take into consideration the benefits of the EEM, otherwise these changes will affect their development in the long run.

1.3 Research Questions

The main purpose of this research paper is to answer to the following research questions:

➢ Which are the directives, rules and generally, the regulatory framework that hotels should follow in Greece regarding the energy efficiency.

➢ Which are the hardware and software parts and generally, the cross-functional architecture of the EMS that hotel may use and how they could use this system in order to meet their goals.

➢ How this system affects hotel’s cost management.
➢ Which are the key drivers that affect the ROI of the Hotel EMS.
➢ In the case of an investment in EMS, which are the ROI, IRR & NPV of the investment.
➢ How hotel could exploit the EMS in order not only to reduce costs and energy waste but also to attract customers based on a green and eco-friendly profile and which are the other practices that should be followed so as to achieve that.

1.4 Dissertation Organization

The rest of this dissertation is organized as follows: The next session provides a review of the relevant academic literature on the importance of EMS, the potential barriers to its implementation as well as the connection between the attractiveness of a green hotel and the guests’ environmental concerns. Section 3 provides the regulatory framework that is a mandatory for Greece as member of the European Union. Section 4 provides the cross-functional architecture of the Energy Management System presenting its three layers and the respective benefits of each layer. Section 5 presents a case study where a 5-star hotel is described. Moreover, the data of the questionnaire that the hotel developed, and run is presented as well as the initial hotel’s condition. Furthermore, this section analyses the investment and the Return of Investment, Internal Rate of Return and Net Present Value are calculated. The last section summarizes the main finding and concludes the paper by providing the main financial and marketing reasons that a hotel owner or manager should install an EMS.
2. Literature Review

There are a lot of studies that focus on the importance of EMS generally and in the hotel segment more specifically. Moreover, there are a lot of cases in which on the one hand, confirm the existence of barriers to the implementation of such a system and on the other hand confirm the obligation of such an implementation based on regulations and policies. Finally, there are a lot of cases in which the implementation is connected with the tourists’ behavior regarding the environmental issues and the current climate changes.

2.1 The importance of an Energy Management System

As Patterson (1996) explains, energy efficiency means using less energy to perform the same task and, in this way, reduce the energy waste. The main concept of the energy efficiency is either to increase the performance with the same level of energy or to remain the performance at the same level with less consumption of energy (Jollands et al., 2010). There are a lot of authors that mention the importance of energy efficiency in order to meet the goal of reducing cost and gas emissions through the usage of cost-effective strategies that based on energy efficiency (Abulfotuh, 2007; Stanford, 1997; Jollands et al., 2010; Martin et al., 2011;)

Quite recently, the hotel’s management team understood the importance of the existence of an EMS in order to reduce the greenhouse gas emissions, the demand for energy and the respective costs. There are a lot of authors who mention the importance of the commitment of the managers to the application of a proper management system (Kannan & Boie, 2003; Capehart et al., 2003; Doty & Turner, 2004) otherwise there will be little or even no results. Based on the Bureau of Energy Efficiency (2005), the main objectives of energy management are:

➢ The reduction of energy waste / cost without disrupting the production & quality.
➢ The diminishment of the environmental impacts.

In order to achieve the aforementioned objectives, it is important for the managers to develop an energy management plan or program of which the structure is suggested to be the following (Kannan & Boie, 2003)
Based on the Energy Management Handbook (Doty & Turner, 2004) the effectiveness of the implementation of such systems can be enhanced further if four basic principles are adopted:

➢ “Control the costs of the energy function or service provided”.
➢ “Control energy functions as a product cost, not as a part of manufacturing or general overhead”.
➢ “Control and meter only the main energy functions, the roughly 20% that make up 80% of the costs”.
➢ “Put the major effort of an energy management program into installing controls and achieving results”.

2.2 Implementation of Energy Management System – Barriers & Obligations

On the one hand, there are a lot of cases in which companies decide to not proceed with an investment in EMS despite the fact that this system allows more energy savings than the respective costs (Jackson, 2010). The main reasons that this happens are mentioned as market failures and barriers (Goldman et al., 2005) and there are a lot of previous research that confirm the existence of such barriers that lead either to avoid implement the proper energy efficiency techniques or to delay
significantly the adoption of them (Brunke et al., 2014). The main barriers that mentioned by Martin et al. (2011) are:

- “Credit constraints”.
- “Uncertainty about the future”.
- “Managerial factors such as: lack of information, managerial resources or attention to cost-cutting projects outside the scope of the firm’s main business, short run optimization behavior or the application of different hurdle rates to energy related projects”.

On the other hand, there are almost 7,000 companies that have already adopted ISO 50001 Energy Management certificate worldwide. Thus, it is clear that for more and more companies, the energy management become more vital and popular since the implementation of an energy management standard such as ISO 50001 is expected to increase the energy efficiency by more than 20% (Pinero, 2009). Additionally, for almost all the large hotels, the adoption of ISO 50001 is a mandatory. Apart from that, there are also regulations and policies such as safety, legislation, education and economic development (Mayaka & Akama, 2007), (Warnken et al., 2005) that should be fulfilled by the hotels and require the existence of the proper EMS.

2.3 The Connection between Environmental Concerns & Green Hotel Attractiveness

The last few years is commonly acceptable, almost from all studies, the importance of climate as a key driver for the tourism industry (Hu & Ritchie, 1993). On the one hand, all the activities related to tourism such as traveling, accommodation and other activities increase the total carbon dioxide emissions contributing to the climate change (Nicholls, 2006) and was estimated something between 5% and 14% of the total emissions (Simpson et al., 2008) and on the other hand, climate change affects significantly the tourist industry since, nowadays, the attractiveness of a specific place and as a result the tourists’ flow to this place is highly dependent on the climate conditions there (Lise & Tol, 2002; Amelung et al., 2007). Since hotels are the key players in the tourism industry, they rely heavily on the nature and as a result on the climate change since all the changes have a large potential to destroy the hospitality industry. All the previous years, especially large hotel’s management, did almost nothing so as to have a proactive approach to environmental concerns (Frey & George, 2010).
Nowadays, the competition among large hotel firms encourage them to find a way in order to attract customers using new ways of creating value for them (Koopman et al., 2014). Almost by 1997 that the Kyoto Protocol was developed, the environmental awareness increased every year since not only tourists, but also all the people recognize the environmental problems and identify the relationship between these problems and the economic issues and the modern social standards of living (Chaineux & Charlier, 2007). This may explain the reason that a lot of hotels implement more green practices since more and more tourists prefer to consume green products and are willing even to pay more in order to visit an eco-friendly hotel instead of ordinary hospitality services (Do Valle et al., 2012). In many cases, tourists feel that they have moral obligation and that they should follow a socially responsible behavior to visit green hotels based on their environmental concerns (Chen & Tung, 2014). Since there are plenty of practices that followed by hotel managers in order to be eco-friendly, it is of paramount importance for them to recognize which of them are the most important for tourists that prefer to stay in a green hotel. In this way, the proper attributes can be the main points of their promotion in order to attract the environmentally conscious tourists through sending the right message to them (Millar & Baloglu, 2008; Dolnicar & Otter, 2003; Kasim, 2004).
3. Regulatory Framework

Currently, energy management is in the global spotlight, due to the pressing need to save energy and reduce greenhouse gas emissions worldwide. For this reason, EU measures focus mainly on sectors such as buildings, where the potential for savings is the greatest. In 2012, under the Energy Efficiency Directive 2012/27/EU, the EU set a 20% energy savings target by 2020 which means to reduce the energy consumption from the primary amount of 1,483 million tonnes to the final amount of 1,086 million tonnes. In December 2018, the revised Energy Efficiency Directive entered into force and it establishes a headline EU energy efficiency target for 2030 of at least 32.5% (compared to projections). To reach the EU’s energy efficiency target by 2020, individual countries set their own national energy efficiency targets, which is for Greece to reach the final amount of 18.4 million tonnes from the primary amount of 24.7 million tonnes.

3.1 Energy Audits

On November of 2015 was published the Law 4342/2015, which is the harmonization of the Greek law regarding the Directive 2012/27/EU on energy efficiency. This law sets out indicative national energy efficiency targets for 2020, measures to promote them and rules designed to overcome energy market failures. Based on this law, hotels that employing more than 250 employees and their turnover exceeds the 50 million euros, or their total annual balance sheet exceeds the 43 million euros, are required to undergo an energy audit, which is a systematic analysis and inspection of the energy use and consumption of the hotel with the main objective of identifying potential undesirable energy flows and report how energy efficiency improvements could be implemented in a cost effective manner, by individual group of people, which carrying out such an audit, within the next year and after that, repeated audits every 4 years. The primary goal of the energy audit is to improve hotel’s energy efficiency, reduce energy consumption and bring finally, environmental benefits. For this reason, the energy auditor should collect the following data (European Committee for Standardization (CEN) & European Committee for Electrotechnical Standardization (CENELEC), 2012):

- List of energy using systems, processes and equipment.
- Detailed characteristics of the audited object(s) including known adjustment factors and how the hotel believes they influence energy consumption.
- Historical data:
  - Energy consumption
• Adjustment factors
• Relevant related measurements
➢ Operational history and past events that could have affected energy consumption.
➢ Design, operation and maintenance documents.
➢ Energy audits or previous studies related to energy and energy efficiency.
➢ Current and projected tariff, or a reference tariff to be used for the protection of commercial confidence.
➢ Other relevant economic data.
➢ The status of the energy management system.

The next phase of the audit is the analysis of the collecting data:
➢ The existing energy performance situation becomes a reference against which improvements can be measured. It shall include:
  • A breakdown of the energy consumption by use and source.
  • Energy flows and an energy balance.
  • Pattern of energy demand through time.
  • Relationships between energy consumption and adjustment factors.
  • One or more energy performance indicators.
➢ The energy auditor shall evaluate the impact of each energy efficiency improvement opportunity on the existing energy performance situation based on:
  • The financial savings enabled by the energy efficiency improvement measures.
  • The necessary investments.
  • The ROI or any other economic criteria.
  • The other possible non-energy gains (such as maintenance).
  • The comparison in terms of both cost and energy consumption between alternative energy efficiency improvement measures.
  • Technical interactions between multiple actions.

3.2 ISO 50001 Certification

Alternatively, hotels that implement an energy or environmental management system certified by an independent body in accordance with relevant European or international standards (e.g. ISO 50001) are exempt from the requirements for auditing by energy auditors, provided that such management system includes energy audit based on the minimum criteria set out in Annex VI of
ISO 50001 is based on the Deming methodology of Plan-Do-Check-Act approach, where (TUV UK LTD, 2014):

➢ Plan: Perform an energy review and identify the key energy performance indicators as well as the targets, objectives and action plans that needed in order to deliver results that will improve energy efficiency according to the organization’s energy policy.

➢ Do: The implementation of the energy management action plans.

➢ Check: Monitor and measure procedures as well as the key characteristics of the operations that determine energy performance against the energy policy and objectives and finally report the respective results.

➢ Act: Take actions in order to improve the energy performance and the implemented energy management system.

Similar to almost all the other standards published by the International Organization for Standardization (ISO), ISO 50001 main goal is to achieve, in a systematic way, a continual improvement in energy use, energy efficiency and energy consumption. The relationship between its main elements is illustrated below.

![Diagram](image)

Figure 3.1: ISO 50001 key elements relationship
ISO 50001 requires, apart from the system specifications such as documentation checking, staff training, monitoring of preventive actions, inspection and review, also the following (World Tourism Organization, 2019):

➢ The establishment of an appropriate energy policy in order to state the organization’s commitment for achieving energy performance improvement.
➢ The identification of energy aspects / energy needs and improvement opportunities.
➢ The identification of all the legal and other requirements regarding the energy aspects of the hotel in order to ensure that the hotel complies with all the applicable legislation and also that stays abreast of new or revision of legal and other requirements related to energy uses.
➢ The definition of specific objectives and goals, regarding the efficient use of energy, which completed by the implementation of systematic energy management programs.
➢ The establishment of an organizational structure in order to achieve an effective implementation of the energy management system.

With respect to monitoring of the key characteristics, the hotel should review all significant energy uses to determine which aspects should be monitored in order to check that the controls are being effective. The results help management define appropriate energy performance improvement actions. A monitoring schedule could be drafted in order to facilitate the monitoring activities. According to the standard, key characteristics required monitoring shall include at a minimum (World Tourism Organization, 2019):

➢ Significant energy uses and other outputs of the energy review.
➢ The relevant variables related to significant energy uses.
➢ Energy Performance Indicators.
➢ The effectiveness of the action plans in achieving objectives and targets.
➢ Evaluation of actual versus expected energy consumption.

### 3.3 Leadership in Energy and Environmental Design Certification

Based on the aforementioned regulatory framework, it is clear that for large hotel chains in Greece, it is a mandatory either to undergo recurrent energy audits or to adopt ISO 50001. Moreover, in case that these hotels have already set as a goal to be promoted as green and eco-friendly, they should also adopt Leadership in Energy and Environmental Design (LEED) certification, which is the most widely used rating system for green buildings in the world. LEED certification provides a framework in order to create highly efficient and cost-saving green buildings. For adopting this
certification, hotel should follow specific guidelines and collect points by completing specific steps. Based on the total points that will have been collected, the hotel will be in one of the following four categories: Registered, Silver, Gold or Platinum. The higher the category, the higher the hotel’s public reputation (U.S. Green Building Council (USGBC)).

It is clear from the aforementioned regulatory frame that large hotel chains should adopt not only ISO 50001 but also the LEED certificate in order to be competitive in the new technological era and the trend of being green and eco-friendly. For this reason, almost all the large hotel chains have already signed global agreements with multinational companies such as Schneider Electric, ABB, Siemens, etc. who can provide the proper solution. This solution can be implemented in the following 3 levels.

![3-layer Architecture](source: www.se.com)

4.1 1st Layer - Connected Devices

Digitization of the power distribution has become a reality due to the increased connectivity of devices thanks to the global trend of Internet of Things (IoT). The usage of IoT means that the connected devices can transfer data directly to applications and programs that based on either a cloud or a local server making easier to exchange data and the collaboration among maintenance teams for one or more installations. There are also a lot of devices that offer instant access through a web browser in a computer or even in a mobile phone. The most popular and widely used communication protocols are Modbus RTU, Ethernet and the wireless protocol Zigbee. In this case of a large hotel, the transferred data is mainly from the medium voltage panel which is the heart of the electrical installation. For this reason, it is proposed to be equipped with a monitoring system that enabling the user to monitor its operation in order to:
➢ Increase operation time.
➢ Minimize maintenance time.
➢ Minimize maintenance cost.
➢ Improve operator and equipment safety.

Apart from the medium voltage panel, since the primary goal of the usage of connected devices is to reduce the energy costs and carbon emissions while meeting the regulatory demands that have already mentioned before and satisfying customer comfort, convenience and expectations for sustainable hotel, the transferred data is also from:

➢ Guestroom Management System: integrates with the building management system in order to provide accurate information regarding the energy consumption and even turn off services in guest rooms in case that these are unoccupied.
➢ Door Lock System: integrated access control that enhance the hotel security and provide accurate information regarding all the hotel’s areas.
➢ Lighting: smart lighting control and EMS provide advanced monitoring and reporting capabilities that lead to reduce energy consumption, reduce maintenance cost and improve lighting efficiency.
➢ Heating, Ventilation & Air conditioning (HVAC): smart sensors provide accurate information in order to activate the system only when required and turn off the system when areas are vacant for a period of time.
➢ Elevators: intelligence elevators through the connected devices, provide accurate information leading to less unnecessary trips. Through the monitoring of these devices, help in proactively taking maintenance measures saving not only money but also time.
➢ Video Surveillance: advanced monitoring system providing information regarding all the hotel’s areas enhancing the security for property, hotel assets, staff and guests.
➢ Emergency lighting control: connected controller provides information regarding the status of each sign, the status of the battery in order to know when maintenance is required. There is also the capability to turn off all the signs simultaneously in case that the hotel should close for a period of time.
4.2 2\textsuperscript{nd} Layer - Edge Control

Smart buildings, such as large hotels, demand simple integration across systems and easy access to IoT devices. It is of paramount importance in order to achieve this, the use of the appropriate software that deliver the necessary insights so as to better manage and optimize buildings, improve maintenance efficiency and increase the cybersecurity as well as compliance needs. Mission-critical scenarios can be unpredictable, so control of devices at the edge of the IoT network is a must. This essential capability provides real-time solutions that enable local control at the edge, protecting safety and uptime. The software facilitate the secure exchange of data from the smart devices of the systems that have already mentioned above and the hotel management system while leveraging digitization and big data. The main benefits of such software are that provide the following:

- Open, end-to-end internet protocol (IP) solution that maximize opportunities in data-intense modern hotels providing:
  - Higher bandwidth for more data throughput.
  - Greater design flexibility.
  - Access to cloud and connected devices.
  - Faster and more reliable communication.
  - Easier support and as a result lower operation cost.

- Data management and visualization tools that make easier and smarter insight-based decisions:
  - Directly access to data without the usage of other tools.
  - More data stored and accessed so as to have unlimited historical data migrated to external timescale database.
  - Customized charts and graphs to convey large amount of data.
  - Customized dashboards for easier monitoring and more accurate and speedier decision making.

- Maintenance and commissioning faster than ever before:
  - Standard and configurable applications that lead to no need for design and build up from the ground.
  - All the applications included easily can be integrated with the other solutions.
  - Multi-version support to upgrade the system.

- Exceptional user experience with access anywhere at any time increasing the convenience and efficiency:
- Concise reports, alarms, notifications and trends.
- Customized user interfaces and dashboards.
- Attractive and scalable graphics.

As it is already mentioned before, there are different software that can be used in order to integrate all assets, systems, devices, and services for monitoring, analysis, and control to help hotel’s managers to improve financial performance and operational efficiency, reduce carbon emissions and energy costs, and maybe reinvest savings into the guest experience. These software could cover:

- **Building operations management**: building management software for optimized performance. It integrates and facilitates data exchange in order to improve staff productivity, reduce guest complaints, and enable superior operational efficiency and guest room functionality.
- **Guest room management**: it provides centralized visibility and control to both individual guest rooms and the entire network of rooms.
- **Power monitoring management**: this is maybe the most important software since the uninterrupted power supply of the hotel is of paramount importance for the operator who should be in position to see, analyze and quickly understand where the damage occurred in order to solve it as soon as possible. It also provides diagrams, reports, dashboards and real time data providing immediate monitoring and updates regarding the status of the equipment and installations.

### 4.3 3rd Layer - Apps, Analytics & Services

The third layer consists apps, analytics and services and enables advance analysis and condition based real-time decision-making. This layer gives users complete visibility of all connected products in their ecosystems, while delivering the analytics needed to drive efficiency. The software in this layer works as advisor to hotel’s engineers, operators and managers regarding the following:

- **Resource software platform**: Enables the manager to simultaneously operate the energy supply, sustainability and energy efficiency data. In this way, the manager can reduce the energy consumption, optimize energy supply with procurement and budgeting best practices through the collection, aggregation, verification and analysis of the energy and sustainable data.
- **Power software platform**: Increases metering diagnostics from device-based troubleshooting to full system analysis in order to validate the quality of the provided data and identify potential
gaps and issues in the hotel’s power management and power quality systems. The main purpose of this software is to keep the stakeholders aware of the energy performance and set the path to corrective actions that improve the health of the hotel’s electrical network. In this way, by carefully managing the energy consumption and costs make the most of capital and operating budgets and help the managers to meet all the sustainability goals.

➢ Asset software platform: Evaluates live data from the connected devises and applies advance analytics in order to identify potential threats. In this way, the operators move to proactive maintenance of the critical parts so as to avoid unplanned downtime which is a disaster if happened during the high season for a large hotel.

In the next chapter, taking into account the case study of a 5-star hotel in Halkidiki, a certain methodology has been followed in order to end to specific conclusions and results.
5. Case Study

In this chapter, a 5-star hotel in Halkidiki has been used as a case study where an EMS has been implemented so as to increase the hotel’s energy efficiency in order to meet its objectives. It is a 5-star hotel that includes 290 rooms and suites in a garden of 60 acres. There is also a deluxe collection building that provides more personal space and sought-after services. There are also 6 restaurants, 5 pools and spa as well as 2 private beaches. Moreover, there are 3 gyms, 6 coffee spaces, where the visitor can play board games, 3 tennis courts and another 2 basketball courts and also 2 cinemas and 1 large theater. This is a large hotel with a lot of rooms and other areas that consume a lot of energy, especially during the high season period. This means that apart from their potential obligation to fulfill the regulations regarding energy efficiency and the respective energy audits and certifications, they need also an EMS in order to reduce the continually rising operation costs.

5.1 Methodology

The dissertation followed mainly a real case study. The first part is a personal interview with the hotel’s general manager and operational manager in order to understand their needs and how these could be satisfied. The main point in which they focus on was that they would like to find a way in order their investment to combine a positive ROI and an increase of the guest’s delight. For this reason, they mentioned that the hotel management developed a survey, a printed version of which they put it in the desktop of each room so as the guest to have the opportunity to fill it in before leaving the room. They run this survey for 10 months and the main objective of this survey was to understand visitors’ preferences, what they would like from the hotel to offer to them and also some information that would be really helpful for the hotel managers in order to steer their investments and changes to the right direction.

The sample that they used was the hotel’s guests. The survey had 2.500 responses, which includes only the responses where all the questions had been answered properly and represents a response rate of 56,8% since there were almost 4.400 visitors during this period. The questionnaire structure was as follow:

1. Section I addressed the general information regarding the demographics of the visitors and their habits taking into consideration the hours that they spent in each place of the hotel.
2. Section II was comprised of questions regarding the delight of the visitors.
3. Section III included questions regarding the importance of green hotel practices and their willingness to pay for them.

Based on the results of this questionnaire, that will be presented in the next chapter, and taking into consideration how these could affect hotel’s cost management and after analyzing the key drivers that affect the ROI of the hotel EMS, specific solutions suggested to the managers and after that, they proceeded with investments where the ROI, IRR and NPV are calculated in order to evaluate whether the investment was worth it or not. In order the managers to check the rightness of their decision regarding the investment, they took into consideration not only the aforementioned economic factors but also factors related to marketing that are very important in the guest’s decision to stay at the hotel again or to recommend this hotel to others.

5.2 Questionnaire - Data Presentation

As it is already mentioned before, the hotel management designed a questionnaire in order to understand better guests’ needs and expectations so as to start their investment from the most important, for them, places of the hotel. This questionnaire designed and used only for internal purposes in order the managers to understand the guests’ preferences. The section I includes the average hours that the guests spent per day in each place of the hotel during their stay. The guests spent an average of 11 hours per day in their room, which responds to 45.83%, followed by restaurant, where they spent an average of 4 hours per day (16.67%), the pool with an average of 3.5 hours per day (14.58%), the common areas with an average of 3 hours per day (12.5%) and finally, the beach with an average of 2.5 hours per day (10.42%). It is clear from the above analysis that the hotel’s operators spent a significant portion of their budget on guestroom energy consumption and for this reason, it is of paramount importance that interventions in this area should be included in the investment plan.

<table>
<thead>
<tr>
<th>Hotel’s Place</th>
<th>Average Hours per Day</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room</td>
<td>11</td>
<td>45.83%</td>
</tr>
<tr>
<td>Restaurant</td>
<td>4</td>
<td>16.67%</td>
</tr>
<tr>
<td>Pool</td>
<td>3.5</td>
<td>14.58%</td>
</tr>
<tr>
<td>Beach</td>
<td>2.5</td>
<td>10.42%</td>
</tr>
<tr>
<td>Common Areas</td>
<td>3</td>
<td>12.50%</td>
</tr>
</tbody>
</table>

Table 5.1 Average hours per day spent by guests in each hotel’s place

Source: Based on data from hotel’s questionnaire
The question regarding the days that the guests stayed at the hotel showed (Figure 5.2) that the vast majority (86%) stayed multiple nights and only 14% stayed only for one day. This means that the data from Figure 5.1 should be taken seriously into account since the guests had enough time to visit all the places and as a result, they allocated their time based on their needs.

<table>
<thead>
<tr>
<th>Accommodation</th>
<th>Number of Guests</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>One night</td>
<td>350</td>
<td>14.00%</td>
</tr>
<tr>
<td>Multiple night</td>
<td>2150</td>
<td>86.00%</td>
</tr>
</tbody>
</table>

Table 5.2 How many days guests stayed at the hotel

Source: Based on data from hotel’s questionnaire
Another important question is regarding the demographics of the guests. Demographics is also one of the key drivers of the ROI of the hotel EMS since it can be an indicator of their occupancy habits. This information is of vital importance for the hotel operator since can be a guidance regarding how to set more optimum the respective settings.

From the figure 5.3 below, it is clear that the vast majority of the guest is vacationing families (73.2%), followed by business travelers (22%) and retired couples (4.8%). Taking into account some characteristics of each category, it is easier for the managers to understand better what and where should make changes in order to maximize the energy savings. Vacationing families are more likely to spend more time in their room during the morning and afternoon in order to take advantage of the hotel’s amenities. By contrast, business travelers, are more likely to depart early from their room for meetings and then to spend most of the day away from their rooms having business meals and entertainment.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Number of Guests</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Travelers</td>
<td>550</td>
<td>22.00%</td>
</tr>
<tr>
<td>Vacationing Families</td>
<td>1830</td>
<td>73.20%</td>
</tr>
<tr>
<td>Retired Couples</td>
<td>120</td>
<td>4.80%</td>
</tr>
</tbody>
</table>

Table 5.3: Guest’s demographics

Source: Based on data from hotel’s questionnaire
Figure 5.3: Guest’s demographics

Source: Based on data from hotel’s questionnaire

From the analysis of the collected data above, it is clear for the managers that they should focus on the guestroom control since it seems that based on the demographics of the guests, the days that they stayed at the hotel and the average time that they spent per day in the different places of the hotel, this is one of the hotel’s places that consume the most energy.

The next section includes questions regarding the guest’s delight. Customer’s delight has already been defined from 3 different perspectives. In the first one, Patterson (1997) mentioned that the delight includes a pleasant experience which goes beyond just a satisfaction. Keinningham at al. (1999) mentioned that for each guest there is a specific threshold in his zone of tolerance and if the experience performing beyond that threshold, then this is a pleasant and lead to his delight. Finally, Schneider & Bowen (1999) mentioned that for all the customers, their delight is the function of the satisfaction of three human needs: justice, secure and self-esteem. Through these questions, the hotel’s manager tried to identify what they should do in order to increase the customer’s delight and for this reason the main question focused on what should be improved or what the customers feel that decrease their delight.

The main cause of dissatisfaction is that the room often is not at the desired temperature (61.8%). This is because of the key card holder system. When the guests enter their room, they place the card in the designed holder in order to take the control of the heating and air-conditioning as well as the light, which is the second cause of dissatisfaction (17.8%). With this system, when the card is removed, these two systems are switched off. Thus, when the guest comes back to the room, the room does not have the right temperature or light. Another important cause of dissatisfaction is that the pool does not have the desired temperature (12.9%) especially when the weather is not too warm.
This is because there is not a central control of all the pools and there are no sensors in order to activate the respective system (warm / cold) when is needed. Finally, there are also other causes of dissatisfaction but with very few answers such as poor restaurant & lobby services (4.0%), lack of professionalism of the staff (3.2%) and lack of sense of security (0.6%).

<table>
<thead>
<tr>
<th>Cause of Dissatisfaction</th>
<th>Number of Guests</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room's Temperature</td>
<td>1538</td>
<td>61.5%</td>
</tr>
<tr>
<td>Room's Light</td>
<td>445</td>
<td>17.8%</td>
</tr>
<tr>
<td>Pool's Temperature</td>
<td>322</td>
<td>12.9%</td>
</tr>
<tr>
<td>Restaurant and Lobby service</td>
<td>100</td>
<td>4.0%</td>
</tr>
<tr>
<td>Professionalism</td>
<td>80</td>
<td>3.2%</td>
</tr>
<tr>
<td>Security</td>
<td>15</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

Table 5.4: Causes of guest’s dissatisfaction
Source: Based on data from hotel’s questionnaire

Section III includes questions regarding the importance of green hotel practices and guest’s willingness to pay for them. The first question is how important is for you the hotel’s effort to be environmentally friendly. The answers are from 1 (I do not care) to 5 (it is of paramount importance).
Table 5.5: The importance of hotel’s effort to be green

Source: Based on data from hotel’s questionnaire

<table>
<thead>
<tr>
<th>Importance</th>
<th>Number of Guests</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>575</td>
<td>23%</td>
</tr>
<tr>
<td>4</td>
<td>1125</td>
<td>45%</td>
</tr>
<tr>
<td>3</td>
<td>450</td>
<td>18%</td>
</tr>
<tr>
<td>2</td>
<td>250</td>
<td>10%</td>
</tr>
<tr>
<td>1</td>
<td>100</td>
<td>4%</td>
</tr>
</tbody>
</table>

Figure 5.5: The importance of hotel’s effort to be green

Source: Based on data from hotel’s questionnaire

It is clear from the above figure 5.5 that the majority of the guests answered that it very important for them since the sum of answer 5 (23%) and 4 (45%) is over the two third of the total answers. If we take into consideration also the answer with grade 3 (18%), the total guests that they mentioned that the fact that the hotel they visited is eco-friendly has little (2 with 10%) or no importance (1 with 4%) is only 14%. Since for the vast majority of the guests, hotel’s effort to be green is very important, it is very interesting also the next question regarding their intention to support such a hotel by paying a premium at the usual rate. It is very important to analyze if there is a difference between the intention of the guests to support green hotels and their willingness to pay a premium for this reason.
<table>
<thead>
<tr>
<th>Willingness</th>
<th>Number of Guests</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>730</td>
<td>29%</td>
</tr>
<tr>
<td>4</td>
<td>1327</td>
<td>53%</td>
</tr>
<tr>
<td>3</td>
<td>235</td>
<td>9%</td>
</tr>
<tr>
<td>2</td>
<td>128</td>
<td>5%</td>
</tr>
<tr>
<td>1</td>
<td>80</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table 5.6: Willingness of guest to pay a premium for staying at green hotel

Source: Based on data from hotel’s questionnaire

Based on the above figure 5.6, the 29.2% of the responders strongly agree to pay a premium in order to support a green hotel, the 53.1% agree, the 9.4% are neutral, the 5.1% disagree and only the 3.2% strongly disagree. Thus, almost the 91.7% of the sample are willing to pay a premium for eco-friendly hotel despite the fact that less (86%) of them consider this as important factor for their choice.

Taking into account all the answers of the aforementioned questionnaire, it is clear that the hotel management should proceed with an investment in EMS in order not only to increase the guest’s delight, decrease the operation and maintenance cost but also to increase hotel’s reputation and even more the rate per night as a green and eco-friendly hotel. The EMS should be installed covering all the hotel buildings and facilities and more specifically, to focus on the guestroom energy management since the room is the place where guests spend most of their hours during a day. Rooms are also related to the main reasons of guests’ dissatisfaction and they are the main reason for a
guest to choose and pay a premium in order to stay at such a hotel. All these results had been taken into account by the management before proceeding with the respective investments, but they were not the only that affected the final decision since they designed and executed this survey in order to have an idea regarding the guests’ opinion for these issues. In the next chapter, there is a description of the hotel’s initial condition before the investment and what this means related to energy operation cost.

5.3 Initial Energy Operation Cost

The hotel includes 290 rooms and suites as well as other facilities such as pools, restaurants, etc. Initially, the hotel had none of the three layers of an EMS. This means that there was no way to get measurements regarding the energy consumption of every room separately. Moreover, there was even no way to calculate the energy consumption of each building or among facilities since only the total amount of the consumed energy was available through the Public Power Corporation (PPC) and the respective total operation cost can be calculated taking into account the average cost of the energy unit during one year. The total energy consumption between June 2017 and June 2018 was 2,037,500 Kilowatt Hours and the average price per Kilowatt Hour was 0.118€/KWh (Market Observatory for Energy of the European Commission, 2018). Thus, the total operation cost that related to the energy consumption for the aforementioned time period was 240,425€. This price does not include any taxes or other charges that increase significantly the total amount that should be paid to the PPC since they are percentage of the net price.

Based on Bohdanowicz et al. (2001), a typical breakdown of how the energy is used within the hotel environment is shown in the figure 5.7 below, taking into account various factors such as the type and size of hotel, location and other parameters.
It is clear that the climate has a significant effect on the overall used electricity. Almost half of the total electrical energy is used for this reason. Depending on the category of the hotel, the lighting can be up to 12% - 20% of the total energy consumption and in some cases can be up to 40% (EU – Rational Use of energy in the Hotel Sector, 1994).

Based on the results of the questionnaire, the fact that the largest portion of the energy consumed in the hotel comes from the heating, air conditioning, ventilation, cooling and lighting systems and the intention of the hotel’s management to proceed initially to a limited investment, the hotel management decided to install initially, an EMS in the guestrooms and the public areas of the hotel. In the next chapter, the installed EMS is described, the key drivers that affect the ROI of the investment are analyzed and the ROI, IRR and NPV are calculated.

5.4 Implementation of the Energy Management System

The implemented EMS utilize sensors and controls in order to adjust heat, ventilation and air conditioning (HVAC) as well as lighting and all the other environmental factors in guestrooms, based on scenarios that run according to whether the room is occupied or not, and public areas such as lobbies, the front desk, guest corridors, bars, etc. These systems are set up in different ways.
Initially, regarding the guestrooms, instead of installing the traditional key card holder system, where the HVAC and lighting system switched off when the card is removed and as a result, when the guest comes back, the temperature and lighting are not at the desired level, they installed a guest presence detection system which requires the combination of the door status and the movement detection. Unlike the key card holder system, where the system can be bypassed using a second key card, this system cannot be bypassed and also it is compatible with new access control devices such as mobile phones that can be used in order to enter the room. These systems include wireless door and window contact sensors as well as a room controller with on-board presence detection in order to identify guest’s presence in the room. Although a motion sensor can be a solution for presence detection in the bathroom so as to control the lighting, this is not valid for the living room or bedroom where several parameters should be taken into account. As it is already mentioned before, in order to achieve the combination of the door status and the detection of presence and based on the shape and size of the room, different number of sensors should be used in each case.

In case that the room is unoccupied based on the signal of the installed sensors, the system adjusts the lighting and HVAC to specific settings based on pre-determined scenarios. Then, when the guest comes back, new scenarios are run, and the lighting and HVAC’s settings restored, and the guest can regain the respective manual control. Based on the advanced capabilities of this system, the scenarios may include different target temperature settings that can be fluctuated up or down in a pre-determined way activating the heating or cooling system in the guestroom. Since these devices are connected and integrated to a central EMS, the hotel operator and main user of these software can design the scenarios by selecting the respective parameters. The main goal of these scenarios is to ensure that the lighting and the temperature of the guestroom is at the desired level and at the same time the vacant energy expense is eliminated when the room is unoccupied. When the guest comes back, the settings return to the normal scenario increasing the guest’s delight.

Apart from the scenarios that the operator may design, there are also ready to use scenarios based on the historical data of the EMS. Thus, it is possible, when the room is unoccupied, the scenario that run to include a signal that send to the light switches to turn off any light that is left on, the electrical circuits are also turned off and there is also the capability to decide which outlets to remain on so as the guest to have the opportunity to recharge the laptop or mobile phone while his absence. In the same way, heating and cooling settings can be programmed taking into account a time delay based on operator’s preferences or historical data analysis. Moreover, in order to increase the energy
efficiency, the door and/or window sensors can send signal so as to stop the heating and cooling system when they are open.

In order to increase the energy efficiency, it is of paramount importance for the staff of the hotel to have access to the screens of the EMS so as to control and monitor the energy consumption of each room and design or decide which scenario to activate based on the category of the room which can be occupied, rented but unoccupied or not rented. For each of these categories of rooms, there are different energy optimization scenarios. All the installed sensors gather information regarding the comfort, safety and energy consumption per room and the energy management software analyze the data and turn it into actionable insights that increase the guest’s delight and reduce the operational cost.

The software in the 3rd level of the EMS provide artificial intelligence that receive the data, analyze it and through this analysis, identify problem conditions in various rooms and can also provide suggestions and actions that should be taken into account in order to address the problematic situations. This type of problem detection and diagnostics is saved to cloud-based data storage so as to be accessible from various places and devices. These software can also provide a detailed report that includes not only problems of the equipment and system but also proposals for operational improvements and energy usage trends. Moreover, the software provide analysis for avoidable costs and energy savings during specific time periods.

In the same way as in the rooms, respective system installed also in the hotel’s public areas where the scenarios designed based on the different time slots of the day since in this case, the three categories of the rooms are not valid. Thus, there are different scenarios for morning, noon, evening and night and also customized selections based on the completeness of each floor. The aforementioned software receive also data from the public areas providing the respective analysis and proposals.

5.5 Return of Investment (ROI) Key Drivers and Energy Efficiency Benefits

There are a lot of key drivers that affect the ROI of the hotel EMS. The better understanding of these drivers lead to maximize the energy efficiency benefits and minimize the payback periods. The key drivers are the following:

1. Installation Costs: These costs are minimized using wireless devices not only in rooms but also in the public areas which required the minimum effort since it is really simple such as installing
a light switch. Another important thing is that these installations did not restrict hotel’s daily operation and did not require to shutdown individual floors. Since the installations completed in the period between spring and summer, there was also the capability to install the system in each room when this room was unrented since required less than a day.

2. Management Strategy: The guestroom EMS helps hotel’s managers and operators to develop effective management strategies since all the decisions are based on real data provided by the sensors to the central software that analyze and propose solutions and improvements. All these have a positive impact on hotel’s performance and profitability.

3. Room Efficiency: It is commonly accepted that all the rooms do not have the same energy efficiency since there are a lot of factors that affect it such as the room’s orientation, the insulation status and any potential thermal leakages. Based on the received data from each room and the provided reports from the software of the EMS, the operator can decide the order in which the rooms will be rented starting from the most efficient to the least.

4. Location: Apart from the climate that affect the energy consumption and as a result the ROI of the EMS, there are also other local variations such as the average cost per Kilowatt Hour that depends on many factors and fluctuates during a long period of time.

5. Hotel’s Size: The software of the 2nd and 3rd level of the EMS is a fixed-one-time expense and spread over all the available for rent rooms. This means that large hotels with a high number of rooms will experience a faster ROI. In this case, the hotel includes 290 rooms and suites and the cost per room for this equipment is limited.

6. Demographics: This analysis has already been held using the questionnaire analysis above. It is very important also for the ROI since it is an indicator for the habits of each demographic category and helps hotel’s operator to understand better the energy savings that may expect.

7. Incentive and Funds: The EU has increased the amount of public funds available for energy efficiency. At the EU level, the European Structural and Investment Funds (ESIF) will allocate €18 billion to energy efficiency in the period 2014-2020 in order to boost such investments since this is one of the most important and strategic priorities. Furthermore, the EU has already developed other support schemes in order to help businesses such as hotels to implement projects related to energy efficiency. The implementation of the EU’s energy strategy in order to reach the climate objectives for 2030 necessitates over the period of 2021-2030 an additional €177 billion per year (European Commissioning, 2019).
The fact that the installed system is not a standalone system, but a networked and integrated system is also very important since provide significant benefits such as:

1. Eliminate unnecessary expenses for unrented rooms: When a room is rented but unoccupied, then certain scenarios may run in order to increase not only the energy efficiency but also the guest delight. The fact that the installed system offers a networking, integrating and centralized control is of paramount importance for the unrented rooms which can be set to specific settings that can decrease the setpoint in heating and cooling seasons and even to shut them down increasing the energy efficiency and eliminating the unnecessary expenses. The ability to have the control of each room changing immediately the settings when the status of each room changed, has a significant impact on ROI and reduce the payback period, especially for this hotel in Halkidiki, which for almost 3 months is closed and the rest 9 months, only for almost 5 months the occupancy rate is higher than 80%.

2. Increase guest delight and revenue: The main priority for a hotel manager is the guest’s delight and for this reason, directly affects the profitability. Based on 2012 research by Cornell’s Center for Hospitality Research “If a hotel increases its review scores by 1 point on a 5-point scale … the hotel can increase its price by 11.2% and still maintain the same occupancy or market share”. The guest delight increased by the following:
   a. When something goes wrong to a rented room, the system send a signal and preventive maintenance takes place before there will be any guest complain.
   b. The operator has the ability to change the parameters of a room remotely so as to accommodate a guest.
   c. Pre-heating or pre-cooling scenarios can be run immediately after just the room having been rented instead of waiting until the guest enters the room and control it manually.
   d. Guests can change the language of the thermostat and select their native language making the usage of it much easier.
   e. When a window or door has been left open for a long period of time, a signal send to the operator and the maintenance personnel can check if something serious has happened especially in cases of rented but unoccupied rooms.

3. Decrease Maintenance Cost: By installing networking controllers inside the guestrooms, the maintenance process converted from reactive to proactive mode. Many problems can be resolved remotely, and the respective software recognize performance problems and propose
prevented actions so as to proceed with the essential repairs with lower cost and less guest disruption.

### 5.6 ROI, IRR & NPV Calculations

The connected devices that installed inside the rooms and the public areas and the software installed in the hotel’s main server, followed all the above analysis in order to increase the guest’s comfort and decrease the operation and maintenance costs and in parallel minimize the payback period of the investment.

The installation of all the systems completed in May 2018 and the measurement of the energy consumption started from June 2018 to June 2019. Compared to the previous year (June 2017 – June 2018) the energy consumption decreased by 285,500 Kilowatt Hours. Since the EMS installed only in the rooms and public areas, we can assume that this reduction came from this investment and should be taken into account in the calculation of ROI. Based on the price of the Kilowatt Hour for businesses which was 0.18€ per Kilowatt Hour (GlobalPetrolPrices, 2019) the total energy savings is almost 33,700€. The average installed cost per room was approximately 275€ per room and the cost for the respective software and licenses was approximately 55,100€ which corresponds to 190€ per room. Thus, the total project cost was 134,850€ or 465€ per room. The ROI timeframe is approximately 4 years.

The basic formula for ROI is:

$$\text{ROI} = \frac{\text{Gain from Investment} - \text{Cost of Investment}}{\text{Cost of Investment}}$$

For a time period of 7 years,

$$\text{ROI} = \frac{(33,700 \times 7) - 134,850}{134,850} = \frac{101,050}{134,850} = 0.7493 \text{ or } 74.93\%$$

The formula in order to calculate the annualized ROI is:

$$\text{Annualized ROI} = (1 + \text{Total Return})^{\frac{1}{\text{Time (years)}}} - 1 = (1 + 0.7493)^{\frac{1}{7}} - 1 = 1.083166 - 1 = 0.083166 \text{ or } 8.3166\% \text{ per year.}$$

The IRR is the discount rate that makes the NPV of the investment zero. The IRR formula is as follows:
NPV = CF₀ + \frac{CF₁}{(1+IRR)} + \frac{CF₂}{(1+IRR)^2} + \frac{CF₃}{(1+IRR)^3} + \ldots + \frac{CFₙ}{(1+IRR)^n} = 0

Where:

CF₀ = Initial Investment / Outlay

CF₁, CF₂, CF₃, … CFₙ = Cash flows

n = Each Period

In this case, the IRR calculated for a period of 7 years since after that period, we assume that the license expired and the connected devices it is highly possible that should be replaced. For this period of time the IRR is equal to 16.314%.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flows</th>
<th>PV of Cash Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-134,850.00 €</td>
<td>-134,850.00 €</td>
</tr>
<tr>
<td>1</td>
<td>33,700.00 €</td>
<td>28,973.30 €</td>
</tr>
<tr>
<td>2</td>
<td>33,700.00 €</td>
<td>24,909.55 €</td>
</tr>
<tr>
<td>3</td>
<td>33,700.00 €</td>
<td>21,415.78 €</td>
</tr>
<tr>
<td>4</td>
<td>33,700.00 €</td>
<td>18,412.04 €</td>
</tr>
<tr>
<td>5</td>
<td>33,700.00 €</td>
<td>15,829.60 €</td>
</tr>
<tr>
<td>6</td>
<td>33,700.00 €</td>
<td>13,609.37 €</td>
</tr>
<tr>
<td>7</td>
<td>33,700.00 €</td>
<td>11,700.54 €</td>
</tr>
</tbody>
</table>

Table 5.7 Cash flows for 7 years

NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. The expanded formula for NPV is

\[
NPV = \frac{FV₀}{(1+r₀)^t₀} + \frac{FV₁}{(1+r₁)^t₁} + \frac{FV₂}{(1+r₂)^t₂} + \ldots + \frac{FVₙ}{(1+rₙ)^tₙ}
\]

where FV₀, r₀, and t₀ indicate the expected future value, applicable rates and time-periods for year 0 (initial investment), respectively, and FVₙ, rₙ, and tₙ indicate the expected future value, applicable rates, and time-periods for years n. In this case, n is equal to 7 years, r₀ is equal to 4%.

\[
NPV = \frac{-134,850}{(1+0.04)^{0}} + \frac{33,700}{(1+0.04)^{1}} + \frac{33,700}{(1+0.04)^{2}} + \frac{33,700}{(1+0.04)^{3}} + \frac{33,700}{(1+0.04)^{4}} + \frac{33,700}{(1+0.04)^{5}} + \frac{33,700}{(1+0.04)^{6}} + \frac{33,700}{(1+0.04)^{7}}
\]
NPV = \(-134,850 + 32,403.85 + 31,157.54 + 29,959.17 + 28,806.9 + 27,698.94 + 26,633.6 + 25,609.23\)

NPV = 67,419.23

<table>
<thead>
<tr>
<th>Number of Rooms</th>
<th>290</th>
<th>Average Installed Cost per Room (€)</th>
<th>275</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Energy Consumption (KWh)</td>
<td>2,037,500</td>
<td>Software &amp; Licenses Cost per Room (€)</td>
<td>190</td>
</tr>
<tr>
<td>Electricity Reduction (KWh)</td>
<td>285,500</td>
<td>Total Cost per Room (€)</td>
<td>465</td>
</tr>
<tr>
<td>Total Energy Savings (€)</td>
<td>33,700</td>
<td>Project Cost (€)</td>
<td>134,850</td>
</tr>
<tr>
<td>ROI Timeframe (years)</td>
<td>4</td>
<td>IRR (over 7 years)</td>
<td>16.31%</td>
</tr>
<tr>
<td>ROI (over 7 years)</td>
<td>74.93%</td>
<td>NPV (over 7 years) (€)</td>
<td>67,419.23</td>
</tr>
<tr>
<td>Annualized ROI</td>
<td>8.32%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8 Impact of Investment on Energy Cost

Apart from the rapid payback period, the study above showed an IRR over 7 years of 16.31% and an NPV over 7 years of 67,419.23€. The fact that NPV is positive means that the projected earnings generated by this investment exceeds the anticipated costs and as a result will be a profitable investment. Moreover, an IRR of 16.31% means that the investment is attractive.

**5.7 Marketing of Green & Eco-friendly Hotel**

The main purpose of the investment that has already been described above was to increase guest’s delight and reduce the energy efficiency of the hotel and as a result the respective operation and maintenance cost which is of paramount importance for the viability of such a business. Furthermore, the implemented EMS helps the hotel to be more environmentally friendly since increase the energy efficiency through the decreasing of energy consumption and as a result the reduction of its carbon footprint. Taking also into consideration the questionnaire’s results regarding the importance of the green profile in guests’ decision and even their willingness to pay more in order to stay in such a hotel, managers decided to proceed also with practices that would have a positive impact in hotel’s reputation as green and eco-friendly with limited cost compared to the cost of the EMS. Managers also invested in water-saving equipment and techniques as well as reduce dramatically the waste hauling through recycling and avoiding wastefully packaged products. Moreover, hotel followed also more eco-friendly practices such as a voucher of 10€ for the hotel’s restaurant for each day that the guests decide that they do not want their room to be
cleaned or if they get new towels every 3 days instead of everyday. All these practices helped the hotel to be promoted as green and eco-friendly and become a member of Green Hotel Association attracting more and more guests.

5.8 Recommendations for further Investments

Hotel’s owners and managers decided to install connected devices only in the guestrooms and the public areas. Since the ROI timeframe of the implemented investment is only 4 years, the annualized ROI 8.32%, the IRR 16.31% over 7 years and the NPV 67,419.23€ over 7 years, this means that the initial investment is profitable and attractive and for this reason the hotel’s managers should also install connected devices to other areas such as the kitchen of the restaurants, the pools as well as the medium voltage and the transformers in order to increase further the energy efficiency of the whole business and reduce the operation and maintenance costs. In this way, the payback period for the servers, software and licenses costs will be reduced further since these costs will be distributed also to other places apart from the rooms. Moreover, there is no need for other software and licenses since the current EMS can also gather information for all the new sensors and has the capability to analyze them and propose the proper improvements and solutions and as a result the only cost that should be taken into account will be the new connected devices. After proceeding to such an investment, the hotel’s managers and operators will have the opportunity to control the whole hotel since they will get measurements from each system, they will prepare scenarios for all cases and also reduce significantly the total maintenance cost since the software will provide proposals for the maintenance of the central system of the hotel that provide energy, from PPC, to the different areas which is critical, especially during the high season period. This is of paramount importance because if something happened in the medium voltage of the hotel, then the cost will be huge since the hotel will be out of operation for a long period of time which will be a disaster not only financially but also regarding the hotel’s reputation.
6. Conclusion

This dissertation provides an analysis of the EEM in hotel segment in Greece. Two opposing views presented, through the literature review, where on the one hand, the authors describe the importance of the implementation of an EMS and on the other hand, others stand on the barriers that exist against this implementation. Regardless of the opinion of the hotel managers regarding which of the two views is the right one, there are a lot of cases in which the implementation of such an EMS is a mandatory based on the EU and Greek law. An in-depth analysis is presented regarding the options that the management has in order to be in accordance with the current regulatory framework so as to avoid any potential fine. Whether it is a mandatory or a desire of the hotel management to install such a system, a 3-layer architecture for EMS is presented and the capabilities and benefits of each layer are highlighted so as to be easier for the management to decide the degree of investment taking into account the importance of each layer. There are different combinations of devices and software that could be chosen with different respective cost that could meet better the needs of all the hotel types, maximizing the benefits and minimizing the payback period, which is of paramount importance for the hotel’s cost management.

A real case study is used in order to prove regarding the effectiveness of the EMS and confirm all those that are in favor of its implementation. Through this case study, this paper provides a solution that can help the hotel managers and operators to meet all their goals such as to increase the energy efficiency, to decrease the operation and maintenance cost and the most important, to increase the guest’s comfort and delight. There are a lot of cases in which all these are disputed because of the total cost. Through the analysis of the installed EMS, savings of hundreds of euros per room per year have been verified providing a rapid ROI and a positive IRR and NPV. Taking also into consideration the fact that the implemented EMS is totally integrated and connected, provide an unprecedented level of visibility and control of energy use increasing significantly the provided benefits. The key drivers of ROI are also analyzed since they are very important for hotel managers since by understanding them, they can ensure that they will have an EMS that meets their needs, works within a defined budget and pays for itself by optimizing the energy efficiency. This is valid not only in the case of a very large hotel, as this in the case study but also for all types of hotel if the proper EMS will be chosen.

Apart from the direct financial benefits from the implementation of an EMS, there are also indirect benefits which are related to marketing and the willingness of the guests to pay a premium for green hotels since an EMS is the key point in order a hotel to increase its energy efficiency and to be
classified as green and eco-friendly. Taking into account the answers of the guests in the respective questionnaire that the hotel management designed and also the respective literature review, it seems that there is a strong relationship between environmental worldviews and the willingness to pay a premium for eco-friendly hotels. The vast majority of the hotel guests mentioned that they would choose a hotel based on its green practices and even more stated that they would pay an extra in order to support and enhance such practices. There is no possibility for a hotel to become green and eco-friendly without the implementation of the appropriate EMS. Thus, the installation of the EMS is the first and the most important step in order to get all the benefits of an eco-friendly profile. Finally, analysis for continuous improvements and innovation is presented. The EMS has the capability to be expandable. This means that there would be more connected devices that could be installed in different places of the hotel and they could be integrated to the existing system in order to gather real data from all the installations and provide the respective solutions in an easy and cost-effective way.
7. References


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