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Master Thesis

SUSTAINABLE OPERATIONS IN HOTELS:

Methodology to benchmark the water consumption in small and medium-sized hotels in Germany

International Master of Science in Construction and Real Estate Management

Submitted on 22.08.2017 from

Mariana Hernáiz
s0552952

supervised by

First Supervisor: Prof. Dr.-Ing. Nicole Riediger
Second Supervisor: M.Arch. Eric Pollock

at

Hochschule für Technik und Wirtschaft Berlin
and
Helsinki Metropolia University of Applied Sciences

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Conceptual Formulation
Master Thesis for Ms. *Mariana Hernáiz*
Student number: *s0552952*

Topic: *SUSTAINABLE OPERATIONS IN HOTELS: Methodology to benchmark the water consumption in small- and medium-sized hotels in Germany.*

Summary

In the hospitality sector there is a wide range of methods and indicators developed to measure the consumption of resources in buildings. However, these measures are address at largest hotel chains, and are mainly focused on energy consumption measures, leaving water consumption measurements in the background.

The proposed methodology consist in developing a procedure for the management of water consumption, with indicators adapted to small- and medium-sized (SMS) hotels in Germany (*according with DEHOGA (Deutscher Hotel- und Gaststättenverband) 2 and 3 star hotels represent the 67,8% of the total number of hotels in Germany*), in order to provide a reliable and systematic method that allow internal control of the water use of any SMS hotel in Germany as an opportunity to define the best practices for water consumption management.

From this particular issue, arise the research question:

- *How to create a simple and reliable methodology* for water consumption management *in small- and medium-sized (SMS) hotels in Germany?*

Sub-Questions derived from the research question:

- *What elements influence water consumption in SMS hotels in Germany?*
- Is it possible to create a reliable procedure for the management of water consumption applicable to all types of SMS hotels?
- What can be the barriers and limitations in the application of a *methodology to benchmark the* water consumption in SMS hotels?

Unites of analysis

Small- and medium-sized (SMS) urban hotels in Germany

Signature of the Supervisor

ABSTRACT

Climate change, which seemed to be a long-term reality, has now become a tangible fact. This emphasizes the urgency of taking effective and timely measures, within which the hotel sector has acquired an important value, since its services are highly dependent on the uses of natural resources, like for instance water.

However, even with the relevance of this issue, the response of hotel companies on the efficient management of resources consumption, is inconsistent and difficult to monitor for the hotel operator. Among hotel categories, this is most evident in small and medium-sized (SMS) hotels, which are usually less ecologically active than their larger counterparts (Hotel Energy Solutions, 2011). Hence, the great importance of providing simple and clear procedures, suitable to this category of hotels, in order to efficiently implement resource consumption management.

This Thesis focuses its research on small and medium-sized (SMS) urban hotels in Germany, which represents the most abundant category in the country, in order to create a methodology for the management of water consumption, thus closing the gap created by the absence of systems adapted to the limitations and characteristics of this accommodations.

Given that water reserves are abundant in Germany, hotel operators do not consider the management of this resource as a priority. However, the upward trend in the concentrations of pollutants in the groundwater bodies (Richter et al., 2010, pp. 11-37), is a fact that should not be taken lightly. For that reason, the aim of this research is to offer SMS hotels operators in Germany, a new perspective that allows them to expand their environmental awareness, and to incorporate successfully and responsibly sustainable practices.

Throughout the research, three stages were developed:

- First stage: a literature review;
- Second stage: a qualitative questionnaire; and
- Third stage: a case study.

The first two stages were used as an essential preparatory process, which were founded, first, on the literature review, that allowed to find current practices and tools for water consumption management, and second, a qualitative method based on a

questionnaire was used as qualitative information to obtain attitudinal data. The case study (third stage) allowed the collection of primary data directly from hotels operators. All the information gathered during this stage was use to answer the research question and sub-questions, and satisfy the research objectives.

Finally, this thesis has led to the development not only of a systematic methodology to monitor water consumption, but also has proposed easy-to-use methods for SMS urban hotels in Germany, in order to collect data from on-site measurements, and internally benchmark their water consumption performance.

Keywords:

hotel, resource, water, consumption, methodology, sustainable, benchmarking, management

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LIST OF ABBREVIATIONS

BMUB	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (Federal Minister for Environment, Nature Conservation, Building and Nuclear Safety)
BMVBS	Bundesministeriums für Verkehr, Bau und Stadtentwicklung (Federal Ministry of Transport, Building and Urban Affairs)
BNB	Bewertungssystem Nachhaltiges Bauen (Assessment System for Sustainable Building)
DGNB	(Deutsche Gesellschaft für Nachhaltiges Bauen) German Sustainable Building Council
EAP	Environmental Action Program (EU 2014)
EMAS	Eco-Management and Audit Scheme
EU	European Union
GDP	Gross domestic product
GSTC	Global Sustainable Tourism Council
HOTREC	Hotels, Restaurants and Cafés in Europe
HTW Berlin	Hochschule für Technik und Wirtschaft Berlin (University of Applied Sciences for Technic and Economy Berlin)
SMS	Small and medium-sized
STR	Smith Travel Research
UNWTO	The World Tourism Organization
URL	Uniform Resource Locator
VAT	Value – added Tax
WFD	EU Water Framework Directive
WHG	Wasserhaushaltsgesetz (Federal Water Act)

LIST OF SYMBOLS

bask	Basket (basket of the dishwasher)
L	Liter(s)
€	Euro(s)
hr	Hour(s)
m^3	Cubic meter(s)
m^2	Square meter(s)
min	Minute(s)
°dH	Degree of hardness

1 INTRODUCTION

In this chapter the author will give an overview of the topic that is investigated in this thesis. To do this, the topic will be broken down into three parts: The general background, background in Germany, and the problem. Finally, the research questions, the purpose, and the structure of this thesis will be introduced.

1.1 Background

Climate change, which seemed to be a long-term reality, has now become a tangible fact. Changes in normal patterns of atmospheric phenomena are now more evident and affecting the entire planet. This reality emphasizes the urgency of taking effective and timely measures, within which sustainable tourism has acquired an important value, highlighting the hotel sector, as it covers much of the consumption.

Tourism has become, thanks to globalization, an important sector for socio-economic development both local and global. It is also an activity that generates large amount of direct and indirect jobs, attracts both local and foreign investments and contributes to the Gross domestic product (GDP) (tourism represents 10% of global GDP) (The World Tourism Organization [UNWTO], 2016), thus providing economic and social benefits. However, their mishandling can cause the opposite effect, generating excessive spending of resources such as water, as well as the deterioration of the environment.

Taking this into consideration, the implementation of sustainable business practices in the accommodation sector, towards the responsible use of natural resources and the care of the environment, has become a priority objective, due to the globalization of the markets, and the growing sensitivity of customers in environmental issues. Therefore, it is a key point to improve quality and reduce operating costs.

However, even with the relevance of this topic, the response of hotel companies is not enough due to some restrictions, such as economic factors, lack of availability of time, and the difficulty of integrating some of the criteria expressed in the schemes and regulations, resulting in the implementation of isolated measures, hard to monitor for the hotel operator, and without tangible results.

According to a report made by Hotel Energy Solutions (2011) (an official partner of the UNWTO), among the different categories of accommodation service providers, small and medium-sized (SMS) hotels are usually less ecologically active than their counterparts belonging to large chains.

The adoption of Sustainable management practices, for SMS hotels, requires the commitment of the hotel management to collect data periodically. To develop this activity, it is necessary not only to have time, but also to know what kind of information is required and what tools are needed for its evaluation. These two requirements are a real challenge for this category of hotels, not only because of the limited staff they have, but also because of lack of experience, knowledge, and a reduced budget to achieve consistent sustainable management. As a result, they do not carry a detailed monitoring of their consumption and the impact of this consumption on their operational costs (Page, 2015. pp.216-220).

A report sponsored by the company Hilton (Hotel News Now Special Report. 2015. pp.5-11) developed a breakdown of the percentage of global hotels rooms by class. The report shows that 66% of the hotels are among the categories of Budget, Economy Class and Midscale Class, which cover the majority of SMS hotels, while 34% is occupied by Upscale Class and Luxury Class hotels.

Taking into account these statistical data on the proportion of SMS hotels worldwide, and the fact that this category is less motivated to the implementation of sustainable management methods, it creates enough concern about the real applicability of sustainable operations. Hence, the great importance of providing simple and clear procedures, adapted to the characteristics and limitations of this type of accommodation, in order to efficiently implement resource consumption management plans.

1.2 Background in Germany

Although the water supply in Germany is not a problem, since the country has abundant groundwater bodies (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety [BMUB], 2017a), the concentration of pollutants in the water reserves does represent a point of concern for the state (Richter et al. 2010. pp. 11-37). This increase is partly due to the fact that Germany

is the European country with the highest rate of wastewater treatment, which, despite the use of state-of-the-art technology for its treatment, is not yet possible to completely eliminate pollutants present in sewage water (BMUB, 2017b).

Hence the significance of collaboration and responsible management of water consumption, not only by the state, but also by all sectors of society, including the accommodation sector, which is, as established by the World Tourism Council, an important sector within the economic growth of the country, generating 3.9% (EUR 117.9bn) of GPD (direct contribution), and with an expected growth of 2.7% by 2026 (World Travel & Tourism Council [WTTC], 2016. p. 3).

On the other hand, as in global level, the hotels within the classification of Budget, Economy and Midscale in Germany, account for the largest number of SMS hotels, with 67.2%, while hotels classified as Upscale, Upper-Upscale and Luxury represent only 32.7% (Horwath HTL. Hotel, Tourism and Leisure Consulting, 2016*;* Hotelstars Union, 2017). However, despite the large number of SMS hotels in Germany, and their possible impact on the consumption of natural resources, and more specifically on water consumption, no exhaustive research has been carried out in the country related with the implementation of water management in this category of hotels.

1.3 Problem

Nowadays the large hotel brands have developed their own systems to report their sustainable operations, using management tools such as monitoring programs. Unlike SMS hotels, these large companies have multi-disciplinary teams and more comfortable commercial conditions, which allows them to remain at an advantage over handling environmental issues. SMS hotels on the other hand, are characterized to have only few staff members. They are usually managed by their owners, or have a small workforce. For that reason, the employees or the owner himself or herself, are responsible for multiple and varied tasks (Ingram, 2017), therefore, the time of the hotel employees is mainly focused on managing the daily routines of the facilities, leaving little time for strategic planning of sustainable practices (Beaver, 2002. pp. 69-71).

Studies on the distribution of water consumption in hotels are mainly focused on Upscale and Luxury hotels, like the one shown in Styles, et al. (2013, p. 268). Also,

the studies related to the implementation of sustainable business practices in SMS hotels are very scarce, and even fewer are those research that address the execution of plans for the management of water consumption adapted to these lodging providers.

Although the hotel industry is dominated by SMS hotels (both in Germany and globally), which can have a significant impact on water consumption that should not be ignored, they have been little studied. For this reason, the aim of this research is to provide a broader understanding of attitudes and the current situation of water consumption management, as well as the elements that affect the use of this resource in SMS urban hotels, in order to provide clear and simple procedures, adapted to the characteristics and limitations of this group of hotels, to implement efficient water consumption management plans.

1.4 Research questions

From the particular issues expressed above, arise the research question:

How to create a simple and reliable methodology for water consumption management *in small and medium-sized (SMS) urban hotels in Germany?*

The sub-Questions derived from the research question are:

1. What are the elements that influence water consumption in SMS urban hotels in Germany?

2. Is it possible to create a reliable procedure for the management of water consumption applicable to all types of SMS hotels?

3. What can be the barriers and limitations in the application of a methodology to benchmark the water consumption in SMS urban hotels?

1.5 Purpose

The purpose of this thesis is to develop a procedure for the management of water consumption, adapted to the characteristics of small and medium-sized (SMS) urban hotels in Germany. To achieve this the researcher focuses on the following objectives:

1. Identify the elements that affect water consumption in small and medium-sized (SMS) urban hotels in Germany.

2. Propose a methodology that allows the implementation of a systematic plan for the monitoring and internal benchmarking of water consumption, in all small and medium-sized (SMS) urban hotels in Germany.

3. Identify the barriers and limitations in the implementation of the methodology.

Following the development of these objectives, this research work aims to offer a simple and reliable option to improve the water consumption management plan of SMS urban Hotels, as well as to expand the information available in this field to encourage future research.

1.6 Thesis structure

The structure used in this thesis work is divided into 5 chapters

1. *Introduction:* overview of the topic that is investigated in this thesis. Description of the research questions, the purpose, and the structure of this study is introduced.
2. *Literature Review*: essential preparatory stage to strengthen the author's knowledge and point of view on the topic of this research, through the evaluation of previous studies related to the subject of study.
3. *Methodology*: description of the research techniques used to answer the research question and sub questions, and meet the objectives.
4. *Results:* description and analysis of the current situation of water consumption management in SMS hotels, and development of easy-to-use methods for the monitoring and benchmarking of water consumption.
5. *Conclusion*: summary of the results, and review of research questions and objectives, and discussion of how they were answered. At the end of the chapter the contributions of this thesis work, and the recommendations for future studies, will be presented.

2 LITERATURE REVIEW

This chapter is an essential preparatory stage to strengthen the author's knowledge and point of view on the topic of this research. The literature review will be divided in five section starting with the concept of sustainable development to understand the foundations underlying environmental and best practice schemes and policies, which will be reviewed later in the second section. The next three sections of this chapter will present the general characteristics, statistics, use of water, and management of water consumption in hotel sector. Finally, the definition and types of benchmarking will be described.

2.1 Sustainable development

To understand the reasons why programs, policies, and schemes have been developed to promote tools for good resource management by the tourism industry, and therefore the sustainable development of this sector, it is necessary to begin with the definition of Sustainable Development and later in this chapter, the definition of sustainable tourism and its relationship with sustainable business practices, to provide the environment in which tourism service providers, and more specifically hotels, have begun to play an important role given their heavy reliance on the use of resources for their operation.

2.1.1 Sustainable development concept

The idea of sustainable development is not a new concept. However, the term began to take form and relevance at the end of the twentieth century as a guide for the progress and conservation of the life in the planet facing the environmental degradation.

In 1972 is published a study carried out by the Club of Rome called Limits to Growth (Meadows et al., 1972), that was one of the first publications to use the word Sustainability, and which warned about the ecological imbalance caused by the growth and development of the human population.

The wake-up call about the degradation of the global Natural Capital by industrial production, led to The United Nations Conference on Human Environment, held in 1972 in Stockholm (United Nations Department of Economic and Social Affairs. [UN-

DESA]., 2017) This report opened the way to other treaties as, "*The World Heritage Convention*" and "*The Montreal Protocol on Onzone Depletion*", from which germinated the idea of "*Global Trusteeship*" (Basiago, 1999), and of the latter the concept of Sustainable Development was based, where "*a new philosophy emerged based on the belief that development and sound environmental management were not incompatible*" (McCormick, 1986, p. 177).

But it was not until 1987 that the idea of Sustainable Development was formalized in the report Our Common Future (better known as the Brundtland Report), in which the main objective was to ensure the rational use of natural resources, not only from the business perspective, but encouraging the active participation of society. Its famous definition that states that "*Sustainable development is development that meets the needs of the present without compromising the ability of the future generations to meet their own needs"* (United Nations [UN]., 1987, p. 41), would become a benchmark for all subsequent events connected with Sustainable Development.

2.1.2 Sustainable tourism definition

The definition of sustainable tourism has many definitions, the most accepted is as follows (UNESCO Regional Bureau for Science and Culture in Europe & United Nations Environment Programme [BRESCE-UNEP]., 2009, p. 9):

> Sustainable tourism development meets the needs of present tourists and host regions while protecting and enhancing opportunity for the future. It is envisaged as leading to management of all resources in such a way that economic, social, and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity, and life support system.

In short, the World Tourism Organization (2016) defines sustainable tourism as:

> Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities.

2.1.3 The three pillars of sustainable development in the hotel sector

The concept of sustainable development rests on three fundamental pillars, Environmental responsibility; Social responsibility, and Economic responsibility. When these three pillars remain in balance within the management of a company and its environment, then it can be said that a sustainable development has been achieved (Legrand et al., 2014, p. 249):

Since hotels depend on the use of natural resources to meet the demands of their guests, their sustainable management must also be based on these three pillars to ensure the good performance of their operations (Legrand et al., 2014, p. 249):

1. *The Environmental responsibility* is based on respect for the environment. Its fundamental purpose is to mitigate the negative effects that the operation of the hotel can cause to the ecosystem.

2. *The Social responsibility*, is concerned with maintaining of the social equity and respect for the local culture where the hotel is located.

3. *The Economic responsibility,* aims at a better financial performance, through the training of the personnel and increasing the awareness of the clients on the good use of the resources, in order to reduce costs. A hotel also has an economic impact on the community, increasing job offers, and therefore local development.

A key element in the management of sustainable practices is the environmental pillar, which, as it is linked to the optimal use of natural resources, influences the way in which many of the hotel´s performance strategies are created (Legrand et al., 2014, p. 250), such as the reduction of operational costs for the efficient management of water consumption, which in turn translates into greater protection of the quality, not only for the resource itself, but for the entire ecosystem. Thus contributing to the healthy development of future generations.

2.1.4 Sustainable business practices

The development of sustainable business practices should not only ensure the implementation of environmentally-friendly practices but also ensure that they make financial sense. In this field each company, according to its characteristics, creates its own processes to fulfill its objectives in matters of environmental sustainability (Belcher, 2017).

Sustainable business practices establish the objectives and goals to address and resolve, in a responsible manner, the environmental problems that companies may face during their operation, in order to protect the natural environment (Daub et al., 2005). This types of management practices uses support systems such as guidelines and schemes. In Europe for example, EMAS (Eco-Management and Audit Scheme) is one of the most recognized among many others.

Within this field, two management concepts have emerged (Daub et al., 2005):

- *Sustainable management*. This Concept was developed in 1987 with the publication of the "Our Common Future" report. Sustainable management motivates companies to merge economic objectives with environmental and social issues. Taking as a support point the attachment to an ethically correct behavior.
- *Sustainability management*. This concept is more focused on reducing in a sustainable and ecologically responsible way, the impacts that the operational processes of a company can have on the planet, incorporating initiatives at a strategic and operational level, and using as tools schemes or internal programs of the company.

The application of these management practices depends on the organizational system. There are two types of systems that are classified according with level of interaction of the organizations with their environment. An open system which allows the mutual interaction between the environment and the company, exchanging materials, people, information, etc. And a closed system which is totally the opposite (Mullins, 2005, p. 146).

An open system can change and influence its environment, but it must also be able to adapt itself to changes in its ecosystem through innovation.

Hotels are, therefore, an open system model, because they take resources from the environment, such as water to set an example, and use those resources to provide services in their facilities and finally return them to the environment.

Because the hotel industry is highly dependent on natural resources, good management practices, with a sustainable management philosophy, and using tools that allow the sustainability of the hotel's operations in the long term, should become a fundamental objective within the Hospitality industry.

- ***Engagement of the hotel sector to sustainable business practices***. The adoption of Sustainable management practices requires the commitment of the hotel management to collect data periodically. To develop this activity, it is necessary not only to have time, but also to know what kind of information is required and what tools are needed for its evaluation.

For SMS Hotels, these two requirements are a real challenge, not only because of the limited staff they have, but also because of lack of experience, knowledge, and a reduced budget to achieve consistent sustainable management. As a result, they do not carry a detailed report of their consumption and the impact of this consumption on their finances (Page, 2015, pp. 216-220; Peters et al., 2004, p. 407).

Nowadays the large hotel brands have developed their own systems to report their sustainable operations, using management tools such as monitoring programs and codes of conduct. Unlike SMS hotels, these large companies have multi-disciplinary teams and more comfortable commercial conditions, which allows them to remain at an advantage over handling environmental issues. So it would be unfair to try to compare or even expect the same level of compromise between accommodation service providers, without taking into account their size or features.

The literature describes different points of view on the ways how accommodation providers adopt sustainable strategies. Smith et al. (2009) mentions three strategic approaches: Ad hoc, Integrated and Comprehensive. The first one is based on short-term business objectives, without long-term follow-up of adopted strategies. Unfortunately this type of management planning is widely used by small and medium hotel industry. The last two approaches are mainly used in hotels with more complex organizational structures, able to develop environmental policies that allow the coordination and participation of all the interested stakeholders.

According to Rezaee et al. (2015, p. 27) there are two different points of view when implementing sustainable business practices. One view establish that organizations are motivated to apply sustainable practices to maximize their profits and thus create value for their shareholders through the improvement of the public image and leadership in the industry. The other view points out that the properties belong to their owners and not to their shareholders, so the owner has the right to choose how

to manage his property, and his motivations may be linked to economic issues, or social responsibility, or even both.

Another point of view is more related to the managerial attitude of small and medium enterprises. Given that the management structure of this type of industry is more linear than that of its larger counterparts, Rahman et al (2012, p. 721) points out that "*the manager or owner generally enjoys considerable freedom to operate his or her facility".* Therefore, it is easier for them to adopt simpler and more sustainable management methods adapted to their own limitations and characteristics, because its implementation depends only on the sensitivity and knowledge of the owner or manager towards environmental management, and not in decisions at the corporate level (Rahman et al., 2012, p. 721).

Due to the fragmented nature of the tourism sector, the adoption of universally applicable policies that minimize their impact on the environment becomes very difficult. For this reason the effort should focus on increasing the awareness of hotels to support and implement sustainable practices. And even more important, include those practices in the daily management of the hotel, and not see them as an extra task. (Davies et al., 2000).

- Benefits of sustainable business practices. The application of successful sustainable practices requires the commitment of the owner/ manager of the hotel to promote the vision of sustainability and incorporate these practices to the routine management of the facility.

In order to achieve the integral development of sustainable operations, it is necessary not only to involve all stakeholders (employees and guests), but also to carry out regular monitoring of the progress of the sustainable actions taken, with the aim of assess their performance.

Among the benefits most recognized by the application of sustainable management practices are the following:

- *Reduction of Operating Expenses*: this benefit is closely linked with increased productivity and resource efficiency. It is also one of the most mentioned incentives when implementing sustainable operations in a Hotel. For example, the installation of water-saving devices can reduce the consumption of water by 15% on service water (Cremona et al., 2012, p. 6).

- *Incentive for employees*: A clear communication of objectives, which the hotel manager or owner wishes to achieve, to all its employees, can increase the commitment of the staff to collaborate in improving the productivity of the hotel. Therefore, the values of the entire hotel team are aligned with the responsible use of resources (Seneviratne, 2007, p. 264).
- *Hotel image*: Publicizing the initiatives taken for the sustainable development of the hotel and its results, always within a framework of transparency of information, improves the relationship of the hotel with the community where the accommodation is located, as well as creates new opportunities not only to increase guest awareness of resource consumption but also to attract new guests. (Sustainable Business Associates [sba], 2008, p. 6).
- *Identify problems in the resource consumption*: Periodically monitor of resource consumption to detect possible problems on time, is a priority in the sustainable management of a hotel. For example, the implementation of a water management policy within the hotel, allows the detection of water leaks and irregularities in the consumption pattern, as well as the possibility of identifying potential opportunities for water saving.

2.2 Water status in Germany

In Germany 70% of drinking water consumption depends on groundwater bodies (BMUB, 2017a), which are abundant at national level and, according to The European Commission Water Framework Directive (WFD), these water reserves are in good condition (ATT, BDEW, DBVW, DVGW, DWA, VKU., 2015. pp. 12-30).

However, the concentrations of pollutants in the groundwater bodies that have been evaluated to date, show an upward trend (Richter et al., 2010, pp. 11-37). This increase is partly due to the fact that Germany is the European country with the highest rate of wastewater treatment, which, despite the use of state-of-the-art technology for its treatment, is not yet possible to completely eliminate pollutants present in sewage water (BMUB, 2017b). In addition to this, due to the extensive sewage system in the country, it is estimated that millions of m^3 of wastewater is leaking each year by failures in the sewage system, becoming one of the main sources of contamination of groundwater reserves. (Held et al., 2006, p. 190)

An efficient consumption of water has an impact both ecologically and economically, because it allows not only energy savings in the treatment of waste water, but also in the reduction of it.

Hence the importance of collaboration and responsible management of water consumption, not only by the state, but also by all sectors of society, in order to ensure the future quality of groundwater, and to fulfill the objectives stipulated by The WFD to prevent the deterioration of water bodies and improve their status no later than 2027.

2.3 Environmental and best practice schemes and programs

This section will review the policies, programs and schemes related to the care of the environment and best practices in the provision of services in buildings life cycle, both in the European Union in general and in Germany.

2.3.1 European Union

The European Union has Policy Frameworks ranging from broad environments such as cities or urban areas, to more specific environments such as buildings.

The 7th Environmental Action Program was launched by the European Union in 2014 with the aim of reducing carbon emissions and promoting the efficient use of resources by the year 2020. Despite being a program aimed at the development of more sustainable cities, among its goals promotes also the design of responsible buildings with the environment. In its Article 95, the Decision No 1386/2013/EU points out that “a majority of cities in the Union are implementing policies for sustainable urban planning and design, including innovative approaches for… sustainable buildings”.

The Roadmap to a Resource Efficient Europe (COM (2011) 571) is launched in September 2011 and presents the basis for the economic development of all member countries through "sustainable consumption and production" by 2050.

In its chapter 5 regarding Improving Buildings is expressed how a good use of resources in the European Union buildings “*it could also help us save up to 30% water”* (COM (2011) 571), and highlights the need to stipulate specific policies to “*stimulate SMEs, which make up the vast majority of construction companies - to*

train and invest in efficient resource building methods and practices" (COM (2011) 571).

More specifically related to water protection is the EU Water Framework Directive (WFD), established by The European Parliament in 2000 (Directive (EU) 2000/60) as a legislative act whose aim is to promote measures to prevent pollution and deterioration of the water resources of the countries members.

Each country is responsible for establishing its own laws to achieve the objectives of the Directive (EU) 2000/60, including the participation and collaboration of communities, as well as the different sectors such as tourism, to ensure good quality of drinking water (established in Articles 14 and 16 of the Directive (EU) 2000/60).

In the European Union there are also some schemes focused on evaluating the sustainable management of buildings and the provision of ecologically friendly services. Some of these initiatives at European level that categorize the building according to the degree of compliance of certain criteria are, The EU Eco-management and Audit Scheme (European Commission. Environment. Eco-Management and Audit Scheme (EMAS), 2017), and The EU ecolabel, also known as "Flower" (which includes Tourist Accommodation services) (European Commission. Environment. EU Ecolabel, 2017). Both schemes are voluntary and developed by the European Commission.

These schemes take into account criteria related to the improvement of water consumption. For example, EU ecolabel incorporated in 2009 (17 years after its creation), a criteria for sanitary tapware, flushing toilets, and urinals, within the criteria for water (Abarca, et al., 2014, p. 21; Decision (EU) N° 2013/250). However, the Water efficiency criteria of the EU Ecolabel does not yet include other activities within the hotel, such as restaurant, which also generate water charges.

Specifically related to tourist accommodation, is the COMMISSION DECISION (EU) 2017/175 on establishing EU Ecolabel criteria for tourist accommodation (Decision (EU) N° 2017/175), in its criterion 42 and 15 establishes the best practices for bathroom fittings, and in its criteria 27, regarding the monitoring of energy and water consumption, points out the need to install sub-meters in different areas of the hotel to keep consumption under control (See Table 1)

Table 1: Criteria for maximum water flow rates, and monitoring of consumption

DECISION (EU) 2017/175: on establishing EU Ecolabel criteria for tourist accommodation			
Efficient water fittings Max. Water Flow	Taps	6 litres/min.	CRITERION N°42
	Showers	7 litres/min	CRITERION N°42
	Toilets	≤ 4,5 L	CRITERION N°15
Consumption monitoring	Water sub-metering: to allow data collection on consumption of different activities		CRITERION N°27

Sources: Adapted from Decision (EU) N° 2017/175

2.3.2 International hotel schemes

Among the wide range of environmental certifications one of the most recognized schemes for the hotel sector is Green Key, a non-profit and non-governmental environmental labeling scheme.

This scheme allows the labeling of small accommodation services of less than 15 rooms (Green Key. Small accommodations, 2017). However the criterion for the improvement of water consumption (See Table 2) is essentially the same for both hotel sizes (hotels with more than 15 guest rooms, and hotels with less than 15 guest rooms). Sampaio et al. (2011) argues that the criteria set out in these environmental schemes and guidelines for the small hotel industry, tend to adopt the same formal approaches used by large companies.

It is also possible to note in Table 2 that the Green Key criteria establish the maximum value of water flow rate for some hotel's restaurant/cafeteria appliances, such as the tunnel dishwasher, criterion that is not covered for the Decision (EU) N° 2017/175.

The Global Sustainable Tourism Council (GSTC) is a basic guideline for certification schemes and to promote sustainable tourism programs. This global initiative places particular emphasis on the social and cultural impact of tourism, and does not offer numerical values to measure the efficiency of products and equipment, as does the scheme outlined above, it only indicates what must be done to achieve the objective, and offers educational material and tools for its implementation (Global Sustainable Tourism Council [GSTC], 2017b).

Table 2: Green Key criteria for hotel, hostel, and small accommodations

GREEN KEY CRITERIA: 4. WATER		Maximum water flow rates	Hotels and hostels (> 15 rooms)	Small accommodation (< 15 rooms)
4.1	The total water consumption must be registered at least once a month.		X	X
4.2	Toilets.	6 l/flush	X	X
4.3	The staff and cleaning personnel must check for water leaks.		X	X
4.4	Water flow from at least 75% of the showers in guest room	9 l/min	X	X
4.5	Water flow from at least 75% of the taps in the guest.	8 l/min	X	X
4.6	The urinals either have detection sensors, "push" button or be water free.	3 l/min	X	
4.7	Cover or tunnel dishwashers.	3.5 l/basket	X	
4.10	The use of domestic appliances are in general avoided or minimised.		X	
4.11	Separate water meters are installed in areas with a high degree of water consumption.		X	X
4.12	Taps and toilets in public areas	6 l/min	X	X
4.13	Wastewater is, where feasible, reused after treatment.		X	X
4.14	Rainwater is collected and reused.		X	X
4.15	Dual Flush toilets 3/6 litres.	3/6 l/flush	X	X

Sources: Adapted from Green Key. Hotels and hostels (2017); Green Key. Small accommodations (2017)

An example of what is stated above is the GSTC Hotel Criteria D1.4 for water conservation which states that (GSTC, 2016):

> water consumption is measured by type, and steps are taken to minimize overall consumption. Water sourcing is sustainable and does not adversely affect environmental flows (p. 9)

This criteria establishes a list of recommendations to be followed to achieve good water management. Some of these steps are (GSTC, 2016):

c. Water used per tourist/night per source is monitored and managed.

d. Equipment and practices are used that minimize water consumption.

f. Consideration is given to cumulative impacts of tourism in the locality on water sources.

g. Goals for reducing water consumption are in place.

h. Staff and guests are given guidance on minimizing water use. (p. 9)

The GSTC reviews the set of standards used by other schemes, such as Green Globe, EU Ecolabel, and even Green Key, to mention the most prominent among many others, and recognizes "*that the set of standards used to certify includes the minimum elements to ensure sustainability*" (GSTC, 2017a) and are align with the criteria expressed in the GSTC. Hotels that have been approved by one of the schemas recognized by the GSTC, are also free to use the GSTC Logo.

2.3.3 Regional level: Germany

The German Water Act (Wasserhaushaltsgesetz, WHG) regulates the provision of water supply and sewage disposal services and establishes that waste water treatment is the responsibility of the municipalities and is, therefore, always recognized as a public service. (ATT, BDEW, DBVW, DVGW, DWA, VKU., 2015. pp. 18-19)

On the other hand, the supply of fresh water can be supplied by public companies, mixed organizations, or by private companies that have the municipality as shareholder with a broad influence on strategic decisions. (ATT, BDEW, DBVW, DVGW, DWA, VKU., 2015. pp. 18-19)

In Germany, unlike other European countries with problems of water shortage, the Water Law does not apply regulatory instruments that restrict or regulate the volume of water that can be consumed. In general, the Government encourages efficiency in the proper use of natural resources through labels and regulations for buildings.

The Federal Building Ministry published a Guideline for Sustainable Buildings in 2001, to take into account the three dimensions of sustainability: ecology, economy and socio-cultural, during the design, construction, and remodeling phases of a building (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety [BMUB]., 2016, pp. 7-38).

This guide is mandatory for Federal Buildings, but since 2011 it is open for voluntary use of the private sector as a tool to generate recommendations on improving the performance of facilities (BMUB, 2016, pp. 7-38).

As a method to evaluate and identify the scope of the sustainable building management expressed in the Guideline, the Federal Building Ministry launched in 2009 The Assessment System for Sustainable Building (BNB) (BMUB, 2016, pp. 7-38).

This system is structured in three modules that cover the life cycle of a building. The modules are: New Construction module, Use and Operation module, and Complete Refurbishment module. Each module has 5 main criteria groups or building qualities of a sustainable building which are Ecological; Economic; Socio-Cultural; Technical; and Process Quality (BMUB, 2016, pp. 7-38).

The efficient management of water in a building is specified in two building qualities: the Ecological building Quality, criterion BNB_BN 1.2.3 (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety [BMUB], 2015), which addresses the protection of resources and the reduction of the effects of their use on the environment, and the Process building Quality, criterion BNB_BN 5.3.2 (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety [BMUB], 2013), which addresses the planning process for the development of efficient resource management.

While these the two building qualities are focused on the evaluation of office buildings, the criterion Management of energy and water consumption BNB_BN 5.3.2, part of the Process Quality, it is perfectly applicable to any type of building in its use and operation phase. The criterion establishes as objective the reduction and evaluation of the water consumption through a systematic record, as a part of the water management, in order to detect failures in the system. This water management process is divided into two sub-criteria:

1. Collection and assessment of water consumption data. At this point it is important to determine the time interval in which the water consumption checks will be carried out, as well as the team responsible for doing so. The data collection will allow the comparison of the data with the consumption of previous periods, in order to detect

abnormalities. All results obtained from the evaluation must be documented and subsequently communicated to the relevant authorities.

2. Suggested Actions. Once the whole system has been evaluated, the necessary measures (organizational, structural, or technical) will be taken to reduce consumption.

German Sustainable Building Council (DGNB): The Federal Ministry of Transport, Building, and Urban Affairs (BMVBS), in partnership with The German Sustainable Building Council (German Sustainable Building Council [DGNB], 2017), launched in 2008 the The German Sustainable Building Certificate as a tool to evaluate sustainable buildings from design to construction.

Building projects registered on the DGNB website receive a pre-certification if the building design meets the requirements of the certificate.

When the building is finished the building is checked by an assesor, and according to the degree of compliance, a certificate of Gold, Silver or Bronze is received.

2.4 Hotel sector

This section will explore the characteristics and categorization systems within the hotel sector, focusing on SMS hotels. A comparison of the proportions (both globally and in Germany) between the different categories of hotels will be shown, and their patterns and current systems of management of water consumption will be described.

2.4.1 Small and medium-sized hotels (SMS) - General characteristics

Small and medium-sized hotels (SMS), mainly those that do not belong to large hotel chains, are characterized to have only few staff members. The Organizational structure of a SMS hotel has less management levels than large hotel chains. They are usually managed by their owners, or have a small workforce. Due to the size of this type of enterprises, its structured management frame tends to be flat or self-managed (See Figure 1), and not pyramidal as it is in larger hotels (Ming Chak, 1998; Ingram, 2017). This means that the top-down command levels are short. For that reason, the employees or the owner himself or herself, are responsible for

multiple and varied tasks (Ingram, 2017), for example, the owner of the hotel can be at the reception, and at the same time prepare the breakfast buffet for its guests.

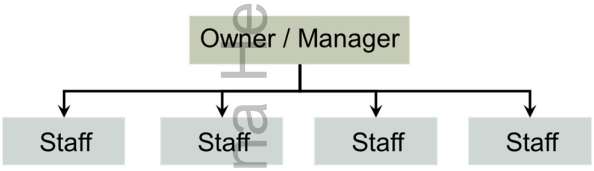


Figure 1: Flat organizational structure

Source: Adapted from Ming Chak (1998); Ingram (2017)

Therefore, the time of the hotel staff is mainly focused on managing the daily routines of the facilities, leaving little time for strategic planning of sustainable practices (Beaver, 2002, pp. 69-71).

This is one of the reasons why, perhaps, the effort made by various schemes to create specific criteria for small tourist enterprises, has not been widely adopted. The criteria set out in these environmental schemes and guidelines, aimed at the small hotel industry, are also inclined to adopt the same formal approaches used for larger companies (Sampaio et al., 2011).

One example of this can be seen in the section 2.3.2 International hotel schemes, when comparing the criteria for Water Effiency applied to hotels with more than 15 guest rooms, and hotels with less than 15 guest rooms (See Table 2). The difference between the two is almost imperceptible.

Added to this, on the one hand, the vast number of labels and schemes leads to a lack of understanding and confusion, and on the other hand, compliance with the criteria expressed in the schemes usually requires the refurbishment and upgrading of the facilities, difficult to finance by the SMS hotel industry, causing the total abandonment of the initial motivation.

Due to this the level of commitment towards the implementation of objectives that address the good management of the resources, seems to be smaller in the SMS hotels, that in its bigger counterparts (Bohdanowicz, 2005). For example, major hotel chains have developed their own environmental policies, such as the sustainable development program "Planet 21", carried out by AccorHotels (AccorHotels, 2016), which sets out internal objectives for the responsible

management of water, energy and waste. These types of programs are motivated mainly by stakeholders pressure, competitiveness, and brand image (Bohdanowicz, 2005; Williams et al., 2013). While in the case of SMS Hotels, motivation in relation to environmental matters is more closely linked to the philosophy and personal aspirations of hotel operators than to the financial benefits (Williams et al, 2013).

However, although many of these SMS Hotels do not have any eco-certification or environmental programs developed on their own, many of them have made changes to their facilities, such as placement of more efficient showers and faucets. This demonstrates a desire to manage their business in an environmentally responsible manner, within their own limitations.

The informal way of environmental management has allowed SMS Hotels to implement some of the requirements set out in the Schemes criteria. Nevertheless, it also results in a lack of monitoring of the performance of the implemented changes, for instance keeping records of the consumption of water, mainly due to the need to devote more time than planned to those tasks (Peters et al., 2004).

2.4.2 Hotel categorization

Due to the variety of services offered in the hotel industry, its categorization and segmentation is difficult and often confusing, so that each country usually uses multiple categorizations. The hotels can be categorized by their size, average room rates, services, number of employees, etc.

The hotel classification system used in Germany is a voluntary system based on the categorization of 1 to 5 stars. The number of stars that can be obtained is determined by the fulfillment of a common criterion to all hotels. Each criterion has a certain number of points, the more points, the more stars the hotel will get (Hotelstars Union, 2017).

As the German system is voluntary, not all hotels have a star classification. For this reason, this study will use the segmentation most commonly used in the hotel sector, which is the one offered by Smith Travel Research (STR), a recognized world leader in data collection for the hotel industry (Smith Travel Research [STR], 2017).

According to STR, the hotels can be classified into 6 segments known as Chain scales, as can be seen in Table 3. The rating is based on the hotel's current average

room rates, and is totally independent of the size of the hotel. Each Chain Scale has a corresponding type of service:

- *Full Service Hotel*: They are hotels that offer the standard services of a lodging (room of guests with bathroom), plus a great variety of amenities like full-service restaurants, fitness rooms, conference spaces, swimming pools or spas (STR, 2017).
- *Limited Service*: These are hotels that offer the standard services of a lodging, but with limited amenities. This type of accommodation usually only offers breakfast and does not count with a full-service restaurant, nor other amenities, such as a conference room or swimming pool (STR, 2017).

Table 3: Categorization by type of

Chain Scale	Hotel Service Type
Luxury	Full Service Hotel
Upper-upscale	Full Service Hotel
Upscale	Full Service Hotel
Upper-Midscale	Limited Service Hotel
Midscale	Limited Service Hotel
Economy	Limited Service Hotel

Source: Adapted from STR (2017)

The size classification is based on the number of rooms offered by the accommodation (See Table 4).

Table 4: Categorization by size.

Size according to STR	Author's own classification.
Fewer than 75 Guest Rooms	Small
75 – 149 Guest Rooms	Middle
150 – 299 Guest Rooms	Middle Large
300 – 500 Guest Rooms	Large
Over 500 Rooms	Major

Source: Adapted from STR (2017); Authors' own elaboration

Finally we find the classification by type of physical location of the hotel (Table 5).

Table 5: Categorization by Physical Location

Location Type	Location type characterists
Urban	Large metropolitan areas
Suburban	Suburbs of metropolitan areas
Airport	Next or close to an Airport
Interstate/Motorway	Close to interstate roads
Resort	Areas whose activity is based on leisure services.
Rural/Small Town	Remote or sparsely populated areas

Source: Adapted from STR (2017)

2.4.3 Hotel sector statistics

According to the statistics, in the case of the European Union, the number of nights spent in tourist accommodations, increased by 1.4% between 2014 and 2015. Since 2009 this trend is upward and is expected to continue in that way (The World Tourism Organization [UNWTO], 2016, pp. 6-9).

Among the top tourism destinations in the world, Germany is within the top 10, ranking No. 7 with a 6% increase, between 2014 and 2015, in international arrivals (UNWTO, 2016. pp.6-9).

The World Tourism Council revealed that the tourism and travel sector in Germany, generate 3.9% (EUR 117.9bn) of GPD (direct contribution), and is expected to continue growing 2.7% by 2026 (World Travel & Tourism Council [WTTC] 2016, p. 3).

These figures show the importance of the hotel sector for the economy of the region. HOTREC (hotels restaurants and cafes in Europe) (HOTREC. Facts & Figures, 2016*)* estimates that employment growth in the Hospitality Industry, which is dominated by SMS enterprises, grew by more than 21% compared to just 6% across the economy.

A report sponsored by the company Hilton (Hotel News Now Special Report, 2015, pp.5-11) developed a breakdown of the Percentage of global hotels rooms by class (See Table 6). The report shows that 66% of the hotels are among the categories of Budget, Economy Class and Midscale Class, which cover the majority of the 1, 2, and 3-star hotels, while 34% is occupied by Upscale Class and Luxury Class hotels (4 and 5-star respectively).

Table 6: Percentage of global hotels rooms by class

Chain scales classification	Percentage	Hotel Service Type
Budget	2.0%	Limited Service Hotel **66.0%**
Economy	29.0%	
Midscale	14.0%	
Upper-midscale	21.0%	
Upsacle / Upper-Upscale	29.0%	Full Service Hotel **34.0%**
Luxury	5.0%	
TOTAL	**100%**	

Source: Adapted from Hotel News Now Special Report (2015)

Germany in particular shows the same distribution (See Table 7). Hotels within the classification of Budget, Economy and Midscale represent 67.2%, and hotels classified as Upscale, Upper-Upscale and Luxury 32.7% (Horwath HTL. Hotel, Tourism and Leisure Consulting, 2016; Hotelstars Union, 2017).

Table 7: German Hotel Classification and proportions

Chain scales classification	N° of Hotels	Percentage	Hotel Service Type
Budget	84	1%	Limited Service Hotel **67.20%**
Economy	552	6.5%	
Midscale	5092	59.7%	
Upscale / Upper-Upscale	2661	31.2%	Full Service Hotel **32.7%**
Luxury	132	1.54%	
TOTAL	**8521**	**100%**	

Source: Adapted from Horwath HTL. Hotel, Tourism and Leisure Consulting (2016); Hotelstars Union (2017)

Even the occupancy rate for 3-star hotels in Germany has remained with a higher growth rate, than the rest of the categories for four consecutive years (See Figure 2). Which expresses a preference of the users towards this category.

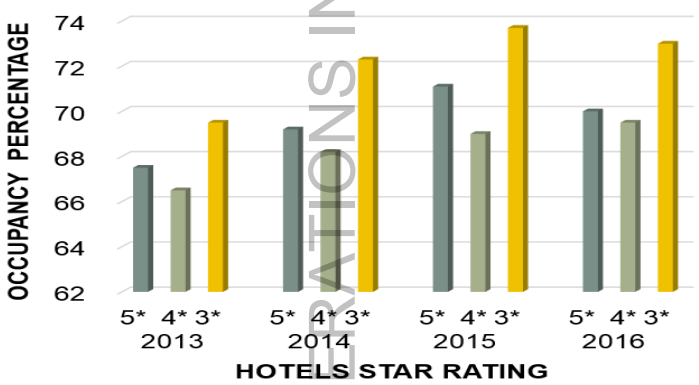


Figure 2: Occupancy in percentage (%) per Star Rating in Germany

Source: Adapted from Colliers International, Fairmas & Revinate (2016)

2.4.4 Water use in the hotel sector

Tourism in general impacts on the consumption of water not only through the maintenance of its infrastructure, but also through the development of new infrastructure to meet the growing tourist demand. The pressure that this generates on the sewage system increases the risk of leaks, thus increasing the amount of waste water that reaches the waterbodies (Davies et al., 2000).

Hotels in particular, since it is a service provider industry, are highly dependent on the use of resources. Water is an important resource in the running of the hospitality industry, to guarantee basic levels of comfort for guests and daily hotel maintenance.

The factors that affect the consumption of resources in a hotel can be separated into two parameters, the physical parameter, and the operational parameter. (Hotel Energy Solutions, 2011)

The factors within the physical parameter can be subdivided into two types. First, the factors that are inherent to the building, such as its size, design, amenities, and age. And second, factors related to the environment in which the facility is located, such as the level of availability of resources in the area, climate, geographical location, regulations and cost of services.

The Operational Parameter includes the services offered by the hotel, such as, full-service restaurant, laundry, etc. It also includes the hotel's operating hours, occupancy rates, levels of comfort offered to customers, and awareness of the consumption of resources by staff and guests.

The consumption of water for sanitary purposes in the bathrooms of the hotel rooms (toilet, shower and sink), and its use for the cleanliness and maintenance of the facilities, are the common factors that all hotels share. However, the proportions and levels of water consumed vary by size, services and recreational activities offered, type of hotel, location, etc.

Luxury, Upper-upscale, and upscale hotels offer a wide range of amenities, such as swimming pools, spas, fitness centers, full-service restaurants, landscaping, laundry, conference centers, air conditioning, etc. (Davies et al., 2000), therefore, they usually consume much more water than hotels offering more limited services (Upper-Midscale, Midscale, and Economy)

In a study conducted in Germany in a 300-room full-service hotel, water consumption was distributed as shown in Figure 3, where rooms and kitchen reported the highest consumption at 34% and 22% respectively (Styles et al., 2013, p. 268). In this study the swimming pool only consumes 2%, however, its use indirectly generates other expenses, such as washing of additional towels (Gössling et al., 2012).

A similar distribution can be found in studies conducted in different parts of the world. In a survey conducted in Australia, where a large number of hotels were audited, the result was a 42% of water consumption in the guestrooms; 16% in the kitchen; 15% in the laundry; 12% in public restrooms; 10% in the Cooling tower; 3% in irrigation; and 2% in the swimming pools (Smith et al., 2009, p.7).

In the Mediterranean, an audit of a sub-measured hotel of 270 rooms in Portugal resulted in 33.3% water use in the rooms, 16.8% in the kitchen, 4.7% in the laundry, 2.4% in the HVAC, 0.4% Steam Generation, 4.2% in irrigation, and 3.4% in the Bar (Tuppen, 2013).

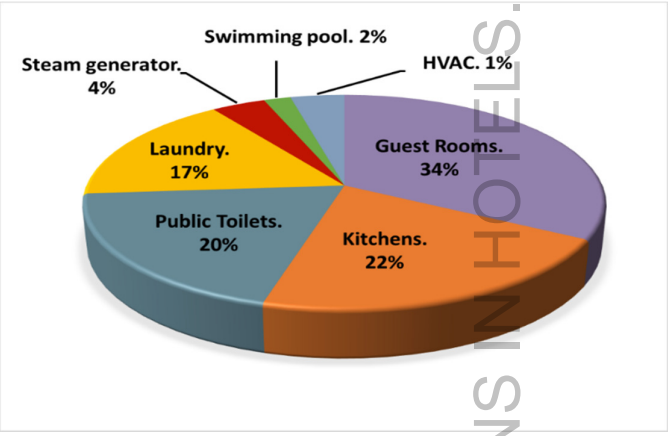


Figure 3: Water consumption distribution in a hotel in Germany

Source: Adapted from Styles et al. (2013)

A more specific study in 4-star hotels in Spain offers a detailed pattern of average water consumption per guestroom, from which it follows that 45% of the water consumed in the room is for the sink, 33% for the shower, and 22% for the toilet. (Cobacho, 2005, p. 5).

An average daily use of the sanitary equipment in bathrooms was calculated by The Seattle Public Utilities in a luxury hotel in Seattle, Washington. The result gave an average of 7 times for the toilet, 1 minute for the sink, and 12 minutes for the shower (O'Neill & Siegelbaum and The RICE Group., 2002, p.16)

The best practices in water consumption also vary from research to research. In Europe, The European Commission (Decision (EU) 2016/611, p. 41) established a limit of ≤140 liters per guest-night, based on a hotel with full-services. Becken (2014) established that in Germany the average use per guest-night is 198 liters, below Italy with 264 liters, and above Spain with 188 liters.

A comparison by Moore (2015, p.5) related with the average water use per guest-night in the world, places Europe well below the rest of the regions, with a consumption of less than 300 liters per guest-night. The Caribbean, the Middle East and South Asia top the list.

With respect to specific data on water consumption in the small and medium-sized hotel industry, there is very little literature that can be found, since most studies are carried out on the basis of larger hotels.

In conclusion it could be said that the consumption of water by the European hotel sector, can reach a máximum of approximately 300 liters per guest-night and a mínimum of ≤140 liters per guest-night.

According to a report related with annual expenses made by a small-scale hotel (34 rooms) in Rottenburg am Neckar, Germany (Kronenhotel GmbH, 2015), annual (2014) water expenditure accounts for 23% of the total annual cost of the hotel's utilities, located below electricity and energy costs (See Table 8).

Table 8: Annual utility expenses at a 3-stars hotel in Germany

Annual utilities expense Hotel Martinshof		Proportion
Kosten der Wärmeenergie (Cost of heat energy)	18,965.00 €	41%
Kosten des Stromverbrauchs (Cost of electricity consumption)	17,177.00 €	37%
Kosten Wasser/ Abwasser (Cost water / waste water)	10,518.00 €	23%
TOTAL Annual utilities expense	**46,660.00 €**	**100%**

Source: Adapted from Kronenhotel GmbH (2015)

This is one of the reasons (among others) why hotel operators do not consider the water consumption management as a priority, always placing it below the consumption of other resources. However, the upward trend in the concentrations of pollutants in the groundwater bodies (Richter et al., 2010, pp. 11-37), is a fact that should not be taken lightly.

2.4.5 Sustainable water management plan

The control and efficient use of water developed through a water management plan is an integral part of the sustainable business practices, because it promotes the correct use of the resource, thus contributing to the environmental stewardship, and at the same time decreasing the hotel's operating expenses. Giving as a final result, the offer of an ecologically responsible service.

The implementation of water management plans in the hotel sector are carried out through a series of steps, generally based on schemes such as those mentioned in the section 2.3 about Environmental and best practice schemes and programs, which establish recommendations for the effective management of resources in a building. The Global Sustainable Tourism Council (GSTC), for example, in its criteria for achieving good water management proposes, among many other recommendations, to collect data per tourist / night, and educate guests and staff for good water use (GSTC, 2016).

More specifically in Germany, The Assessment System for Sustainable Building (BNB), establishes two fundamental steps in the water management criterion. The first step, like the GSTC, is to collect water consumption data, and the second step is to suggest actions based on data collection results (BMUB, 2015; BMUB, 2013).

In general, the hotels that have implemented a water management system carry out the following process (Kuoni, 2014):

- Planning: This first step, requires a certain amount of time and commitment from the hotel management, to carry out a plan in order to establish strategies and monitoring methods in an orderly and systematic way, for the efficient consumption of water in the facilities.

The manager may assign or serve him / herself as leader of the team who will carry out the entire process. The leader must be fully committed to the project to be able to transmit the benefits (reduction of operating costs, environmental care), reinforce, and support the team, as well as know the tools to be used at all levels of the process.

Manuals for water management in the hotel sector suggest that the work team formed for water management should have one person representing each area of work (management, kitchen, housekeeper, maintenance, etc.). This person should not only collect data, but also monitor the water consumption of the department under his/her supervision (Kuoni, 2014).

- Collection of water consumption data: The purpose of this stage is to establish a baseline of consumption and to understand in depth the normal consumption patterns of the hotel. During data collection it is necessary to determine the factors or indicators that influence the consumption of water in the hotel, according to their

characteristics, with the aim of being able to detect variations in the systems. Data collection also allows for clear and objective results of efforts and changes made, both physical and behavioral, to achieve efficient water use. If the results show that the objectives have not been achieved, new strategies will be established.

Many schemes suggest the installation of water sub-meters in different areas of the hotel, such as rooms, kitchen, and laundry, as it is recommended by the Green Key scheme (See Section 2.3.2), in its section for water management applicable to hotels and hostels. It is also proposed to calculate the flow rates from various areas of the hotel, such as guest bathrooms, kitchen, laundry, etc., as well as establish water consumption by bed/night or tourist/night for several months (Kuoni*,* 2014).

The purpose of these measurements is to identify the areas of greatest consumption, and to know not only current water expenditure, but also to create a historical record of consumption. The results will allow calculating the reduction (if any) in operating expenses.

- Establish strategies for water saving: The implementation of this stage can be done before or after the collection of consumption data, according to the management characteristics of the hotel (Kuoni, 2014).

These strategies for water saving include:

- *Water conservation and reuse measures*: Use of equipment for more efficient bathrooms such as use of low-flow toilets, taps and showerheads, both in guest bathrooms, and in public/staff toilets. Use of more efficient washing machines and dishwashers. Reuse of waste water for irrigation or cooling towers.
- *Staff Training*: the objective is to modify the behavior of the staff in the operational processes through training and motivation, in order to make them aware of the good use of water. An example is the placement of posters in staff rooms explaining how to make a good consumption of the water in the daily tasks, or training the staff on the correct use of equipment with new technologies, as well as timely communicate the detection of water leaks.

  An important element to take into account in the relationship with the staff is to encourage the contribution of water saving suggestions based on their own experiences.

- *Guests awareness*: as with staff, it is important to encourage guest participation in the water management plan to reduce the consumption of such precious resource. Through flyers and announcements in the rooms and different dependencies of common use of the hotel, it is possible to raise awareness and inform the clients about the efforts made in matters of environmental sustainability.

- Monitoring and Evaluation: This stage is of high priority within the whole process, and is the one that closes the cycle in the water management plan. Without systematic and periodic monitoring it is impossible to determine and track the effectiveness of the implemented strategies or to detect abnormalities within the system.

It is essential to establish periodic revisions of water consumption, and compare hotel water consumption, both internally with previous records and (if possible) with other similar service providers in order to understand the behavior of the system. This comparison will identify areas where water consumption efficiency can be maximized and also it will reveal failures or possible improvements, thus establishing a link between planning, strategies and cost-benefit (Kuoni, 2014).

- Reduction of costs: as its name indicates, at this stage of water management will determine the money saved after the implementation of actions and measures to save water. The manuals suggest doing this calculation separately in the different areas of the hotel.

2.5 What is Benchmarking?

The concept of Benchmarking can be applied to different activities within the organization. In this way, through Benchmarking, a company can improve not only the final service it offers, but also all the processes necessary to provide that service.

For this reason it is not possible to find a unique definition of the word Benchmarking. Spendolini (1992, p.12) proposes a method to form several definitions of Benchmarking, in which different words are grouped in separate columns. From each column is possible to choose one or several words to form a definition. An interesting point of this method is that the word PROCESS is alone in one of the columns, the rest are nouns and verbs that fall on this word.

Using this method our definition of Benchmarking would be: a systematic and continuous process to measure, evaluate and compare the operations of the company with other similar companies or with the internal performance of the company, in order to set priorities, goals and targets.

2.5.1 Types of Benchmarking

There are three fundamental types of Benchmarking (Spendolini, 1992, pp.19-26):

- Competitive
- Best Practice
- Internal

Although this thesis will be focus on Internal Benchmarking, a brief description of the other two types will be given because they can influence the evaluation of internal Benchmarking results, once the company has acquired a total understanding of their own performance.

- Competitive Benchmarking: As its name implies, it is to compare the internal performance of a company with other similar companies, or direct competitors. The objective is to identify competitors' specific information regarding an activity to be compared.

- Best Practice Benchmarking*:* this process is again to compare the company's internal performance, but this time focusing on companies that are accredited by having the best practices or services. This type of comparison allows significant improvements in the company.

- Internal Benchmarking: The advantage of internal Benchmarking is the ease with which internal data can be collected and compared. The objective is to identify the performance of similar activities in different departments or areas within the company. Such performance may be influenced by multiple factors such as the characteristics of the facilities, the management system, employees, etc.

The knowledge acquired after carrying out this process of evaluation and comparison, will later be transformed into the basis, not only for subsequent internal comparisons, but also for possible external comparisons.

This type of Benchmarking requires the stimulation of internal communications and the search for solutions among all the members of the organization, making it

particularly easier to implement in smaller companies with more linear organizational structures, than in large companies with more diversified structures.

2.5.2 Types of projects in Benchmarking

Identifying the project on which to carry out the evaluation and comparison process, is the first logical step to establish the appropriate indicators to be measured.

Project types can be based on (Stapenhurst, 2009, pp.61-63):

- A specific process (Staff training; Maintenance)
- A specific physical area (Guest rooms; Laundry)
- A specific activity or small group of activities (Water Consumption)
- A functional benchmarking (Guest rooms cleaning)
- A generic project (Comparison and evaluation of different functions or processes to achieve a specific result)
- A specific project (Renovation of the bathrooms)
- A combination of the different types of projects.

Although this research will be focus on a specific activity such as the measurement and evaluation of water consumption in the hotel sector, the search for greater efficiency in its use can lead to other types of benchmarking projects, such as the measurement of the water expenditure of the staff in the cleaning of the rooms and in the preparation of the meals, which are more related to the functional and process benchmarking.

3 METHODOLOGY

The research techniques used to answer the research question and sub questions, and meet the objectives, were divided into three stages according to the type of data collected (See Figure 4).

During the different stages of data collection for the development of this thesis work, an empirical research were adopted using both qualitative and quantitative techniques. In the collection of initial data, a qualitative research methods were used, both descriptive (document review (occupation rates, water bills), observation (visit to hotel facilities)), and exploratory (literature search and a qualitative questionnaire created to obtain attitudinal data).

In the collection of data of the third stage, the research method used was mainly quantitative, in order to obtain numerical records of the performance and characteristics of the different elements related with the water consumption. This information would later be used to develop a methodology for the management of water consumption in SMS urban hotels.

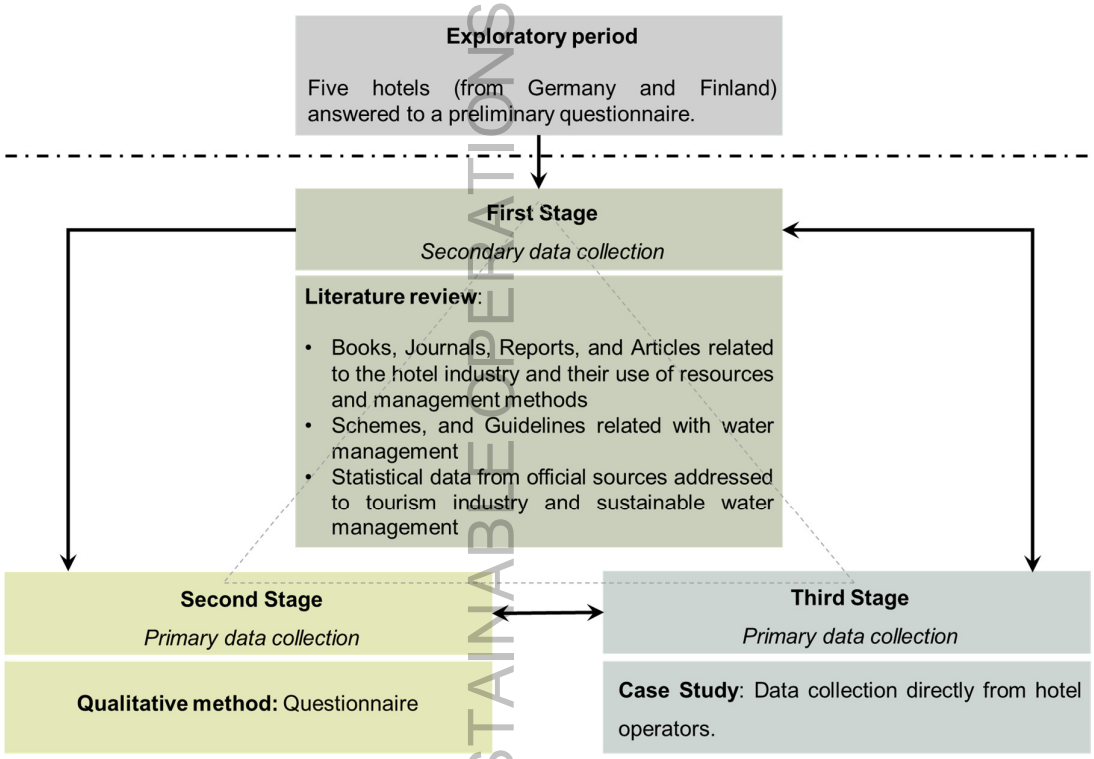


Figure 4: Data collection structure

Source: Author's own elaboration

3.1 Data collection strategies

The data collection in this research was carried out in three stages. The first stage corresponds to secondary data collection based on the literature review, and the second and third stage are based on the collection of primary data developed through a qualitative questionnaire and the case study (See Figure 4).

Data triangulation method was used to support all the information collected in the different stages, through the comparison of the information on the same topic (hotels water consumption management) from different points of view (Bryman, 2012). Thus, was possible to verify the validity and strengthen the knowledge on the topic studied.

3.1.1 First Stage. Secondary data collection

Secondary data is, according to Saunders et al. (2009, p. 256), the information that has already been collected and investigated for some other purpose. The collection of secondary data is based on the literature review, which is an essential preparatory process within this study. During this stage, the author's knowledge and point of view on the particular research topic of this thesis was strengthened.

The objective in this stage was to collect and analyze information mainly in order to familiarize the researcher with the current situation in the management of water consumption in the hotel sector, and the existing tools for its monitoring and evaluation. Since the case study for this thesis is in Germany and the unites of analysis are small and medium-sized (SMS) urban hotels, the current conditions of the water service in the country, as well as the proportion of existing SMS hotels, were also studied.

Through the review of books, journals, and articles related with the accommodation services and their use of resources and management methods, as well as the revision of reports, schemes, guidelines, and statistical data from official sources addressed to tourism industry and sustainable water management, it was possible for the author to understand the initiatives, attitudes, and tools taken by the different categories of hotels with respect to resource management in general, and water in particular, and their possible applicability in SMS hotels.

3.1.2 Second Stage. Qualitative questionnaire

A qualitative survey was carried out through a questionnaire, and its use was considered for several reasons.

- First, due to the relatively few existing literature regarding the implementation of water consumption management plans and their subsequent monitoring in SMS hotels, it was decided to use a qualitative survey method with the purpose, as Fink (2003) points out, to examining the behavior and attitudes of SMS hotels on this specific subject, and thus give more basis to the research question.
- Second, a pilot study was not developed in this thesis due to time constraints. However, an exploratory period was carried out to define the topic of this research. During that period several hotels from different categories were visited and phoned. Among them, only five hotels (from Germany and Finland) agreed to answer a questionnaire, not only on water consumption, but on environmental practices in general. For the rest of the hotels visited that did not agree to answer the questionnaire, it was observed that the main reasons were lack of time of the manager or owner, and a reserved attitude of the hotel to share information about its internal processes.

Finally, the main objective of the questionnaire was to obtain attitudinal data, in order to maximize the information on which the objectives are based.

- The questionnaire. The questionnaire was design based on the literature review findings, and the experience during the exploratory period. The questionnaire was mainly as a structured questionnaire (The University of Sheffield, 2014) where the respondents could only select an answer from a list of options, and it was developed in a web-based survey, called Typeform (2017). Through the personal HTW Berlin (Hochschule für Technik und Wirtschaft) e-mail of the author of this thesis, the hotels received the web address (URL) where the questionnaire was located, and a letter explaining the purpose of the thesis. The letter also explained the anonymity of the survey, in which the name of the hotel was not asked. It was decided to do so, given, as mentioned above, the attitude of hotels to keep their information restricted.

The e-mail was sent to all the hotels of economic, midscale and upper-midscale category, with less than 150 rooms in Germany, which are the hotels that fall into

the category of SMS hotels. The objective of this categorization was to obtain information from a group of hotels as homogeneous as possible, in order to be able to compare them later. A reminder were re-sent to the hotels every two weeks for a period of two months.

The questionnaire was structured in 4 sections, where the questions were presented as simple, consistent and clearly as possible, to avoid confusion and allow the respondent to complete the questionnaire quickly (the complete questionnaire can be seen in Appendix A). The sections are described as follows:

The first section of the questionnaire (questions 1 through 9) begins with the questions necessary to obtain the demographic information of the hotels, such as location; Hotel category; Date of construction, etc.

The next five questions in the second section focus on obtaining information on the measures taken by the hotel for saving and regulating water consumption. An example of this type of question would be: What measures are taken to regulate the water consumption in the rooms?

In the third section there is a single question (question 16) regarding the use of sub-meters in the hotel facilities. This question is important since many schemes and guides pay particular attention to this point.

The last section is intended to collect information on hotel operations. This section asks about help guidelines used in hotel management, and the impact of the water price on such operations.

- The questions. The questionnaire is mainly elaborated with closed-ended questions (Stanford University. Social Science Data and Software, 2011), which allow the respondent to select an answer within a group of opinions. This type of questions were selected with the purpose of making it possible to complete the questionnaire quickly, and also to obtain answers as objectively as possible (Fink, 2003).

Among the close-ended questions used were: yes / no questions; Multiple answer questions, in which it is possible to select one or more options from one question, and Rating questions, in which the responder can select an option from "Very high"; "High"; "Medium"; And "Low".

3.1.3 Third Stage. Case study

The collection of primary data in the third stage of this thesis is through the use of a case study. Although there are many definitions for a case study, Crowe et al. (2011, p.1) compiles several definitions and summarizes the case study concept as an in-depth investigation of a complex subject or phenomenon in its everyday context. In this study the subject that was investigated was the use of methods for the efficient management of the water consumption, in which the unit of analysis were small and medium-sized urban hotels in Germany. All the information collected so far during the two previous stages was used to carry out a more specific data collection of the participants of the case study.

- Design of a Case study. According to Yin (2009, pp.27-34) there are five components for the design of a case study:

1*. Research Question*: *How to create a simple and reliable methodology* for water consumption management *in small and medium-sized (SMS) hotels in Germany?*

2. *Purpose of study*: Develop a procedure for the management of water consumption, with indicators adapted to small and medium-sized (SMS) hotels in Germany.

3. *Unit of analysis*: Small and medium-sized (SMS) urban hotels in Germany.

4. *Logic linking the data to the purpose*: Performance of the concept linking operations and water consumption.

5. *Criteria for interpreting the findings*: Efficient monitoring of water use, reduce water consumption and therefore overall operational costs.

The unit of analysis chosen for this study were SMS urban hotels because they represent the most abundant category in Germany (See Section 2.4.3), but also the less studied in relation to the implementation of sustainable business practices, more specifically practices of managing the consumption of water.

The case study has five hotels located in Germany. Two of them in the city of Berlin, one in Cologne, one in Hamburg, and one in Bonn. In the city of Berlin were used a chain hotel of economic category, and a small independent hotel. In Cologne and Hamburg were used a small and middle size chain hotel of the same category of the previous one in Berlin. And in Bonn was used a small family hotel. All gave their

consent to obtain information on their occupancy rates, water consumption bills, as well as information on their daily operations related to the consumption of this resource, such as preparation of food in the kitchen, laundry, cleaning of rooms and common areas. It was also possible to perform a periodic checks of the water meter in one of the hotels to develop a water pattern.

- Visits and E-mails. In the same way as in the qualitative questionnaire, through the personal HTW e-mail of the author of this thesis, a letter, to more than 800 hotels throughout Germany, was sent explaining the purpose of the research, together with a request to collaborate as a case study for the project. The E-mails were sent from the month of March to May 2017.

The personal visits to the hotels to make the request of collaboration with the project was carried out only in the city of Berlin, place of the author's university studies, due to the financial restrictions that implied to move to other states of the country.

The selection of the hotels to which the e-mail would be sent was made after an online research of all the hotels that fulfilled the characteristics exhibited in the unit of analysis. That is, hotels from Economy to Upper-Midscale chain scale, with no more of 150 rooms, and located in an urban area.

- Third stage research method for data collection. In order to answer the research questions, and satisfy the objectives, during the collection of data of the third stage the research method used was mainly quantitative, to obtain numerical data that would later be used to develop a methodology for the management of water consumption in SMS hotels. A measurement method was used to obtain a water pattern and the water flow rates from the bathroom and kitchen fixtures, and a regression analysis method was used to find the correlation between the different elements that influence the water consumption in the accommodation facilities.

3.2 Information gathering

All information collected, both from the questionnaire and the case study, was kept confidential throughout the entire process, and the data of the participating hotels was not communicated to anyone other than the supervisor of this thesis work.

To preserve the anonymity of the participants an alphanumerical code was assigned to each Hotel, which consists of three letters and a number. The letters refer to the

stage in which they were used, for example in the second stage relative to the qualitative method the letters QMH were used, which means Qualitative Method Hotel. The same was done in the third stage where the letters CSH were used, which means Case Study Hotel. The number is simply a reference to the number of hotels studied at each stage.

3.3 Limitations of the methodology

One of the main limitations found during the data collection process was the reserved attitude of the hotels to share information about their operations, which resulted in a large amount of time needed to complete the second and third stages of the process. As a result, the number of respondents in the questionnaire was very low, so it was used only as a qualitative information rather than a quantitative.

Another limitation was the method of storing data for each hotel. While some were fully digitized, which facilitated their collection, others were kept in files with incomplete information and often even with data amended by hand, so the author had to rely on the operator's word on the veracity of the information (See an example in Appendix D).

4 RESULTS

The results presented in this chapter aim to expand the field of knowledge related to the current water management practices in SMS hotels, in order to create a methodology adapted to their characteristics and limitations, that allows them to collect data from on-site measurements, and internally benchmark their water consumption performance, and therefore, incorporate effective measures and water conservation strategies, thus closing the gap created by the absence of adequate systems addressed to these accommodation providers.

4.1 Exploratory period. Results

As explained in the methodology chapter, before beginning the second stage of data collection, a questionnaire was carried out with the purpose of defining the final topic of the thesis work. During this preliminary exploratory period, five hotels in Finland and in Germany, four of them listed as 3-stars and one listed as 5-stars (with the code EPH5), agreed to complete the questionnaire. The questionnaire was designed in a web-based survey, called Typeform (2017) (See Figure 5)

The exploratory period questionnaire contained questions not only on water consumption, but on environmental practices in general. Of the 50 questions that were asked, 3 of them were directly related to water consumption (questions 1 through 3 of Table 9), and 2 indirectly (questions 4 and 5 of Table 9). Since this thesis work focuses on the management of water consumption in hotels, only the results of the questions related to this topic, which are shown in Table 9, will be explained.

Although the sample was too small to claim that the result would be the same using a larger sample, it gave interesting conclusions that helped to shed light on important aspects to establish the final topic of this work. For example Question 1 and 2 (See Table 9), it seems to show that there is some interest of SMS hotels in reducing their water consumption through the use of low water flow devices, as well as through the education of its customers for the reduction of consumption. In fact, three of the four 3-star hotels claimed to receive assistance on matters related to the care of the environment from private institutions (question 7). However, in question number 3 it is possible to observe that only one of the five hotels that

responded to the survey develops a periodical record of their water consumption (the 5-star hotel EPH-5). This point draws particular attention since keeping a record is a determining factor in monitoring and evaluating the effectiveness of the measures taken, expressed in Question 1 and 2, to reduce water consumption.

Finally this information was the one that defined the topic of this thesis, and was the base to begin the process of secondary data collection.

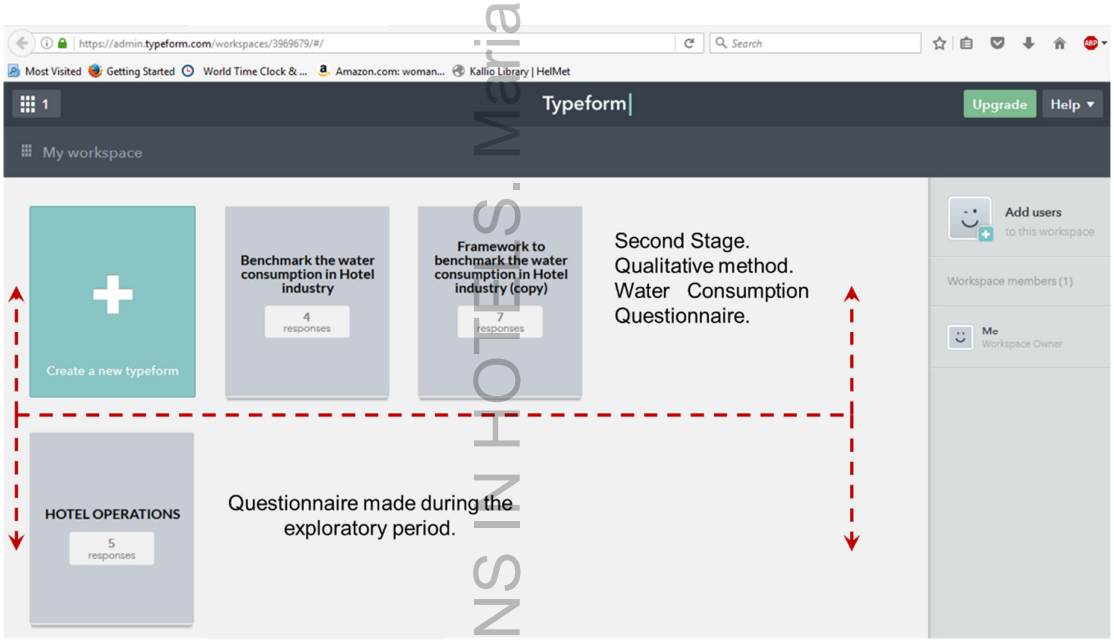


Figure 5: Questionnaire Online platform

Source: Typeform (2017)

Table 9: Answers of the five hotels surveyed during the exploratory period

	Q1-What measures are taken to regulate the water consumption in the rooms?					
	HOTELS SAMPLE	**EPH-1**	**EPH-2**	**EPH-3**	**EPH-4**	**EPH-5**
Answer Options	Leaks control					
	Low-flow Showerheads or Flow regulators					
	Thermostatic controlled shower sets					
	Auto Shut-off showers					
	Electronic faucets					
	Self-Closing faucets					
	Faucet aerator					
	Low flush Toilet					
	Pressure-regulating valves					
	Others					
	None					

Table 9A. Answers of the five hotels surveyed during the exploratory period (Continued)

	Q2-What measures are taken to regulate the water consumption in service areas?					
	HOTELS SAMPLE	**EPH-1**	**EPH-2**	**EPH-3**	**EPH-4**	**EPH-5**
Answer Options	Leaks control	■				
	Flow regulators			■		
	Electronic faucets					
	Self-Closing faucets					■
	Faucet aerator					
	Spray washers	■				■
	Pressure-regulating valves					
	New energy efficiency appliances					
	Regular staff trained in efficient use of water	■				
	Others					
	Not Applicable				■	
	Q3-How often does the hotel maintain a water consumption record?					
	HOTELS SAMPLE	**EPH-1**	**EPH-2**	**EPH-3**	**EPH-4**	**EPH-5**
Answer Options	Very frequently					■
	Frequently					
	Infrequently	■				
	Very infrequently		■			
	No records are made			■	■	
	Q4-What is the training level of the cleaning staff regarding environmentally friendly practices?					
	HOTELS SAMPLE	**EPH-1**	**EPH-2**	**EPH-3**	**EPH-4**	**EPH-5**
Answer Options	Very high					
	High					
	Moderate	■		■	■	■
	Low		■			
	Very Low					
	None					
	Q5-Does the hotel offer recommendations to its clients about the care of the environment? *(e.g, on the water consumption, or if the client prefers or not the daily*					
	HOTELS SAMPLE	**EPH-1**	**EPH-2**	**EPH-3**	**EPH-4**	**EPH-5**
A.O	Yes	■		■	■	■
	No		■			
	Q6-Does the hotel receive information, guidance or assistance from any government entity, on issues related to the care of the environment?					
	HOTELS SAMPLE	**EPH-1**	**EPH-2**	**EPH-3**	**EPH-4**	**EPH-5**
A.O	Yes	■				
	No		■	■	■	■
	Q7-Does the hotel receive information, guidance or assistance from any private entity, on issues related to the care of the environment?					
	HOTELS SAMPLE	**EPH-1**	**EPH-2**	**EPH-3**	**EPH-4**	**EPH-5**
A.O	Yes	■		■	■	
	No		■			■

Source: Authors' own elaboration

4.2 First Stage. Results of the literature review

During the literature review stage, it was possible to be aware of the importance of SMS hotels in the hotel sector, since they represent the most abundant category of accommodation providers both global and local. In Germany for instance, the limited

service hotels that include budget, economy and midscale hotels represent the 66% of the whole population of lodging providers.

It was also possible for the author to become familiar with the current sustainable water management plans developed mainly by larger hotels, as well as the organizational structure of SMS hotels that are characterized by having a flat structure with fewer levels of management than the larger hotels, and with limited staff, which means that the availability of time for the implementation of sustainable water management plans is reduced. That is reason why the commitment towards the implementation of objectives that address the good management of the resources, seems to be smaller in the SMS hotels, that in its bigger counterparts (Bohdanowicz, 2005). This information was corroborated in the hotels of the case study.

With the help of literature review, the knowledge was extended over the existence of useful tools such as schemes Green Key, Decision (EU) 2017/175, and Decision (EU) 2016/611, which establish the limit for the consumption of water per guest, and best practices for water consumption in both bathroom fittings and appliances. It is also important to highlight that this schemes put special interest in the use of water sub-meters to monitor the water consumption in the hotel. Nevertheless, this system is not broadly use in SMS hotels. For this reason, previous studies performed in other hotel categories, on the average daily use of sanitary equipment in bathrooms per guest, was useful to estimate the water consumption per guest in the case study hotels, since this hotels do not have water sub-meter in their rooms. All this tools finally led to the development of a methodology for the management of water consumption applicable to SMS hotels.

4.3 Second Stage. Results of the qualitative questionnaire

With the help of the literature review and the result obtained during the exploratory period, another questionnaire was designed with the purpose of maximizing the information related to the management of water consumption, this time focusing only on SMS urban hotels in Germany. At this stage eleven hotels answered the questionnaire (See Figure 5). However, four of the eleven hotels had to be

eliminated because they did not comply with the characteristics of the hotels studied (See Appendix B).

As the sample obtained is small, and therefore it does not constitute a significant sample of all the hotels of the studied category, no statistical considerations were taken of the collected data, but, instead, it was taken as a basis of qualitative information to strengthen the ideas expressed in this study.

The characteristics of the hotels that answered the questionnaire can be seen in the Table 10. The sample is represented by six 3-star hotels, two of them medium-sized (QMH-1 and QMH-3) with 95 and 137 rooms respectively, and five small size with less than 75 rooms. Additionally, there is a small-scale 4-star hotel (QMH-2). The Hotel QMH-2 is the only one of the group with full services of restaurant, laundry, and conference room.

Analyzing the survey responses it was found that all hotels implement one way or another plans to reduce water consumption through the use of low-flow fittings in the bathrooms (Question 1 (Q1)), periodic checking of facilities for water leakage (Q4), and recommendations for its guests regarding the responsible use of water.

However, when asked if they kept a record of their water consumption (Q3), 5 of the 7 hotels responded not to carry any record, or to make them infrequently, as the small 4-star hotel responded (the answers for each Hotel can be seen in the Appendix C). These answers support what is expressed by Page (2015, pp. 216-220), and Peters et al. (2004, p. 407), they point out that the informal way in which this category of hotels is handled, results in a lack of systematic business management and incomplete or non-existent reports of the hotel's performance.

Question number 5 (Q5) is related to the placement of water sub-meters in the most water-consuming area of the hotel. This question was formulated because, after the data collection of the first stage (Literature review) was carried out, it was found that both the European criterion Decision (EU) 2017/175, as well as the international criterion Green Key, in their criteria 27 and 4.11 respectively (See Section 2.3), suggest the placement of water sub meters for monitoring consumption. For this reason it was considered important to investigate this particular point, with the aim of creating a method for monitoring water consumption adapted as much as possible

to the reality of SMS urban hotels in Germany. The result of this question shown that only one (QMH-4) of the 7 hotels surveyed has water sub-meters.

Table 10: Sample characteristics of the second stage questionnaire

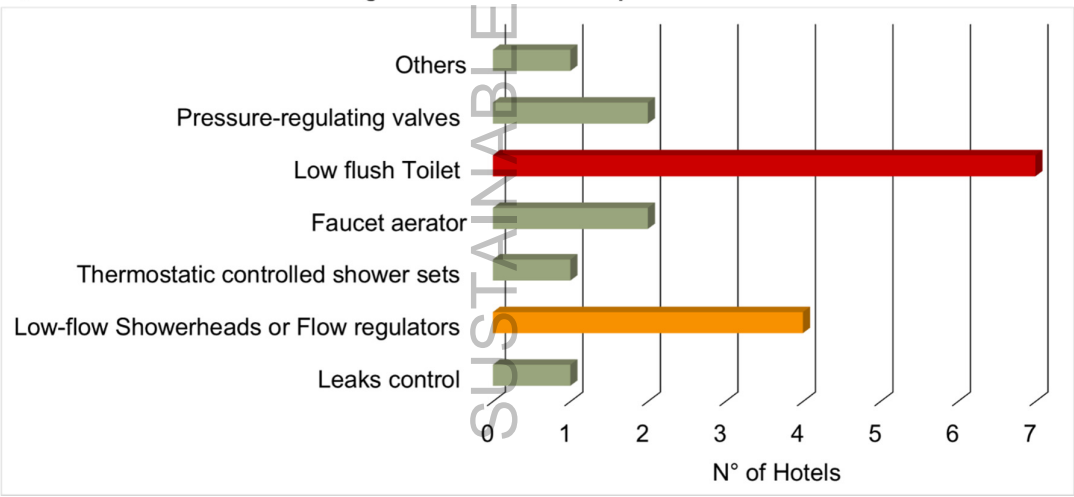
Hotels Sample	QMH-1	QMH-2	QMH-3	QMH-4	QMH-5	QMH-6	QMH-7
Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Hotel Category	Budget	4 Stars	3 Stars	3 Stars	3 Stars	3 Stars	3 Stars
Hotel Location type	Urban	Urban	Urban	Urban	Urban	Urban	Urban
Construction Date.	2015	1982	1974	1890	1897	1966	1927
Last renovation		2003	2016	2016	2010	2013-2016	2009
Construction area m2		240		35	400	867	
Number of Levels	4	4 Levels	6+ Levels	3 Levels	1 Level	3 Levels	3 Levels
Number of Rooms	95	49	137	67	17	22	19
Number of Employees	6	24	25	22	7	7	8
Services		Restaurant, Laundry, Meeting Room	Restaurant, Meeting Room	Meeting Room	Restaurant		

Source: Author's own elaboration

Although Germany is one of the European countries with the highest tariffs per capita for the supply of drinking water (Lauruschkus et al., 2015), so we would expect a more uniform set of responses, on the contrary, the answers obtained varied widely ranging from the selection of a significant impact to a minimum impact, the most voted being the medium impact option. While it is not possible to conclude with certainty the reason for these variations in the responses, an idea could arise from the fact that the selection of the significant impact option was made by the small scale 4-star hotel, which is the only one that offers full services, so the size of the hotel and the services it provides could be the factor influencing the different perceptions.

The breakdown of the questions and answers is shown in the charts below:

Q1- What measures are taken to regulate the water consumption in the rooms



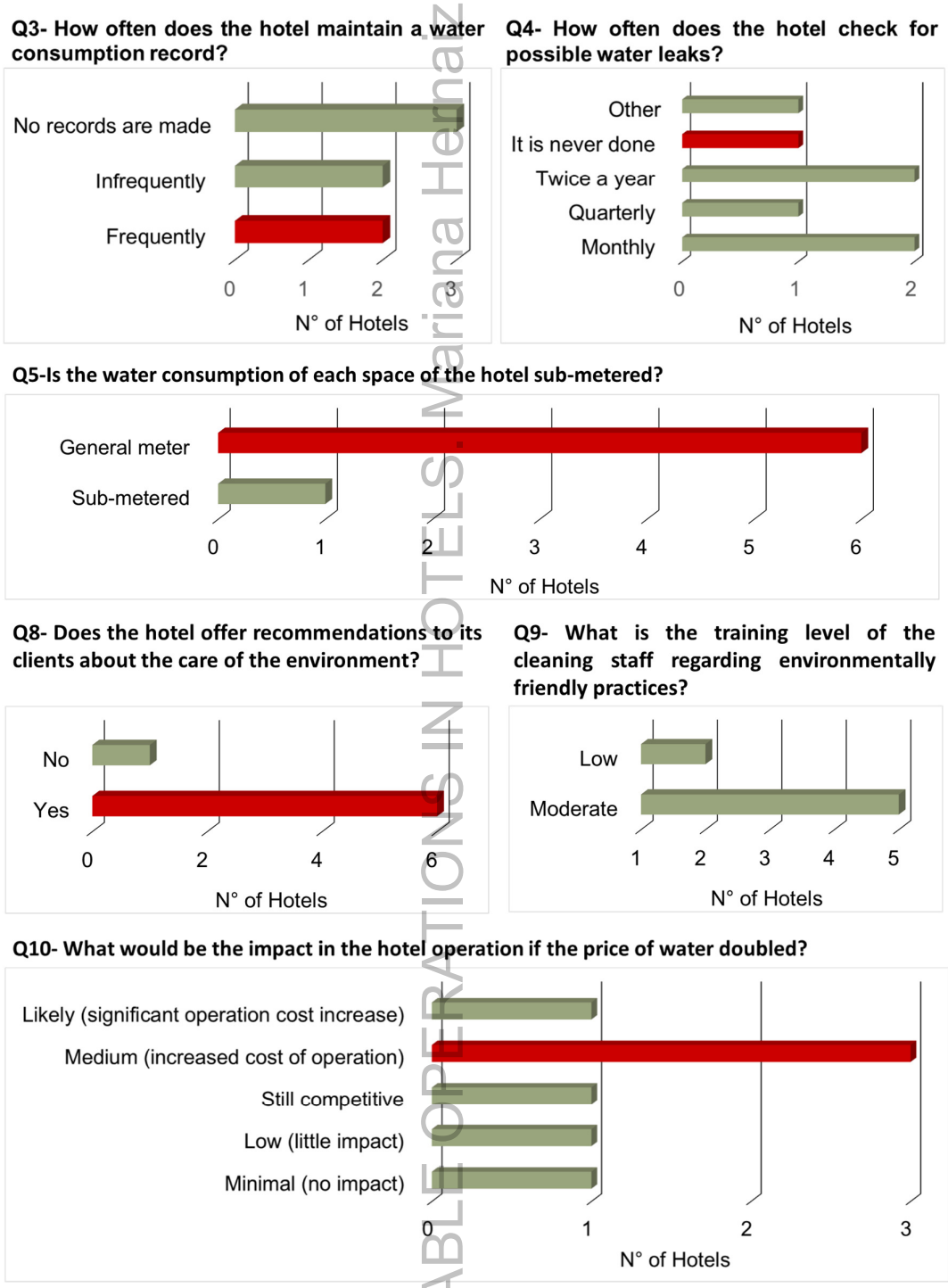


Figure 6: Questions and answers of the second stage questionnaire

Source: Author's own elaboration

Finally, although the response rate of this questionnaire was low, the conclusions obtained added important observations, which support the analysis of the secondary data and at the same time contribute to give more meaning to the information found in the third stage (case study) of the collection of data.

4.4 Third Stage. Results of the Case study

In order to create a methodology for water consumption management adapted to the characteristics of SMS urban hotels, to efficiently evaluate the consumption of this resource, this section will establish a series of easy-to-use procedures for this category of accommodations, to enable the hotel owner/manager to develop an efficient water consumption management plan.

4.4.1 Case study. Sample characteristics

The sample used in this research is relatively small, so it is not fully representative of SMS urban hotels in Germany. However, the sample covers the two main types of hotels in the urban areas of the country, such as independent or family-run hotels, and hotels belonging to hotel chains.

Table 11: Sample characteristics of the Case study

		Case Study Hotels				
		CSH1 ***	**CSH2 *****	**CSH3 *****	**CSH4 ****	**CSH5 *****
General Info.	**Location**	Berlin	Berlin	Hamburg	Cologne	Bonn
	Hotel Chain Scale	Midscale	Midscale	Midscale	Economy	Midscale
	Hotel Size	Small	Middle	Middle	Small	Small
	Construction Date	1969	2008	2009	1965	1888
	Total Renovation Date	2012	N/A	N/A	2006	2005
Physical parameters	**Approx. Construction Area in m2.**	1114	2800	5700	1270	912
	N° of Floors	4	7	6	6	2
	N° of Rooms	31	90	116	52	17
	Bed Stock	50	328	423	170	29
	Water Sub-meters	n/a	n/a	n/a	n/a	n/a
	Garden Area	n/a	n/a	n/a	n/a	n/a
	Swimming pool	n/a	n/a	n/a	n/a	n/a
Operational parameters	**Laundry service**	n/a	n/a	n/a	n/a	n/a
	Full-Service Restaurant	n/a	n/a	n/a	n/a	n/a
	Buffet Breakfast	Yes	Yes	Yes	Yes	Yes
	Water recycling system	n/a	n/a	n/a	n/a	n/a

Source: Author's own elaboration

As can be seen in Table 11 the hotels of the sample are identified with an alphanumeric code to protect their identity and keep their anonymity. Among the small-scale hotels, hotel CSH-1 is independent, hotel CSH-4 belongs to a hotel chain, and hotel CSH-5 is run by its owner. The medium-scale hotels, with the code CSH-2 and CSH-3, belong to the same hotel chain.

4.4.2 Level of implementation of water consumption management plans

A comparison of the level of implementation of water management plans, between the one described in the literature review and the one observed in the hotels of the case study, are depicted in Diagrams 1 and 2.

Diagram 1 shows an ideal plan, which is based on schemes and guidelines such as those presented in the Section 2.3, and Diagram 2, in contrast, shows the water management plan observed in the five hotels of the case study. In this Figure, out of five steps of the process, three of them (steps 1 to 3) are partially carried out, while step 4 is totally neglected.

In the Diagram 2 the step 3 of the process (strategies of water savings) is the most implemented in the hotels of the case study. Among the four points included in this step: use of water-saving fittings, staff training, guest awareness, and creation of historical records, only the first three are executed (Figure 7 shows some examples found in the case study sample), while the last one (creation of historical records), which is related to step 2 (water consumption data), is completely neglected. Apart from the annual water bills, none of the five hotels in the sample keeps a record of water use on the facilities.

Steps 1 and 2 are partially implemented. In step 1 only the implementation of the first point (improvements to reduce overall water consumption) is carried out through the strategies described in step 3, while the last two points, water consumption management team and data collection structure and tools, are not developed, this is because none of the hotels in the sample takes into consideration the inclusion of a water consumption management plans within the hotel's overall management.

In Step 2, as previously mentioned, hotels only keep their annual water bills. More detailed documentation of the behavior of water flows, such as water patterns or water flow rate measurements, are non-existent, because they are considered by the hotel operator as time consuming activities.

Step 4 (monitoring and evaluation) is completely isolated from the process. Among the participants in the case study, the author noted the absence of monitoring records, which leads, on the one hand, to the absence of adequate evaluation of the strategies implemented in step 3 and, on the other, to the lack of awareness of the potential savings that can be obtained in the costs of water consumption (Step 5). That gap has also been highlighted by several authors such as Page, (2015, pp. 216-220) and Peters et al. (2004, p. 407) (See Section 2.1.4 of literature review)

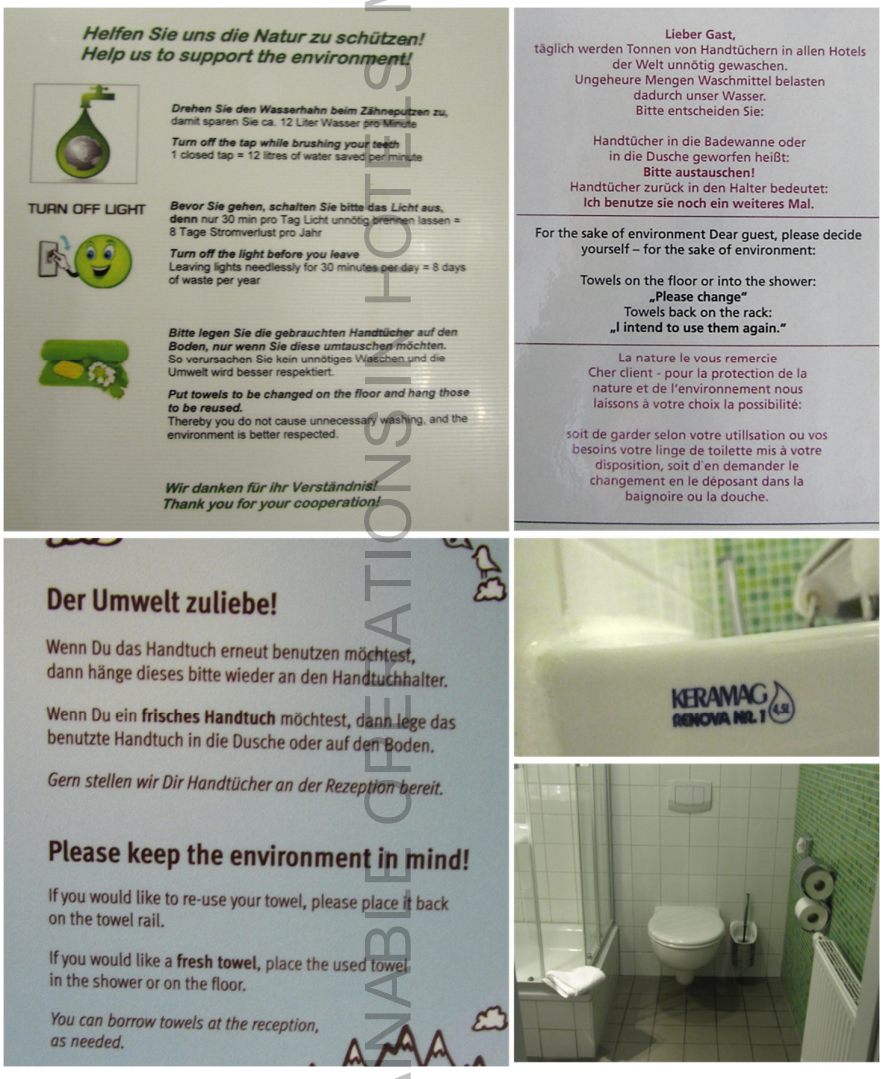


Figure 7: Recommendations for water saving, and low-flow toilet model used in the guest bathrooms of the sample hotels

Source: Author's own elaboration

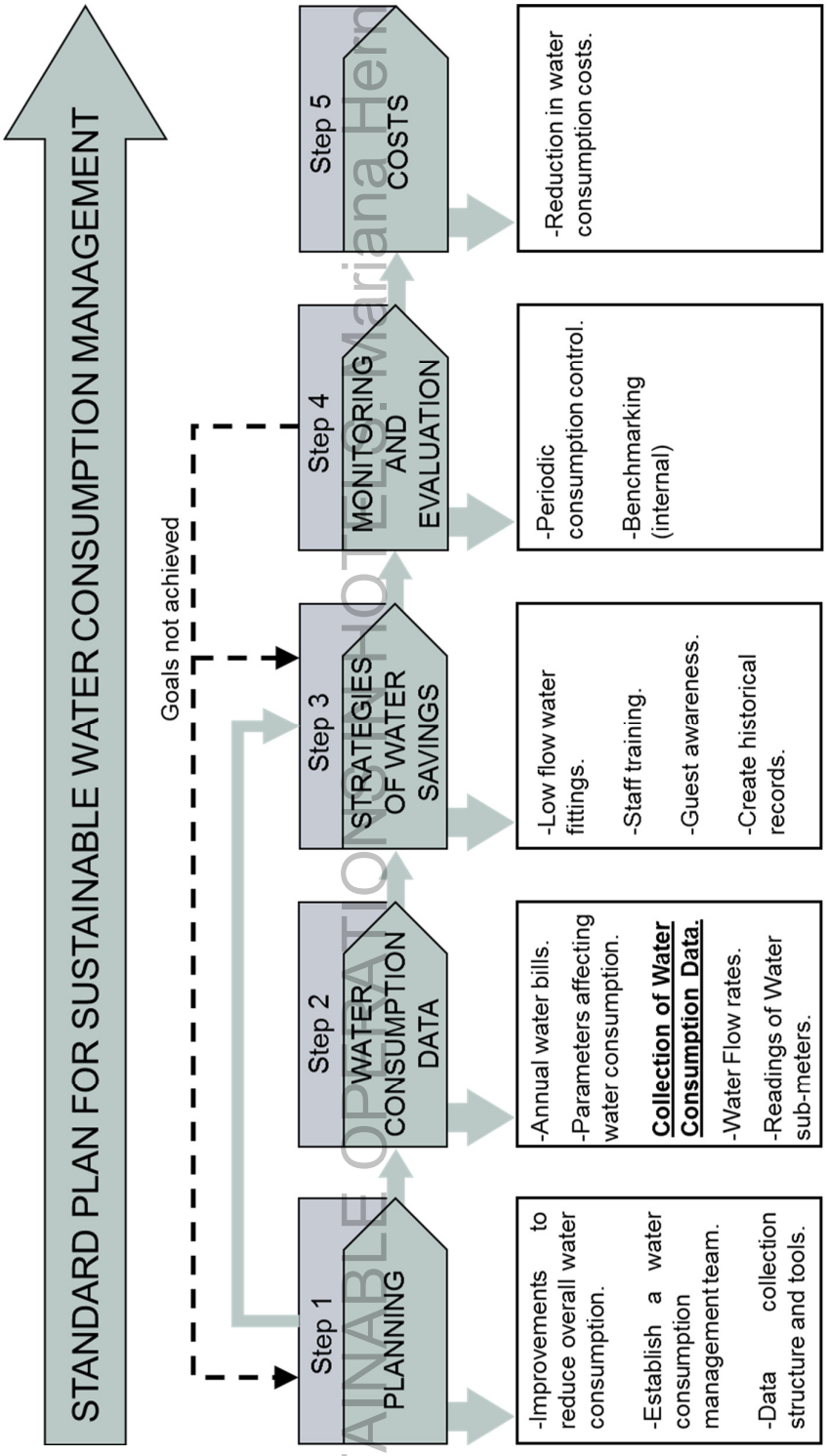


Diagram 1: Ideal Plan for water consumption management in hotels

Source: Author's own elaboration

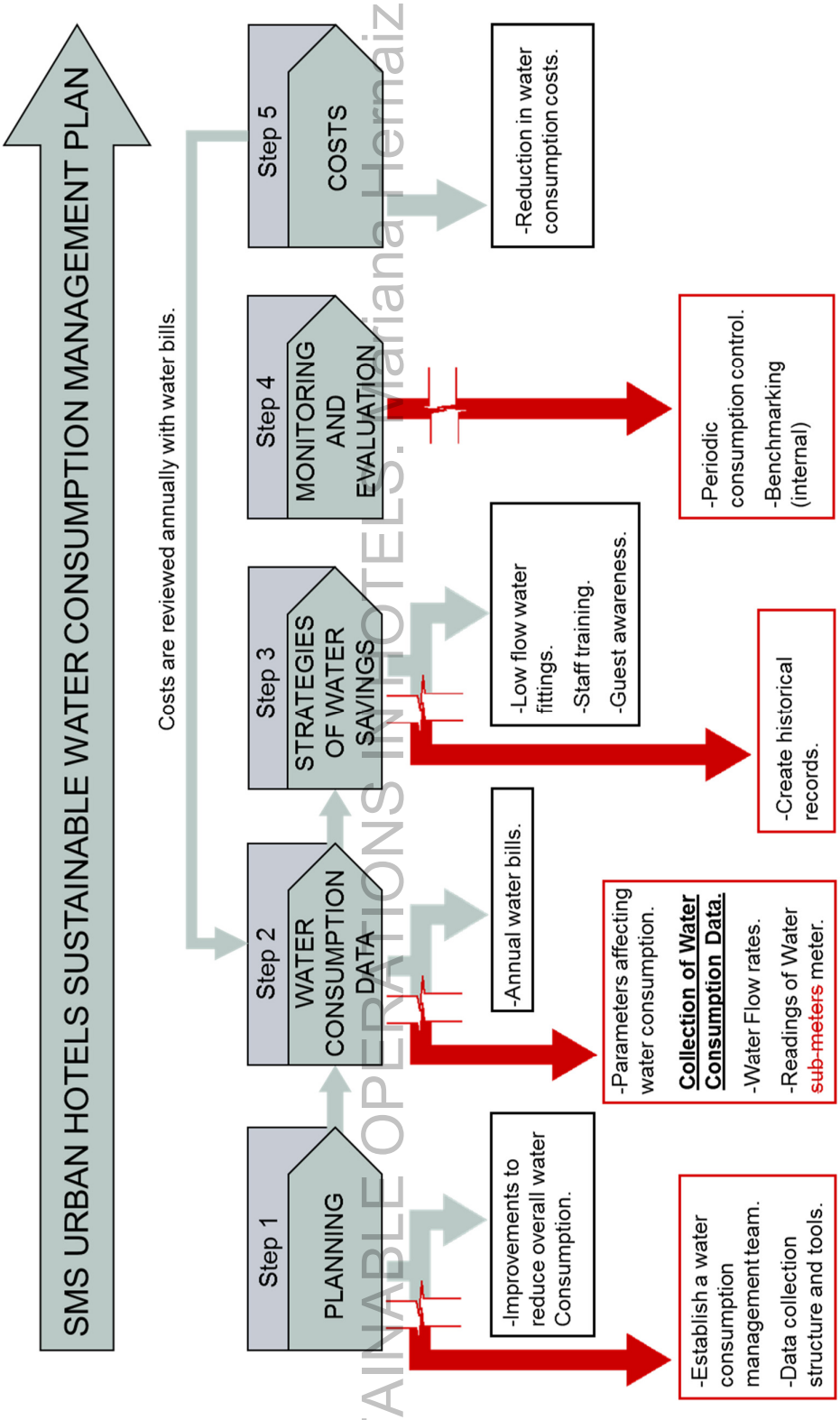


Diagram 2: Plan for water consumption management in SMS hotels

Source: Author's own elaboration

4.5 Design of the water consumption management plan

Since the goal of this thesis is to create a methodology for the implementation of water consumption management in SMS urban hotels in Germany, to design the process applicable to this category of accommodation according to their characteristics and limitations, this chapter has used, in order to fulfill this purpose, meet the objectives, and answer the research questions of this research, the following information:

1- Level of implementation of water consumption management plans of the case study depicted in the Diagram 1 (Section 4.4.2),

2- The criteria established in the schemes seen in Section 2.3,

3- Previous studies on water consumption in hotels seen in Section 2.4.4 and 2.4.5,

4- Empirical data obtained from site observations, collection of annual water bills, and measurement of water use in the hotels of the case study,

- ***Methods of collecting water consumption data.*** The analysis will be done as follows:

A- Establish the elements that influence water consumption in the hotels of the case study. Data will be related with the characteristics of the services offered within the hotel.

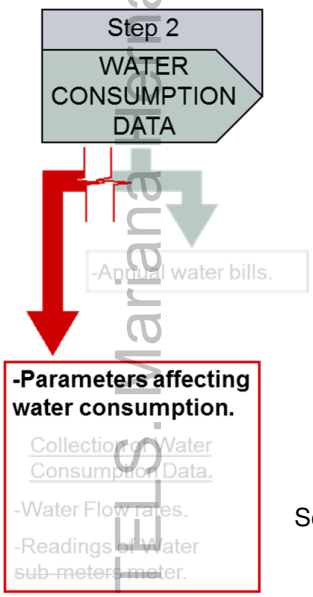
B- Establish prediction models for water consumption.

C- Establish data collection methods:

1C- Measurement of water flow rates for each activity that affects its consumption within the hotel, in order to benchmark the performance of the hotel with the best practices established in the schemes, and obtain potential water saving and costs reduction.

2C- Water meter readings in order to obtain a water consumption baseline per season.

4.5.1 Elements that Influence Water Consumption in SMS urban Hotels



Segment of Diagram 2 to be studied in this section

4.5.1.1 Influence of operational parameters on water consumption

In order to establish if the five hotels studied in the sample were within the average characteristics of the total population of SMS urban hotels in Germany, an Internet-based review was carried out, identifying the features and services offered by this category of hotels in different cities of the country.

To ensure that the results obtained reflected the average characteristics of the total population of hotels, first, the necessary sample size was determined by using the size of the hotel population (denoted by “N” in the equation below) offered by Hotelstars Union (2017), which totals 5728 hotels among the categories of budget, economy, and midscale.

The level of confidence chosen by the author was 95% (95% - Z-Score = 1.96). Due to time constraints the selected margin of error was +/- 6%. As the variability of the population is unknown, a value of .50 was taken for the standard deviation (StdDev in the equation below), which indicates the maximum variability of the population (Israel, 1992).

Finally, the necessary sample size was as follows (formula taken from Krejcie et al. 1970):

Sample size = (Z-Score)^2 x N x StdDev x (1-StdDev) / (Margin of error)^2 x (N-1)) + (Z-Score)^2 x StdDev x (1-StdDev)

Sample size = (1.96)^2 x 5728 x 0.5 x (1-0.5) / (0.06)^2 x (5728-1)) + (1.96)^2 x 0.5 x (1-0.5)

Sample size = 255

In total, 277 hotels were reviewed from less than 75 rooms to a maximum of 149 rooms, which represent hotels within the small and medium scale category. The results of hotels in the sample (See Appendix E and Table 12) showed that 88.8% of hotels offer Buffet Breakfast, only 11.5% have laundry service, less than 4% have spa, fitness center, and garden, and less than 1% has swimming pool.

Table 12: Proportion of services offered by SMS hotels in Germany

Services	BF	RT	LS	SPA	FC	GR
N°	246	37	32	9	6	7
%	88.8%	13.4%	11.6%	3.3%	2.2%	2.5%

Service Abbreviations: BF=Buffet breakfast; RT=Restaurant; LS=Laundry service; SPA; FC=Fitness center; GR=Garden.
Source: The information of each hotel was obtained from its official web pages, and from the web page https://www.hrs.de. (HRS - HOTEL RESERVATION SERVICE)

Source: Author's own elaboration

These results are similar to the one observed in the five hotels of the case study. In Table 11 it can be noticed that, in the section of operational parameters, none of the hotels has full-service laundry, or full-service restaurant. But the whole sample offers buffet breakfast.

It can be said that the services included in the operational parameters (Table 11) that affect the water consumption in the SMS urban hotels in Germany, including the five hotels of the case study, are essentially two: the service of lodging itself, and the service of breakfast. The operational activities that demand the use of water linked to the first service are: the use of the guest bathrooms and the cleaning of the rooms. And in the case of the second service are: the operational activities developed in the kitchen.

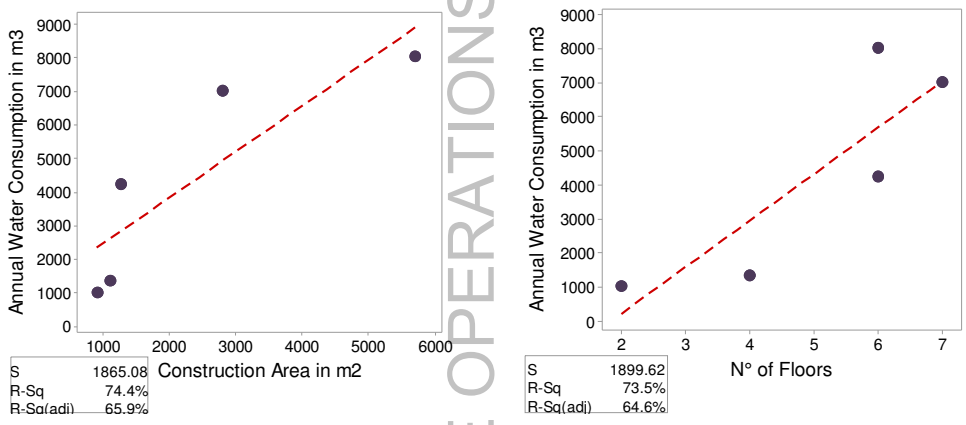
4.5.1.2 Influence of physical parameters on water consumption.

A simple linear regression analysis was used to determine the influence of the physical parameters (See Table 11) on the water consumption of the sample hotels.

The program Minitab was used to establish the correlation between the parameters analyzed and the water consumption.

The physical parameters that were analyzed were: the construction area and number of floors. The number of rooms was not analyzed because it is related to the annual occupation that will be described in the next section, and since none of the hotels in the sample has a garden or pool, these elements were not taken into account for the analysis.

The degree of dependence between the variables: the dependent variable that is the annual water consumption expressed in cubic meters (m^3), and the independent variables which are the construction area expressed in square meters (m^2), and number of floors, were checked by verifying the P-value, which if it is less than < 0.05 indicates that the changes of one variable are associated to the changes of the other variables (Frost, 2013), and with the value of Pearson correlation coefficient, whose values vary between -1 and 1, being the values close or equal to -1 a perfect negative linear relationship, and the values close or equal to 1 a perfect positive linear relationship between variables (Lane, 2017).



Correlation: Construction Area in m2; Annual Water Consumption in m3

```
Pearson correlation of Construction Area in m2 and Annual Water Consumption in
m3 = 0.863
P-Value = 0.060
```

Correlation: N° of Floors; Annual Water Consumption in m3

```
Pearson correlation of N° of Floors and Annual Water Consumption in m3 = 0.857
P-Value = 0.063
```

Figure 8: Construction area in m^2/N° of floors vs Annual water consumption in m^3

Source: Author's own elaboration

In Figure 8, it can be observed that the construction area and the number of floors, versus the annual water consumption, show some linear correlation, since the Pearson correlation value in both cases is relatively high, 0.863 and 0.857 respectively. However, the P-value in both cases was higher than 0.05 (0.060 and 0.063 respectively), which means that although the construction area and the number of floors can certainly influence the hotel's water consumption, they are not necessarily associated. Water consumption can vary by many factors, such as those mentioned above, but these variations are not always associated with a change in the building area or levels of the facilities.

4.5.1.3 Section summary

It can be said that this section has answered the first sub-question of this thesis work, and has fulfilled the first objective:

Sub-question 1: What are the elements that influence water consumption in SMS urban hotels in Germany?

Objective 1: Identify the elements that affect water consumption in SMS urban hotels in Germany.

In summary, the elements that affect water consumption are those included within the operational parameters: service of lodging, housekeeping and the service of breakfast. While physical parameters, such as the area of construction and the number of floors, while indirectly influencing the demand for water, do not have a direct relationship with their consumption.

4.5.2 Water consumption models

Since the operational parameters that affect the water demand that were seen in the previous section are linked to the level of occupancy of the hotel, in other words, the greater the occupancy, the greater the number of rooms that are required to be cleaned (housekeeping), the greater the amount of dishes to be washed (kitchen service). The correlation between the water consumption and the occupancy rate of the five hotels in the sample was verified.

4.5.2.1 Annual and monthly water consumption models

A simple linear regression analysis, using once more the program Minitab, was used to perform the correlation, where the annual water consumption of each hotel,

obtained from its water receipts of 2016 and 2015 (See Appendix F), were compared with the total number of rooms that were rented out in that year in each hotel. There were two exception, hotel CSH-1 and CSH-5, which, due to missing data and some data that were taken by hand (See Appendix D) and whose veracity could not be verified, it was decided to use the water consumption and occupancy rate of the year 2015, which was complete.

The degree of dependence between the two variables: the dependent variable that is the annual water consumption expressed in cubic meters (m^3), and the independent variable which is the number of rooms rented in a year, was verified once again checking the P-value and the Pearson correlation coefficient value.

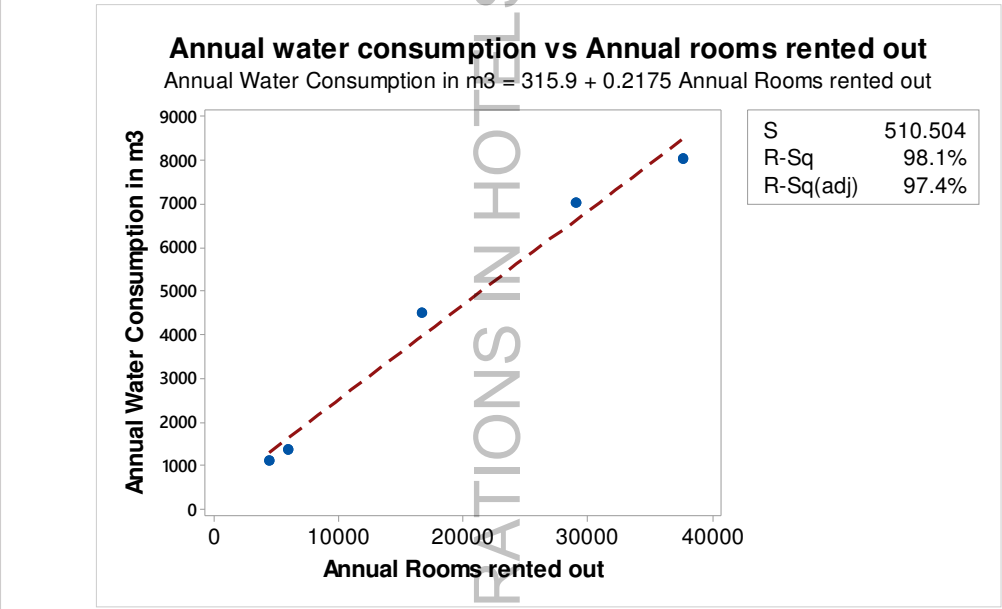


Figure 9: Annual Occupancy Rate (in rooms rented out) vs. Annual water consumption in m^3

Source: Author's own elaboration

A strong correlation was obtained between the dependent variable: annual water consumption in cubic meters (m^3), and the independent variable: Occupancy rate expressed in number of rooms rented in a year. The correlation showed a Pearson

coefficient value of 0.990 very close to 1 (positive linear relationship between variables), and a P-value of 0.001, much lower than 0.05 (See Figure 9).

Since the occupancy rate is linked to the other two operational parameters that influence the demand for water inside the hotel, the linear function that was obtained as a result: Annual Water Consumption in m3 = 315.9 + 0.2175 Annual Rooms rented out, can be used as a predictor of the annual water consumption of SMS urban hotels in Germany, which offer the same services described in the Sections 4.4.1 and 4.5.1.

Hotels can use this function to forecast their annual water consumption by using the average annual occupancy rate obtained from the hotel's historical records and then comparing the prediction with the water receipts at the end of the year. Any significant difference between actual consumption and prediction can mean an overuse or problem in the water system. The equation can also be a useful tool for comparing actual consumption and predicted outcome in the event of any exceptional event at the hotel, where the occupancy rate rises or falls abruptly.

Since it was verified the linear relationship between the two variables that are being studied in this section, the author conducted an analysis to determine the possibility of predicting a monthly water consumption of the hotels based on their monthly occupancy rate.

The results of the analysis are described in Figure 10 (See Appendix G for the calculation). As can be seen in this Figure, all the hotels in the sample have a very different behavior from one another. Even among hotels in the same city the pattern is different. Such is the case of hotels CSH-1 and CSH-2 in Berlin, where the hotel CSH-1 has a similar behavior in January and February to hotel CSH-2. However, from the month of March, while the hotel CSH-1 constantly increases and decreases its water consumption until August, the Hotel CSH-2 keeps a relatively regular increase, with a small decrease in June, until reachs August, from which consumption begins to decrease in both hotels until December.

Another example can be seen in the month of March, in which national public holidays are celebrated. In this month, it could be expected that the occupancy of all hotels would increase. However, it was observed in the sample that while in some

hotels occupancy increased with respect to February (CSH-2, CSH-3, and CSH-4), in others instead decreased (CSH-1 and CSH-5).

These variations in the demand for water based on occupancy may be due to many factors such as the location of the hotel, the offers offered throughout the year, the target group to which the accommodation service is addressed, and the festivals, celebrations, and events of each city.

Figure 10: Behavior of monthly water consumption in the five hotels of the case study

Source: Author's own elaboration

4.5.2.2 Section summary

In conclusion it can be said that it is not possible to generate a predictive model of monthly water consumption in all medium and small urban hotels in Germany, regardless if they belong to the same city or not. It would only be possible to calculate it for each hotel individually.

This section allowed to partially answer and satisfy the second sub-question and the second objective of this thesis.

Sub-question 2: Is it possible to create a reliable procedure for the management of water consumption applicable to all types of SMS hotels?

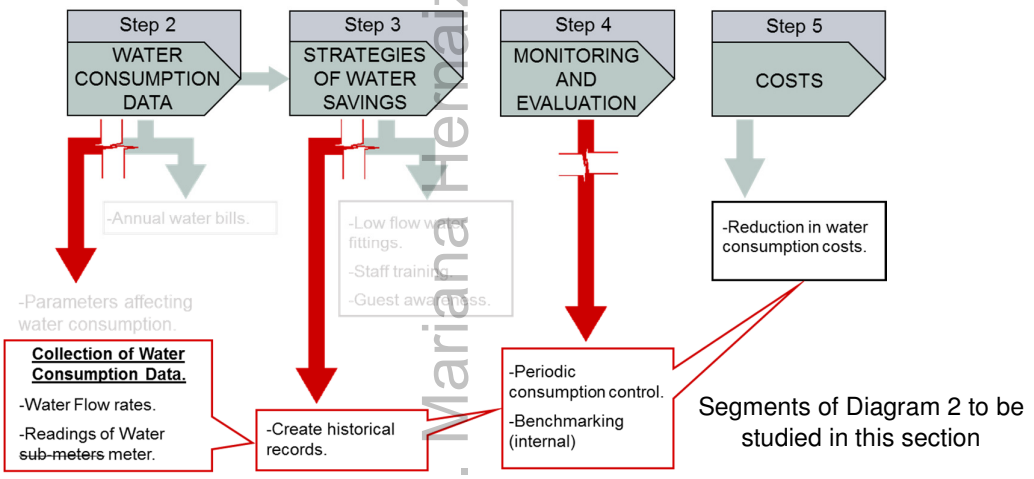
Objective 2: Propose a methodology that allows the implementation of a systematic plan for the monitoring and internal benchmarking of water consumption, in all SMS urban hotels in Germany.

From the point of view of the annual water consumption, it is perfectly possible to create a predictive water consumption model for both small and medium-sized urban hotels individually, as well as for the entire population of hotels that fall into this category and have the same services offered by the hotels in the case study.

However, from the point of view of the monthly consumption forecast, it is not possible to create a model that can be used by the entire population of SMS urban hotels in Germany, due to vast differences in their monthly performance, subject to factors such as location of the hotel, offers published by each hotel, the target group to which the accommodation service is address, and the different holidays and events that are celebrated in each region.

4.5.3 Collection of water consumption data

Once established the areas and activities that influence the consumption of water in the hotel, it is then possible to determine the consumption in those areas in order to create a historical record. Later this information is used to compare the internal consumption with those established in schemes and guidelines, and also, if possible for the hotel, with other establishments of the same category.



4.5.3.1 Water flow rates - Data collection

This process must be carried out regularly, each time maintenance is performed, or improvements or changes are made to the fittings and appliances of the hotel's bathrooms or kitchens. To obtain a more precise average of the hotel's water flow rates, the author recommends to make the measurements in as many rooms as possible, according to the available time of the operator or owner. It is also advisable to record at least five times the water flow of each device (the next section will determine the time required per room), to reduce the margin of error created by the fact that this process uses non-digital tools, susceptible to inevitable human errors, and thus, ensure a more accurate average. If the hotel already has a previous record, the operator will be able to assess the effectiveness of water conservation efforts.

For example, in the case of the city of Berlin, water is very rich in minerals, so its degree of hardness (°dH) is quite high, with an average of 14 to 25 °dH (soft water is less than 8.4 °dH, and medium hardness is between 8.4 °dH and 14 °dH). This characteristic is not harmful to human health, but it can affect the efficiency of the fixtures of the bathrooms and kitchen, due to the accumulation of limescale (Berliner Wasserbetriebe, 2017b). Hence, based on the recommendations established in DECISION (EU) 2017/175, which establishes in its criterion 4 (General maintenance) that "*Preventative maintenance of appliances/devices shall be carried out at least yearly, or more often if required by law or relevant manufacturer's*

instructions", that, in case of regions with hard water, the monitoring of water flows rates should be made at least twice a year.

To give an example of how to carry out this process the exercise was performed in three hotels of the case study. Measurements of the water flow rates in bathrooms and kitchen fixtures were carried out using the bucket and stopwatch method. The author decided to use this system because it is a simple and easy method to apply by the hotel operator or owner, and provides immediate information on the behavior of the devices.

The bucket that was used had a known volume of 1100 milliliters (1.1 liters). This information is important since the volume of the bucket will determine the water flow based on the time. Each device (Taps and Showerhead) was measured at maximum flow, and the time needed to fill the bucket was recorded five times in a Microsoft Excel spreadsheet made in advance (See Appendix H), in order to obtain an average. The results of this measurements can be seen in Table 13.

Table 13: Water flows rates from the fittings of three of the Case study hotels

		Sample Case Study Hotels					
		CSH-1 ***		**CSH-2 *****		**CSH-5 *****	
	Hotel Loctaion	Berlin		Berlin		Bonn	
	Hotel Size	Small		Middle		Small	
Guest Bathroom	**Water Flow Rate Units**	**Litres/min**	**m^3/min**	**Litres/min**	**m^3/min**	**Litres/min**	**m^3/min**
	Taps	6.37	0.00637	5.40	0.00540	5.53	0.00553
	Showers	7.22	0.00722	5.56	0.00556	5.4	0.00540
	Toilet	4.5	0.00450	4.5	0.00450	4.5	0.00450
		CSH-1 ***		**CSH-2 *****		**CSH-5 *****	
Hotel Kitchen	**Water Flow Rate Units**	**L/bask.**	**m^3/bask.**	**L/bask.**	**m^3/bask.**	**L/basket**	**m^3/bask.**
	Dishwasher L/per basket	2.8	0.00280	2.4	0.00240	2.4	0.00240
	Water Flow Rate Units	**Litres/min**	**m3/min**	**Litres/min**	**m3/min**	**Litres/min**	**m3/min**
	Taps	6.82	0.00682	7.41	0.00741		

Litres/min (Liters per minute)

m^3/min (Cubic meters per minute)

L/bask (Liters per basket). The liters per basket of the dishwasher is determined by the manufacturer.

m^3/bask (Cubic meters per basket)

Source: Author's own elaboration

In Table 13 it is possible to see the difference between the hotel CSH-1, and the hotels CSH-2 and CSH-5, the latter two have very similar water flows rates per minute in the guest bathrooms and in the kitchen dishwasher (The liters per basket of the dishwasher were obtained from the appliance manufacturer and can be seen in Appendix J).

Since the Hotel CSH-1 yielded the highest results, the author took this case to make two comparisons. The first was done comparing this hotel with the hotel CSH-2. And the second comparison was made on the basis of two European criteria (Decisions (EU) 2017/175 and Decision (EU) 2013/250), and the Green Key criterion for tourism service providers.

In case the hotel operator does not have any similar hotel with whom to compare their water flows. Comparison with schemes is a tool that can easily be performed using a template similar to the one shown in this example. The benchmarking can be seen in the Table 14.

Table 14: Benchmarking between water flow rates at Hotel CSH-1, and Hotel CSH-2 and scheme

		Sample Case Study Hotels			
		CSH-1 ***	**CSH-2 *****	**Criteria used.**	
	Hotel Loctaion	Berlin	Berlin	**Decisions (EU) 2017/175**	
	Hotel Size	Small	Middle	**Crit. 15 & 42. Efficient water fittings**	
Guest BathRM	**Water Flow Rate Units**	**Litres/min**	**Litres/min**		
	Taps	6.37	5.40	Taps	6 litres/minute
	Showers	7.22	5.56	Showers	7 litres/minute
	Toilet	4.5	4.5	Toilet	≤ 4,5 Litres
		CSH-1 ***	**CSH-2 *****	**Criteria used.**	
Hotel Kitchen	**Water Flow Rate Units**	**L/bask**	**L/bask**	**Green Key. Crit. 4. Dishwashers**	
	Dishwasher L/per basket	2.8	2.4	3.5 litres per basket.	
	Water Flow Rate Units	**Litres/min**	**Litres/min**	**Decision (EU) 2013/250. Crit. 1. Kitchen Taps**	
	Taps	6.82	7.41	8 litres/minute	

Source: Author's own elaboration

The values for the water flow rates of the devices in the guest bathroom of the hotel CSH-1, shown in the Table 14, present high results in comparison with the hotel CSH-2, and slightly higher in comparison to the schemes. In contrast, the flow of water used by kitchen fixture and appliances, such as the dishwasher (The

specifications of the dishwasher can be seen in Appendix J), and the kitchen tap, are below that established in criterion 4 of the Green Key scheme, and criterion 1 of the Decision (EU) 2013/250.

With the use of scheme Decision (EU) 2016/611, which establishes comparative parameters of excellence for the hotel sector, and the use of the water flows rates it is also possible to verify if the hotel is within the limit of daily consumption per guest established in this scheme. To do this it is possible to rely on jobs like the one published by The Seattle Public Utilities about the use of bathroom fittings in a hotel in Seattle, Washington, in order to estimate the daily water use per guest. This study gave an average of 7 times for the toilet, 1 minute for the sink, and 12 minutes for the shower (O'Neill & Siegelbaum and The RICE Group., 2002, p.16), as can be seen in the Table 15.

According to Decision (EU) 2016/611, a full-service hotel should not exceed 140 liters per guest. By looking at the data in the Table 15, we could say that both the hotels CSH-1 and 2 are within that limit with 124,5 liters (0.1245m³) and 103,6 liters (0.1036m³) respectively.

Table 15: Benchmarking liters per guest with the best practice scheme

Daily use of the bathroom fittings per guest by The Seattle Public Utilities *		**Daily Water consumption per guest in m³**		
		CSH-1	**CSH-2**	**Decisions (EU) 2017/175**
Sink	1 min	0.00637	0.00540	0.0060
Shower	12 min	0.08664	0.06672	0.0840
Toilet	7 Times	0.03150	0.03150	0.0315
TOTAL Daily Water consumption per guest in m³		**0.1245**	**0.1036**	**0.1215**

Daily Water consumption per guest = Hotel water flow rate per minute x Duration/times of fitting usage per guest

* Source. O'Neill & Siegelbaum and The RICE Group, 2002, p.16

Source: Author's own elaboration

The usefulness of the water flow rates measurements is not only associated with the benchmarking of the hotel water flows rates with the water flows rates of other similar accommodation or schemes, but also with the calculation of possible savings in order to reduce costs. Although the difference in water flows between the hotel CSH-1 and the hotel CSH-2 and the EU Decision are not very significant, the

comparison will be made to show how this process can be used to determine the savings, both monetary and water consumption. This time the comparison will include the water supplier tariffs (in this case Berliner Wasserbetriebe), in order to establish how much is possible to save at the end of the year for the hotel CSH-1, if it regulates more efficiently the water flows rates in its 31 guest rooms.

The water service in Berlin (Berliner Wasserbetriebe, 2017) is charged twice, once for the service of drinking water and another one for the service of sewage water. The supply of drinking water and sewage water is divided into two tariffs:

- A Base rate, which charges the service to supply and dispose of water, and is calculated per day according to the size of the customer's water meter, regardless of its consumption. The current rate is 1.20 euros per day (€/d).
- A Quality rate, which is calculated based on the customer's water consumption in cubic meters (m³). The charge for drinking water is 1,694 euros per cubic meter (€/m³), and for the sewage water is 2.307 €/m³.

In the case of drinking water, both rates must pay 7% of VAT (value-added tax).

Table 16: Potential savings (Costs and water)

Berlin Water Tariff		**Daily water consumption costs in one guest bathroom of the Hotels**		**Daily water consumption costs in one guest bathroom according to the scheme**
		CSH-1	**CSH-2**	**Decisions (EU) 2017/175**
Drinking Water (VAT included)	**Quality Rate 1.813 €/m³**	0.23 €	0.19 €	0.22 €
Sewage Water	**Quality Rate 2.307 €/m³**	0.29 €	0.24 €	0.28 €
TOTAL Daily water costs per guest in €		**0.5130**	**0.4269**	**0.5006**

Daily Water Costs per Guest in € = TOTAL Daily Water consumption per guest in m³ x Drinking Water /Sewage water Tariff

Possible Savings by Consumption Difference between hotel CSH-1 and CHS-2	**Daily Water consumption per guest in m³**	**Daily Water consumption costs per guest in €**	**Possible savings for hotel CSH-1**
CSH-1	0.1245	0.51 €	17%
CSH-2	0.1036	0.43 €	**0.020 m³/Guest (20.9 l/Guest)**

Possible Savings by Consumption Difference between hotel CSH-1 and Decision (EU)	**Daily Water consumption per guest in m³**	**Daily Water consumption costs per guest in €**	**Possible savings for hotel CSH-1**
CSH-1	0.1245	0.51 €	2.41%
Decisions (EU) 2017/175	0.1215	0.50 €	**0.003 m³/Guest (3 l/Guest)**

Source: Author's own elaboration

The savings in water consumption shown in Table 16 are significant, even when compared to the scheme Decision (EU) 2017/175, which yielded the lowest result with a savings of 3 litres per guest per day. If we take the annual occupancy rate of Hotel CSH-1, which is 5959,23 rooms rented out, and we assume that there was only one guest per every room rented out, the hotel would be saving 17,877.51 litres per year, which is equivalent to the daily consumption of 143 guests (17,877.51 l / 124,5 l/guest).

With the results obtained in the Table 16 and the annual occupancy rate of the hotel CSH-1, it is possible to calculate an estimation of the potential annual savings, if the hotel CSH-1 reduces the water flow rates from the bathroom fittings to the same value as the hotel CSH-2 or Decision (EU) 2017/175 (See Table 17).

Since with the data obtained from the hotels in the case study, it is not possible to know how many guests there are in a year because their records are based on rooms rented out or occupancy rates. The calculations of the Table 17 are assuming once again a single guest per night sold throughout the year. Therefore, it is quite possible that the actual savings that the hotel CSH-1 can achieve in a year would increase.

Table 17: Estimation of the potential annual savings

Difference between daily water costs per guest in the hotels CSH-1 & CSH-2	0.086 €
CSH-1 Annual Occupancy Rate (in Rooms rented out) year 2015	5959.23
CSH-1 Annual savings assuming 1 guest per room rented out in €	**512.89 €**
Annual savings assuming 1 guest per room rented out in € = Annual Occupancy Rate in Rooms rented out x (Hotels CSH-1 daily water costs per guest in € - Hotels CSH-2 daily water costs per guest in €)	
Difference between daily water costs per guest in the hotels CSH-1 & Decisions (EU) 2017/175	0.012 €
CSH-1 Annual Occupancy Rate (in Rooms rented out) year 2015	5959.23
CSH-1 Annual savings assuming 1 guest per room rented out in €	**73.90 €**
Annual savings assuming 1 guest per room rented out in € = Annual Occupancy Rate in Rooms rented out x (Hotels CSH-1 daily water costs per guest in € - Decisions (EU) 2017/175 daily water costs per guest in €)	

Source: Author's own elaboration

Finally with the calculation of the possible savings, the hotel is able to implement the necessary strategies for the reduction of water consumption. An example is shown in Table 18, where it has been assumed that the hotel has decided to implement an update of the bathroom fittings with the products shown in Table 18. It can be observed that if the hotel reaches a similar water flow rates to that of the hotel CSH-2, it could recover the investment in 2.7 years, 2 years before product warranty expires. Other example suitable for the implementation of water saving

strategies is depicted in Appendix M. The example evaluates the costs of two options for water-saving fittings over 5 years of use. The analysis shows that option "A", with the lowest initial cost, proved to be the least effective in the long run that the ones in Option "B".

Table 18: Example of payback period for water saving strategies

Water-Efficient Fittings	Price in €/Unit of Product	Manufacturing guarantee	Quantity	Total
Grohe Vitalio Comfort 100 Handbrause 3 Strahl	34.99 €	5 Years	31 Rooms	1,084.69 €
Grohe mousseur 13929 flow rate class A	10.42 €	5 Years	31 Rooms	323.02 €
Total investment in Water-Efficient Fittings for 31 Guest rooms in €				**1,407.71 €**
Payback period using savings in Case 1 (in Years)				2.74
Payback period using savings in Case 2 (in Years)				19.0

Source: Reuter onlineshop (2017); Screwfix (2017); Author's own elaboration

- Timeframe for water flow rates data collection

The data collected in the previous chapter were performed by the researcher in a single room of each of the three hotels studied (CSH-1, CSH-2, and CSH-5). The average time used was 12 minutes for the measurement of water flows rates. The spreadsheet for filling in the data collected was previously done in the Microsoft Excel software (See Appendix H), which is not a sophisticated tool. The time to make the template in Microsoft Excel was 27 minutes.

To obtain the final results and create a record, the data were transcribed to the same Microsoft Excel spreadsheet, which already had the formula predetermined to automatically obtain the units per minute (in our case, milliliters per minute, and liters per minute), which were used later in the calculations shown above.

To develop the benchmarking between hotels, and between one of the hotels and the criteria of the schemes, it was necessary to make another spreadsheet with the tables shown in this section (Appendix I shows the complete formulas used in these tables). Once the tables are made in the spreadsheet, it is only necessary to enter the data obtained from the measurements of the water flows rates, and the rest of the tables will be filled automatically. Therefore, this method is a simple, fast, and effective tool to obtain valuable information on the performance of water consumption in the hotel. The time to make the spreadsheet was approximately 1hr and 30min.

Finally completing the process A and B of the Diagram 3 just once a year took 2 hours and 52 minutes. If we assume that the monitoring measurements of the water flow rate are carried out twice a year, the time to complete the process would be 4 hours and 14 minutes, because the time required for the design of the spreadsheets is no longer taken into account in subsequent measurements.

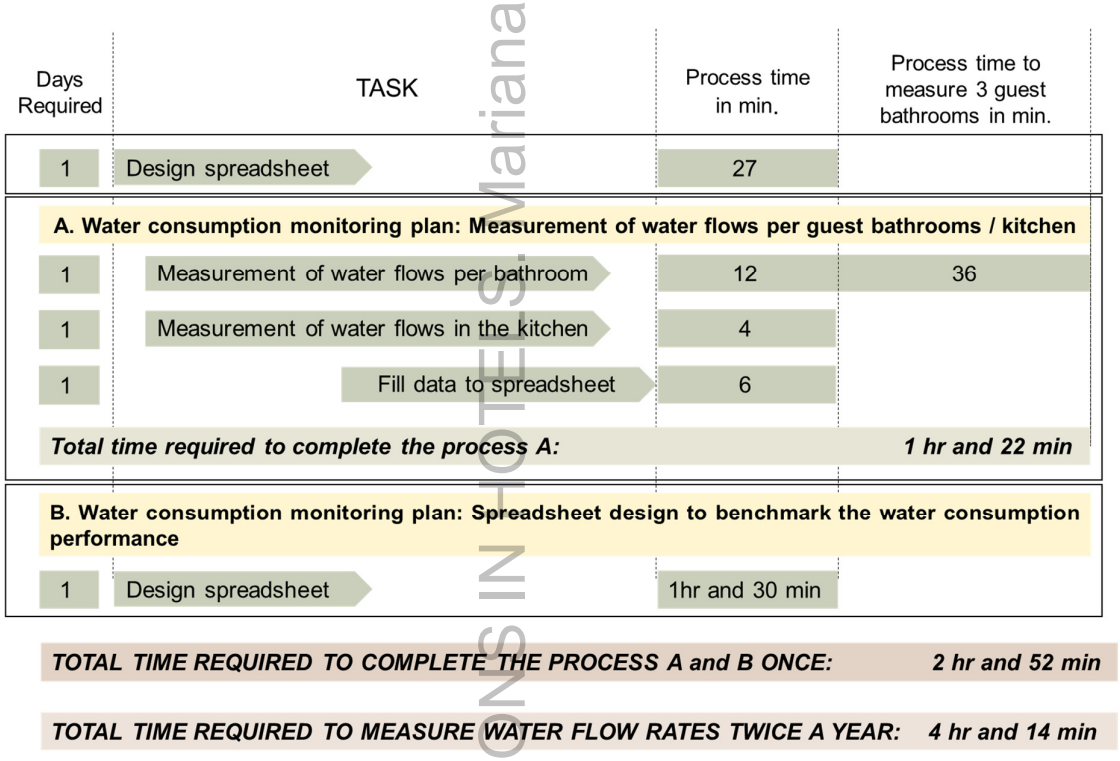


Diagram 3: Timeframe for water flow rates data collection

Source: Author's own elaboration

4.5.3.2 Readings of water meter – Data collection

As mentioned in Section 2.3, the European and international Schemes recommends as good practice the use of water sub-meters to create historical water consumption records for each hotel area and thus determine a baseline water pattern which helps to detect deviations or abnormalities in subsequent measurements (criterion 27 of the Decision 2017/175 and Green Key's criterion 4.11)

However, none of the five Hotels of the case study has water sub-meters and only one of the seven hotels researched during the second stage of data collection claims to have water sub-meters.

Since there were no water sub-meters in the hotels of the case study, the author of the present thesis decided to use the only general water meter in one of the hotels

studied (hotel CSH-2), in order to determine a pattern that helps to understand the behavior of the daily consumption. If such a pattern can be determined, a general method for monitoring and detecting deviations in water consumption can be developed.

Before detailing the results a brief description of the services of the hotel CSH-2 will be given. The hotel has a 24-hour front desk. It has 90 rooms, and offers buffet breakfast service from 6:30 a.m. to 10:30 a.m. Nevertheless, the hotel does not prepare meals, breakfast is fully outsourced, so the main function of the hotel kitchen is the washing of dishes and cutlery. The cleaning of Hotel's linen is also outsourced

The water meter readings were carried out for two consecutive days, in which the hotel had a 98% occupancy. Due to the lack of availability of time by the hotel administration, reading the water meter was not possible to carry it out for more days.

The results obtained can be observed in the Figures 11 and 12. The first figure describes consumption in the morning from 3:00 a.m. to 12:00 noon. The second one describes the consumption in the afternoon from 2:00 p.m. (14:00) to 12:00 midnight (00:00). The time interval for the readings was two hours. The author decided to do it this way, since that would allow any staff member to make on average 4 readings per shift, in order to obtain a pattern as detailed as possible, without taking too much time for the staff to perform their other tasks. It was also taken into consideration that, on the one hand the labor contracts in Germany establish pauses several times a day, for example, for a shift of 6 hours, 30 minutes of pause are established daily, for 8 hours, 45 minutes (Volbracht, 2017). On the other, an average healthy person requires a bathroom break from 4 to 10 times a day (Bladder and Bowel Community, 2017), that is, once every two and a half hours, so the readings could well be done after each break or bathroom break.

In Figure 11 can be observed that in the segment between 7:00 a.m. and 9:00 a.m., it shows a sudden increase in water consumption compared to the other two segments, ranging from 3:00 a.m. to 7:00 a.m. and from 9:00 a.m. to 12:00 noon. This increase is because these are the busiest hours of the hotel, when guests take the breakfast buffet.

After 10:00 a.m. water consumption begins to decrease. From 10:00 a.m. there are fewer activities in the hotel. Most of the guests have finished breakfast, the activity in the kitchen decreases, and rooms housekeeping starts, the latter extends until 3:30 p.m (See Figures 11 & 12).

From 4:00 p.m. to 10:00 p.m. water consumption is quite even, which means that the line obtained from the readings is a straight and more uniform line, without sudden increases. (Figure 12). Due to hotels are establishments that work 24 hours a day, and therefore it is not possible to deprive guests of the water service in order to determine abnormalities in the system, identify this specific segment of the day in which consumption is uniform, is the segment that the hotel will use as a basis for monitoring any abnormal deviation of water consumption in the subsequent years.

This segment had a very similar consumption during the two days it was monitored, with an increase of less than 0.3% (See Appendix K). If monitoring would have continued for a longer time, an average change in consumption could be determined, which would later help detect abnormalities.

At the end of the day from 10:00 p.m. consumption suffers a sudden increase once more. Since at that time the hotel only offers the accommodation service, the increase is only due to the arrival of guests to the facilities

Although the results obtained cannot be generalized for all urban hotels in Germany, since the data were taken in a single hotel for a very short period of time, the approach shown above is possible to adapt it individually to SMS hotels that do not have water sub- meters, as a monitoring plan, in order to control their consumption.

Before taking the measurements, it is necessary to make a spreadsheet like the one shown in the Appendix L, with the pre-determined hours of each measurement. This spreadsheet must be placed in the room where the water meter is located, in order to facilitate its filling every time the consumption is checked, either directly on a computer or on a sheet of paper.

The following are the proposed steps to implement the water monitoring plan within the overall management of the hotel, which can be carried out by the hotel owner/manager, or any member of the staff.

A. *Establish a baseline of water consumption:* This process will be carried out once, or when the hotel is refurbished or had implementing some kind of improvement that can influence its water consumption. The process is as follows:

1. Perform a water pattern for at least fifteen consecutive days in the highest and lowest season of the year, taking water meter readings every two hours.

2. Identify a segment in the water pattern, where a uniform rise of consumption is shown, without sharp increases.

3. Calculate the average volume of water consumed in the segment identified in step A2.

B. *Periodic Monitoring:*

1. Subsequent years the measurements will be taken just in the same segment set out in step A2, taking water meter readings every two hours.

2. Calculate the volume of water consumed in the segment that was predetermined in step A2.

3. Compare the volume of water calculated in step B2, with the volume of water calculated in step A3, in order to determine if any abnormalities exist.

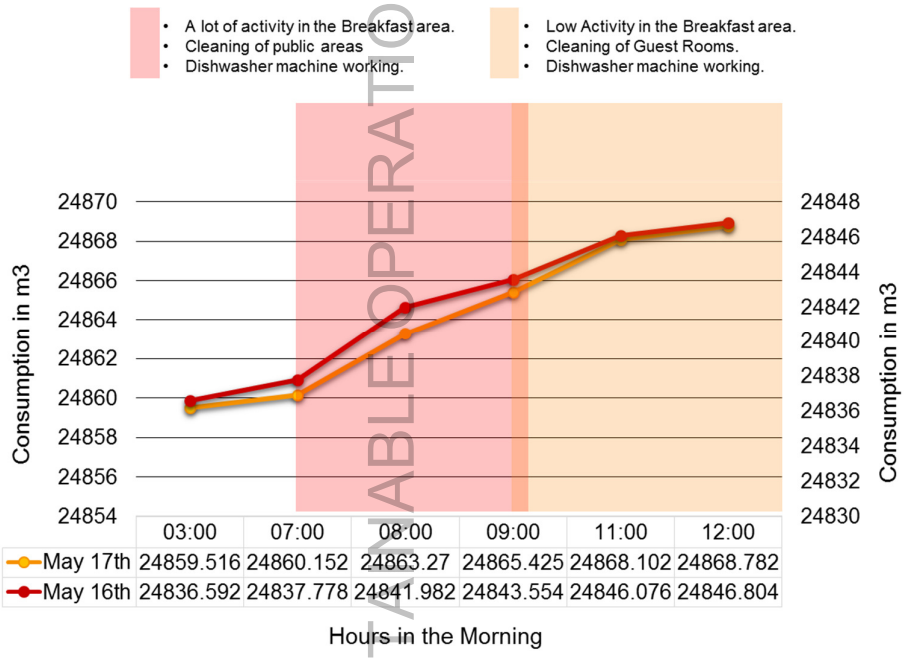


Figure 11: Water consumption pattern in the morning

Source: Author's own elaboration

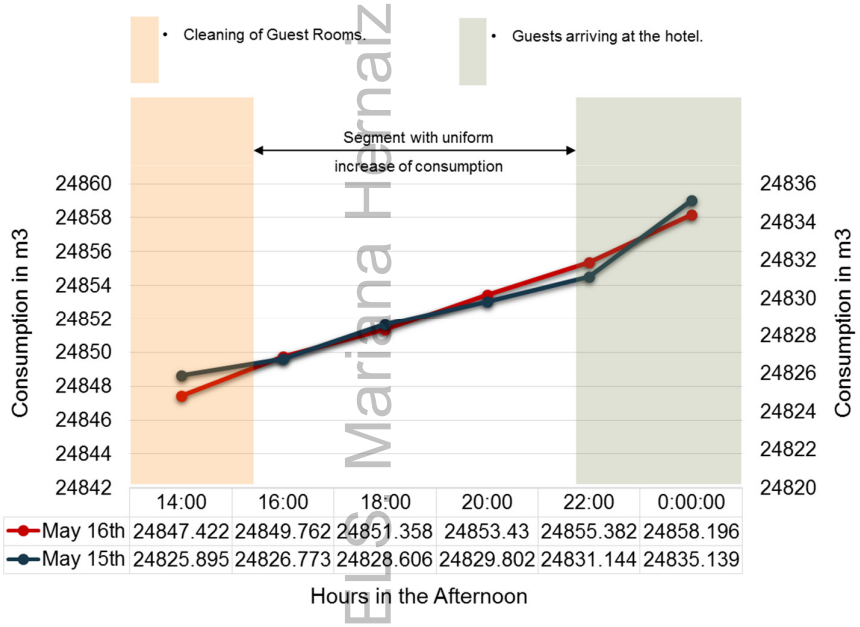


Figure 12: Water consumption pattern in the afternoon/evening

Source: Author's own elaboration

- *Timeframe for the water pattern data collection*

The breakdown of the estimated time of data collection for the development of a water pattern and later for the periodic measurements of water consumption is shown in Diagrams 4 and 5.

Days Required	TASK	Time interval between water meter readings.	Time used per reading in min.	Daily process time in min.	Total process time in min.
1	Design spreadsheet				33
A. Water consumption monitoring plan: Obtaining a baseline of water consumption. First time					
15	Water Meter readings	2hrs. (9 times/d)	3	27	405
1	Fill readings data to spreadsheet				10
Time Frame needed daily					27 min
Time Frame needed in 15 days per season					415 min
Total time required to complete the process "A" per season :					***7 hr and 28 min***
TOTAL TIME REQUIRED TO COMPLETE THE PROCESS "A" PER YEAR :					***14 hr and 23 min***

Diagram 4: Timeframe to obtain a water consumption baseline

Days Required	TASK	Time interval between water meter readings.	Time used per reading in min.	Daily process time in min.	Total process time in min.
B. Water consumption monitoring plan: Periodic monitoring of water meter. Subsequent years					
15	Water Meter readings	2hr (3 times/d) *	3	9	135
1	Fill readings data to spreadsheet				10
Time Frame needed daily					9 min
Time Frame needed in 15 days per season					145 min
Total time required to complete the process "B" per season:					***3 hr and 19 min***

* *In this particular point the author is taking as reference the segment with uniform water consumption of the case study, which extends from 4:00 p.m. to 10:00 p.m. (6 hours). So three daily readings of the meter are required. Each hotel can adapt this example, according to their individual results.*

Diagram 5: Timeframe for periodic monitoring of water meter

Source: Author's own elaboration

To obtain a baseline of water consumption (process "A" in Diagram 4), meter readings are required for 15 days in both the high and low season for a full year. The time to take the readings in each season is in total 7 hours and 28 minutes (See Diagram 4), and the total time required throughout the year would be 14 hours y 23 minutes. This means that 29.5 minutes are required daily for the 30 days needed to create the baseline.

4.5.3.3 Estimation of daily water consumption by area

With the data collected from the two previous sections (Water flow rates and Readings of Water meter), it is possible to estimate the total water consumption per area of the hotel.

In Table 19 it is possible to see the calculation of the demand for each one of the areas associated with the operational parameters that were established in the Section 4.5.1: accommodation service, housekeeping, and breakfast service.

The data shown in this table were collected at the CSH-2 hotel, through on-site measurements and staff performance observation by area. In the case of the estimation of the expenditure in the rooms, was used a study carried out by The Seattle Public Utilities, related to the use of bathroom fittings in a hotel in Seattle, Washington (O'Neill & Siegelbaum and The RICE Group., 2002, p.16). It was also

assumed one guest for each of the 15 simple rooms offered by the hotel CSH-2, and two guests for each of the 75 double rooms.

Table 19: Water consumption for each areas associated with the operational parameters

GUEST ROOMS	**Daily use of the bathroom fittings per guest by The Seattle Public Utilities ***		**CSH -2 Consumption per m³/min or m³/flush**	**CSH-2 Consumption in m³**
	Sink	1 min	0.00540	0.00540
	Shower	12 min	0.00556	0.06672
	Toilet	7 flushes	0.00450	0.03150
	Total Daily Water consumption per guest in m³			**0.10362**
	Total Daily Water consumption per 15 single guest rooms in m³ **			**1.5543**
	Total Daily Water consumption per 75 double guest rooms in m³ **			**15.5430**
	TOTAL Daily Water consumption per 90 guest rooms in m³			**17.0973**
HOUSEKEEPING	**Daily use of public toilet fittings by cleaning staff**		**CSH -2 Consumption per m³/min or m³/flush**	**CSH-2 Consumption in m³**
	Sinks (3 sinks)	1.03 min.	0.00540	0.005562
	Toilets (6 WC)	12 flushes	0.00450	0.05400
	TOTAL Daily water consumption by cleaning of public toilets in m³			**0.05956**
	Daily use of guest bathrooms fittings per cleaning staff		**CSH -2 Consumption per m³/min or m³/flush**	**CSH-2 Consumption in m³**
	Sink	14 sec.	0.00540	0.00126
	Toilet	2 flushes	0.00450	0.05400
	Total Daily water consumption by cleaning of guest bathroom in m³			**0.05526**
	TOTAL Daily water consumption by cleaning of 90 guest bathroom in m³			**4.97340**
HOTEL KITCHEN	**Water flow rates in kitchen appliances and fittings.**		**Daily use of the kitchen fittings and appliances.**	**CSH-2 Consumption in m3**
	Water Flow Rate Units	**m³/basket.**	80 baskets	0.192
	Dishwasher m³/per basket	0.0024		
	Water Flow Rate Units	**m³/min**	15 min.	0.111
	Taps	0.00741		
	TOTAL Daily Water consumption in kitchen in m³			**0.30315**
	Daily Water consumption per guest = Hotel water flow rate per minute x Duration/times of fitting usage per guest			
	Total Daily Water Costs per Guest in € = (TOTAL Daily Water consumption per guest in m³ x Total water cost per Guest RM in €/mim) / Total water consumption per minute in m³			
	* Source. O'Neill & Siegelbaum and The RICE Group, 2002, p.16			
	*** Assuming one person per single room and two per double room.*			
	The water flows rates and the time of use of the fittings were measured and observed respectively on site by the author.			
	Estimated daily consumption of the hotel assuming a 100% occupancy in m³			**22.43341**
	Actual daily consumption of the hotel with a 98% occupancy in m³			**21.52700**

Source: Author's own elaboration

As a result, the guest rooms consume 76% of the total daily consumption of the hotel, followed by the housekeeping with 22%, and finally, with a value well below the other two areas, is the consumption in the kitchen with 1% (See Figure 13). When comparing these results with those found during the literature review, it can

be noticed that the water patterns of SMS hotels are very different from those of a larger scale hotels. Section 2.4.4 shows the water consumption of a 300-room hotel, where kitchen reported the highest consumption after guest rooms (Styles et al., 2013, p. 268), while, the result obtained in this research shows that in small and medium-sized hotels, the highest consumption after the guest rooms, is the housekeeping. Remaining the consumption of the kitchen far below. This is due to two reasons, as mentioned above, the first one is that the hotel does not offer full-service restaurant, and second, the breakfast is completely outsourced, so the consumption in the kitchen is mainly due to washing the crockery and cutlery.

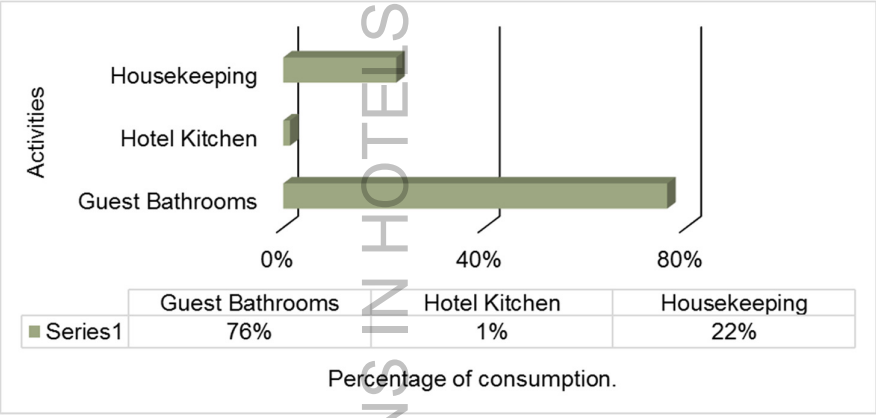


Figure 13: Proportion of water consumption per area

Source: Author's own elaboration

Finally, an estimation of 22.43 m^3 of daily consumption was obtained. By comparing this estimated value, with the daily consumption obtained in the Section 4.5.4.3 through the readings of the water meter (21.52 m^3), it can be verified that, although the estimate value was made assuming a 100% occupancy, while during the meter reading the hotel had a 98% occupancy (See meter readings in Appendix K), both values are very close, yielding a relative error percentage of 4%, which in the opinion of the researcher, it is acceptable, taking into account that the accuracy and precision of the measurements were always subject to inherent human errors, since no electronic tools were used but common use tools, such as the bucket and the chronometer to measure the rates of water flows.

4.5.3.4 Time and cost of data collection methods

One of the limitations that will be described in the following chapter is the lack of available time for hotel operators to implement a solid and consistent water consumption management plan, mainly because they have few staff to carry out the routine tasks of the hotel. Because of this, during the development of this work, and with the purpose of creating a methodology suitable by all the operators of SMS urban hotels in Germany, it was sought that data collection and comparison processes, not only could be carried out by one person, but also were easy to implement, so that they could be part of the overall management of the hotel, without being considered as an extra task.

Table 20: Proportion of time to carry out the data collection process

PROCESS: DATA COLLECTION	Time Required in One Year to Collect Data	Annual Working Hours (AWH) (Assuming 8 hrs Daily)	Proportion of time spent collecting data based on AWH
Water flow rates	4 hr and 14 min (254 min)	1880 hr (112800 min)	0.225%
Readings of Water meters	14 hr and 23 min (863 min)		0.765%
TOTAL	**18 hr and 37 min (1117 min)**		**0.990%**

Source: Author's own elaboration

In Table 20 it can be observed that the time required over a year to carry out both the data collection process of the water flows of the fittings, and the process of reading the water meter, represents only 0.99% of the total annual working hours of a single staff member.

Table 21: Process costs

PROCESS: DATA COLLECTION	Staff required	Time Required in One Year to Collect Data	Cost Rate **	Process cost rate per year	Cost proportion for Data Collection Based on Cost Rate
Water flow rates	**1**	4 hr and 14 min (254 min)	7.71 €/hr	32.63 €	0.225%
Readings of Water meters		14 hr and 23 min (863 min)		110.89 €	0.765%
TOTAL		**18 hr and 37 min (1117 min)**		**143.53 €**	**0.990%**

***The cost rate was calculated assuming an average salary for a hotel receptionist in Germany of € 22,203 per year (PayScale. Human Capital, 2017).*

Source: Author's own elaboration

This proportion of time is very little compared to the potential benefits that can be obtained both ecological (water saving) and economic. An example is the case of the potential savings of Hotel CSH-1 described in the Section 4.5.4.1. In this example, just taking measurements of the water flow rate of the fixtures, whose process cost is 32.63 euros as can be seen in Table 21 (assuming a cost rate of 7.71 euros based on the average salary of a Hotel receptionist in Germany), was possible to obtain annual savings of 73.90 euros in the example with the lowest savings. Which means that there is a probability of achieving some benefits by investing little time and money.

4.5.3.5 Section summary

This section has made possible to create not only a systematic plan for monitoring water consumption, but also an easy-to-use procedures for SMS urban hotels in Germany to collect data from the measurements on site, and internally benchmark their water consumption performance, with the aim to incorporate effective measures and water conservation strategies.

Although these tools need to be adapted to the water consumption patterns of each hotel individually, in principle the methodology is the same as described in the sections mentioned above.

It was also feasible to estimate a daily water consumption both, in the section of water flow rates and the section of water meter readings, and compare these values between them and with the linear regression function obtained in the Section 4.5.2. When is compared the consumption obtained from the readings of the water meter with the linear function, it is possible to assume that the five hotels used in the case study have a similar consumption per room. In the linear function it is understood that for each room rented the consumption increases 0.2175 m^3 (Annual Water Consumption in m3 = 315.9 + 0.2175 Annual Rooms rented out), while the value of the readings gave a daily water consumption of 21.52 m^3, if this value is divided by the 88 rooms, which were occupied at that time (98% occupancy rate), we obtain a value of 0.24 m^3 daily. The two values are very close, and the difference between them is only 0.022 m^3.

The estimation got from the measurements of the water flow rates, was also close to the value obtained from the readings of the water meter (22.43 m^3 and 21.52 m^3

respectively). Both values yield a relative error percentage of 4%, which in the opinion of the researcher, it is acceptable, taking into account that the accuracy and precision of the measurements, were always subject to inherent human errors.These comparisons mean that the methods used so far have been developed using the right tools.

The diagram below is a summary of all the procedures designed to develop a water consumption management plan in SMS urban hotels.

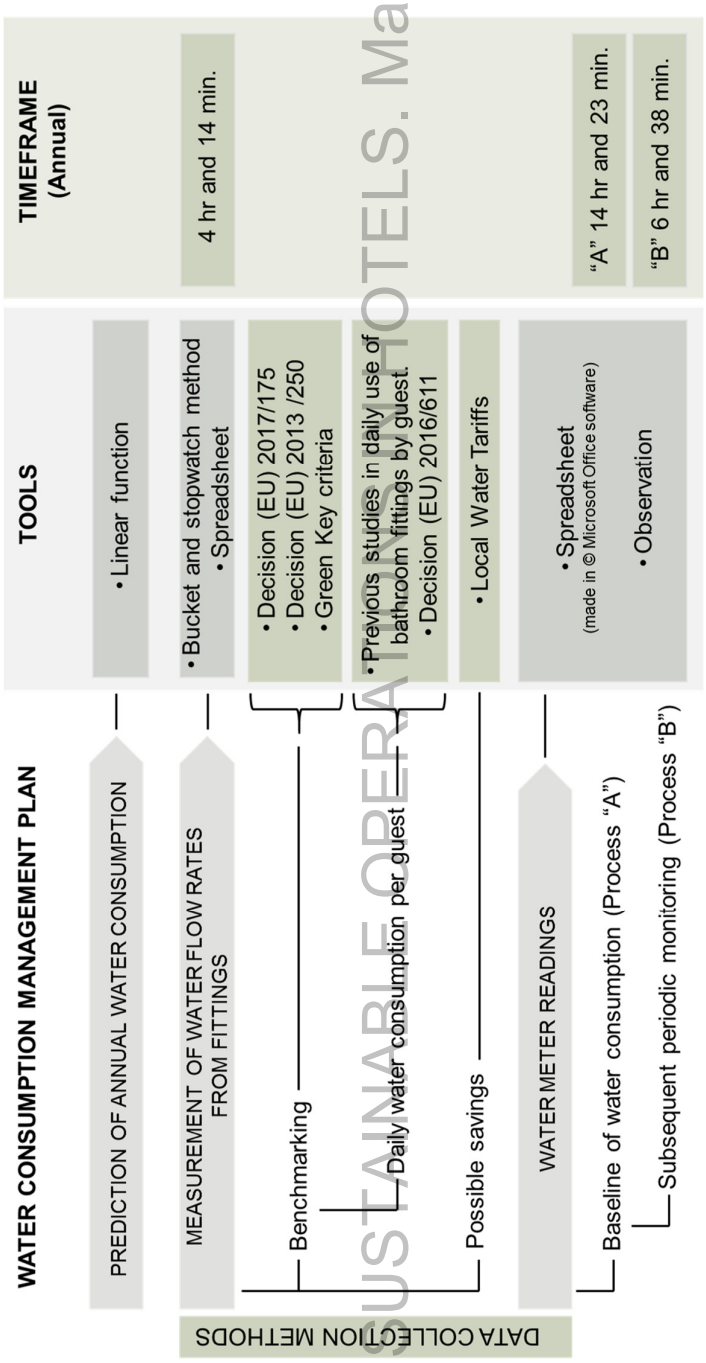


Diagram 6: Complete diagram of the water consumption management plan

Source: Author's own elaboration

Finally it can be said that the research question, as well as the second sub question and the second objective, have been answered and satisfied thoroughly.

Research question: How to create a simple and reliable methodology for water consumption management *in small and medium-sized (SMS) urban hotels in Germany?*

Sub-question 2: Is it possible to create a reliable procedure for the management of water consumption applicable to all types of SMS hotels?

Objective 2: Propose a methodology that allows the implementation of a systematic plan for the monitoring and internal benchmarking of water consumption, in all small and medium-sized urban (SMS) hotels in Germany.

4.6 Barriers and Limitations in the methodology implementation

Research sub-question 3 and objective 3 will be answered and fulfilled in this chapter:

Sub-question *3: What can be the barriers and limitations in the application of a methodology to benchmark the water consumption in SMS urban hotels?*

Objective 3: Identify the barriers and limitations in the implementation of the methodology.

During the development of this thesis work, three limitations could be identified that could represent a barrier to the implementation of a solid and efficient water consumption management plan:

- Lack of time availability of hotel operators;
- Scarce information on best practices in water consumption in small and medium-sized hotels; and
- Impossibility to create a universal monthly modelling to forecast water consumption.

The first limitation found during the development of this work was the attitude of the hotel operators, who stated that they did not have enough time available to implement a solid water management plan. This barrier is partly created by the fact that several of the hotel operators that were studied attempted to implement the criteria expressed in environmental conservation schemes. However, in order to

comply with the requirements imposed by the schemes, a great amount of time and personnel is required, since the tools to be used for the implementation of these criteria are not clearly established, so a thorough search for material is necessary. As a consequence the initial motivation is abandoned, and the final result obtained are inconsistent and incomplete water consumption management plans, in which a total absence of monitoring is highlighted.

The second limitation found is the scarce existing information on best practices in water consumption in SMS hotels. This fact represents a barrier for the hotel owner or manager when attempt to benchmarking the achievements after implementing a water management plan with other similar operators. As a consequence it is only possible to perform an internal benchmark, or a benchmark with values set in schemes such as the Decision (EU) N° 2017/175.

Finally, the last limitation can be seen in the Section 4.5.2 (Water consumption models), which sought to create a tool to predict future water consumption. In this chapter it was possible to obtain a linear relationship to predict the annual water consumption applicable to small and medium-sized (SMS) urban hotels in Germany, which have the same services as the hotels in the case study. However, despite the uniformity of the services offered by the hotels in the case study, it was impossible to create a universally applicable model for predicting monthly water consumption. So it would be more realistic to develop models focused on each hotel individually

5 CONCLUSION

The goal of this study was to establish a series of easy-to-use procedures for small and medium-sized (SMS) urban hotels in Germany, in order to allow the hotel owner/manager to follow a systematic methodology to develop a water consumption management plan.

This chapter starts with a summary that links the results obtained throughout this research, with the literature review and a qualitative survey that was carried out through a questionnaire. The research contribution, and recommendations for further research are also highlighted.

5.1 Summary of research findings

The implementation of sustainable practices in the accommodation sector, towards the responsible use of natural resources and the care of the environment, has become a priority objective, due to the evident climatic changes, globalization of the markets, and the growing sensitivity of customers in environmental issues.

However, during the research of this thesis work it was possible for the author show that, even with the relevance of this topic, the response of hotel companies unto sustainable practices, specifically focused on the efficient management of water consumption, were inconsistent.

The fact that, on the one hand, the organizational structure of small and medium-sized (SMS) urban hotels in Germany, is characterized by limited staff, which means they have little time to incorporate sound and coherent water consumption management plans, and, on the other hand, the difficulty of putting into practice the criteria established in environmental conservation programs and schemes, whose requirements demand a large amount of time and personnel to be carried out, due to the fact that the tools to be used for the implementation of these criteria are not clearly established, or are not specifically addressed to this category of hotels, have created as a result, inconsistent and incomplete water consumption management plans, in which the total absence of monitoring, data collection, and benchmarking methodologies of the water saving strategies, are highlighted.

In order to create a methodology for water consumption management in SMS urban hotels in Germany, which closes the gap created by the absence of adequate systems, adapted to the limitations and characteristics of this category of hotels, three stages were developed throughout this research: a literature review, a qualitative method, and a case study.

The first two stages were used as an essential preparatory process, which were founded on the literature review, and the implementation of a qualitative method based on a questionnaire. The goal of both stages was strengthen the author's knowledge and point of view on the particular research topic, and to obtain attitudinal data.

During the literature review stage, it was possible to observe the importance of SMS hotels in the hotel sector, since they represent the most abundant category of accommodation providers both globally and in Germany.

It was also possible for the author to become familiar with the organizational structure of this category of lodging, which are characterized by having a flat structure, with fewer levels of management than the larger hotels, and with limited personal.

Finally, previous research related to the behavior of water patterns in the hotel sector, and useful tools that would lead to the creation of a methodology for the management of water consumption in SMS hotels, were also studied. An example of these tools are the maximum values of water consumption per fitting expressed in the schemes, both European and international, such as Decision (EU) 2017/175 (criteria for tourist accommodation) and Green Key criteria. These tools can be used to benchmark water consumption in the hotels.

The questionnaire (second stage) focused only on SMS urban hotels in Germany, was designed with the aim of maximizing information related to the management of water consumption in these facilities. At this stage a sample of seven hotels was obtained. As the sample obtained was small, and therefore does not constitute a significant sample of the entire population of the category studied, no statistical considerations were taken of the data collected. Instead the data gathered was used as qualitative information to obtain attitudinal data.

The survey responses showed that the sample hotels implement, one way or another, plans to reduce water consumption through the use of low-flow fittings in bathrooms, periodic checks of installations for water leaks, and recommendations to their guests regarding the responsible use of this resource. However, when asked if they kept a record of water consumption performance, five of the seven hotels responded not to keep records, or to do them infrequently.

Throughout the first stage (literature review) the author was able to verify that many of the schemes demand the installation of water sub-meters for an effective monitoring of the consumption of this resource in hotels, a question related to this issue was asked in the questionnaire. The result of this question was that only one of the seven hotels surveyed had sub-meters.

The data obtained in these first two stages contributed to give more significance to the information found in the third stage (case study).

The case study (third stage) allowed the collection of primary data directly from hotels operators. All the information gathered during this stage was use to answer the research question and sub-questions, and satisfy the research objectives.

The case study consisted of five hotels located in Germany. Two of them midsize and three small sized. All gave their consent to obtain information on their occupancy rates, annual water consumption bills, as well as information on their daily operations related to the consumption of water, such as the kitchen activities, cleaning of rooms and common areas, and water flow rates measures from guest bathrooms and kitchen fittings. It was also possible to perform a periodic checks of the water meter in one of the hotels to develop a water pattern.

In order to create a methodology for water consumption management adapted to SMS hotels, all the findings of the information collected in this stage was divided into four sections: Elements that influence water consumption in SMS urban hotels in Germany (Section 4.5.1); Water consumption models (Section 4.5.2); Data collection (Section 4.5.3): (a) Water flow rates, and (b) Readings of Water meter; and Barriers and limitations (Section 4.6). Each of these segments addresses a sub-question and an objective.

5.2 Answer to questions and fulfillment of objectives

The following is a summary of how the research question, and the sub-questions and the objectives derived from this question, were answered and fulfilled.

5.2.1 Elements that affect water consumption

In the section Elements that influence water consumption in SMS urban hotels in Germany (Section 4.5.1), was possible to answer and satisfy the following sub-question and objective:

Sub-question 1: What are the elements that influence water consumption in SMS urban hotels in Germany?

Objective 1: Identify the elements that affect water consumption in SMS urban hotels in Germany.

The elements that characterized a small and medium sized hotel were divided into two parameters: operational parameters, and physical parameters. To establish if the operational parameters of the five hotels of the case study were within the average characteristics of the total population of SMS urban hotels in Germany, an Internet-based review was carried out, identifying the features and services offered by this category of hotels in different cities of the country.

In total, 277 hotels were reviewed from less than 75 rooms to a maximum of 149 rooms, which represent hotels within the small and medium scale category. The results showed that 88.8% of hotels offer Buffet Breakfast, only 11.5% have laundry service, less than 4% have spa, fitness center, and garden, and less than 1% has swimming pool. These results are similar to the one observed in the five hotels of the case study.

The correlation between the physical parameters was analyzed through the use of a simple linear regression.

In summary was found that the elements that affect water consumption in SMS urban hotels in Germany are those included within the operational parameters of the facility, which are the service of lodging itself, housekeeping and the service of breakfast (the meal is completely outsourced in the hotels in the case study, so the kitchen only complies with the washing function of cutlery and crockery). While

physical parameters, such as the area of construction and the number of floors, while indirectly influencing the demand for water, do not have a direct relationship with their consumption.

5.2.2 Implementation of a systematic plan

Through the develop of the sections Water consumption models (Section 4.5.2); and Water consumption data collection (4.5.3): (a) Water flow rates, and (b) Readings of Water meter, the second sub-question and objective was answer and fulfill:

Sub-question 2: Is it possible to create a reliable procedure for the management of water consumption applicable to all types of SMS hotels?

Objective 2: Propose a methodology that allows the implementation of a systematic plan for the monitoring and internal benchmarking of water consumption, in all small and medium-sized urban (SMS) hotels in Germany.

The Section 4.5.2, Water consumption models, partially allowed to answer and satisfy the second question and the second objective. The goal of this section was create an annual water consumption model, and a monthly consumption model, in order to monitor the demand of this resource through consumption forecast.

From the point of view of the annual water consumption, a linear regression analysis was performed, to obtained a correlation between the annual water consumption (in cubic meters (m^3)), got from the water bills, and the occupancy rate (expressed in number of rooms rented out in a year), of every hotel in the case of study. The results shown that it is perfectly possible to create a predictive water consumption model for both small and medium-sized urban hotels individually, as well as for the entire population of hotels that fall into this category and have the same services offered by the hotels in the case study.

The regression function obtained from the linear regression analysis can be a useful tool for comparing actual consumption and predicted outcome.

However, from the point of view of the monthly consumption forecast, it is not possible to create a model suitable for the entire population of SMS urban hotels in Germany. This is due to the large differences in their monthly performance, subject to factors such as location of the hotel, offers published by each hotel, the target

group to which the accommodation service is addressed, and the different holidays and events that are celebrated in each region.

In order to respond to and fully satisfy the second sub-question and the second objective, an assessment was made of the behavior of water consumption, once the elements that affect water consumption in small and medium-sized urban hotels in Germany were determined. This evaluation was carried out during the development of the sections related to the collection of water consumption data (Section 4.5.3): (a) Water flow rates, and (b) Readings of Water meter.

Measurements of (a) water flows rates from bathroom and kitchen fixtures, proved to be a simple and quick method to perform by the hotel owner/manager of the hotel. This method provides immediate information on the behavior and effectiveness of each fitting. Subsequently this values will help to make better decisions and more successful strategies. With this method it is possible to benchmark the results obtained on site with those expressed in tools like the scheme Decision (EU) 2017/175, which details the maximum acceptable flows rates for fittings, or the Decision (EU) 2016/611, which offers the maximum expenditure in liters per guest. Using the same method were also established the possible savings in order to reduce operating costs.

In the section (b) Reading of water meter, was developed a water pattern that helped to understand the behavior of the daily consumption.

As mentioned in Section 2.3, the European and international Schemes recommends as good practice the use of water sub-meters to create historical water consumption records for each hotel area, and thus determine a baseline water pattern which helps to detect deviations or abnormalities in subsequent measurements (criterion 27 of the Decision 2017/175 and Green Key's criterion 4.11)

However, since none of the five Hotels of the case study has water sub-meters the author of the present thesis decided to use the only general water meter in one of the hotels studied (hotel CSH-2), in order to create a water pattern. With this pattern was determined a general method for monitoring and detecting deviations in water consumption.

With the knowledge gained by the author during the development of this process, it was possible to propose a monitoring plan for water consumption, which can be

easily carried out by the hotel owner/manager or any member of the staff, and since, its implementation represents only 0.99% of the total annual work of a single staff member, it can be incorporated into the overall management of the hotel, without being considered as an extra task. The following are the proposed steps to put into practice this process:

A. Establish a baseline of water consumption: This process will be carried out once, or when the hotel is refurbished or had implementing some kind of improvement that can influence its water consumption. The process is as follows:

1. Perform a water pattern for at least fifteen consecutive days in the highest and lowest season of the year, taking water meter readings every two hours.

2. Identify a segment in the water pattern, where a uniform rise of consumption is shown, without sharp increases.

3. Calculate the average volume of water consumed in the segment identified in step A2.

B. Periodic Monitoring:

1. Subsequent years the measurements will be taken just in the same segment set out in step A2, taking water meter readings every two hours.

2. Calculate the volume of water consumed in the segment that was predetermined in step A2.

3. Compare the volume of water calculated in step B2, with the volume of water calculated in step A3, in order to determine if any abnormalities exist.

5.2.3 Barriers and limitations in the implementation of the methodology

The third and final sub-question and objective were answered and satisfied in the chapter on (d) Barriers and Limitations.

3. What can be the barriers and limitations in the application of a methodology to benchmark the water consumption in SMS urban hotels?

3. Identify the barriers and limitations in the implementation of the methodology.

During the development of this thesis work, three limitations were identified that could represent a barrier to the implementation of a solid and efficient water consumption management plan:

- Lack of time available from hotel operators;
- Scarce information on best practices in water consumption in small and medium-sized hotels; and
- Impossibility to create a universal monthly modelling to forecast water consumption.

5.2.4 Simple methodology for water consumption management

Finally, this thesis has led to the development not only of a systematic plan to monitor water consumption, but also has proposed easy-to-use procedures for SMS urban hotels in Germany, in order to collect data from on-site measurements, and internally benchmark their water consumption performance, with the aim to incorporate effective measures and water conservation strategies. Therefore, this research has fulfilled the research question thoroughly.

How to create a simple and reliable methodology for water consumption management *in small and medium-sized (SMS) urban hotels in Germany?*

5.3 Contributions

Although there are a large number of schemes that can be used in a different way to design a water management plan, many of them are on the one hand focused on Upscale and Luxury hotels, with full-services, and on the other hand, their implementation requires a large amount of time and staff, which most small and medium-sized hotel owners/managers do not have.

From this particular issue was based the development of this thesis work, whose contribution can be summarized as follows:

- A broader understanding of sustainable methods and practices currently used in small and medium-sized urban hotels in Germany;
- Determination of the elements affecting the water consumption of small and medium-sized urban hotels in Germany;
- Simple, fast, and reliable procedures and tools that allow the hotel owner/manager to follow a systematic methodology to:
    - Predict future water consumption;
    - Collect water consumption data;

- Monitoring the effectiveness of water saving strategies that have been taken, or establish strategies that allow an efficient consumption of this resource;
- Benchmark current performance of the hotel with its own data, or with best practice values express in existing schemes.

Although these procedures need to be adapted to the water consumption patterns of each hotel individually, the methodology is the same as described above.

Given that water reserves are abundant in Germany, hotel operators do not consider the management of this resource as a priority, always placing it below the consumption of other resources, such as electricity. However, the upward trend in the concentrations of pollutants in the groundwater bodies (Richter et al., 2010, pp. 11-37), is a fact that should not be taken lightly. For that reason was taking into account during the development of this thesis, to offer to small and medium-sized hotels operators in Germany, a new perspective that allows them to expand their environmental awareness, and to incorporate successfully and responsibly sustainable practices, related with water consumption management plans, into the general management of the hotel, without consider it as an extra task.

5.4 Further studies

The further studies to be carried out in this field, should focus on the prediction models of future water consumption, both annual and monthly, taking into account in more detail all the elements that affect them.

Since in this thesis work, the sample of hotels studied was small, a broader sample would allow to achieve an even more precise tools. For example, a more accurate regression function can be obtained for predicting annual water consumption, or a monthly prediction model could be determined by grouping hotels according to the factors affecting them, such as location, or target group to which the lodging is addressed, among others. This further studies will allow the standardization of the water consumption management methodology.

DECLARATION OF AUTHORSHIP

I hereby declare that the attached Master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

Date	Signature of the student

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APPENDICES

Appendix A – Questionnaire Second Stage

1. Location
2. Hotel Category
   - 1 Star
   - 2 Stars
   - 3 Stars
   - 4 Stars
   - 5 Stars
   - Hostel
   - Other
3. Hotel Location type
   - Rural
   - Urban
   - Other
4. Date of Hotel construction. (It could be an approximate date. If you do not know please leave the answer blank)
5. When was the last renovation in the hotel, including the improvement of bathrooms and water pipes? (It could be an approximate date.) If you do not know, please leave the answer blank.
6. Construction area (in Square meters) (Could be an approximation if you do not know the exact area)
7. Number of Levels (Only above-ground levels)
   - 1 Level
   - 2 Levels
   - 3 Levels
   - 4 Levels
   - 5 Levels
   - 6+ Levels
8. Number of Rooms
9. Number of Employees
10. What measures are taken to regulate the water consumption in the rooms? (You can select more than one option)
    - Leaks control
    - Low-flow Showerheads or Flow regulators
    - Thermostatic controlled shower sets
    - Auto Shut-off showers
    - Electronic faucets
    - Self-Closing faucets
    - Faucet aerator

- Low flush Toilet
- Pressure-regulating valves
- Other

11. What measures are taken to regulate the water consumption in service areas? (e.g. laundry, kitchen and others) (You can select more than one option)

- Leaks control
- Flow regulators
- Electronic faucets
- Self-Closing faucets
- Faucet aerator
- Pressure-regulating valves
- New energy efficiency appliances
- Regular staff trained in efficient use of water
- Other
- None

12. How often does the hotel maintain a water consumption record?

- Very frequently
- Frequently
- Infrequently
- Very infrequently
- No records are made

3. How often does the hotel check for possible water leaks?

- Daily
- Fortnightly
- Monthly
- Bi-monthly
- Quarterly
- 3 times a year
- Twice a year
- Annual
- It is never done
- Other

14. Is the rainwater collected and reused?

- Yes
- No

15. Does the hotel have the following services?

- Restaurant or/and Cafeteria
- Laundry
- Meeting or conference room(s)
- Garden that requires periodic irrigation

- Swimming pool
- Other

16. Is the water consumption of each space of the hotel sub-metered (e.g. Rooms, Kitchen, Laundry, Garden, Swimming pool, etc), or does the hotel have a general water meter for the entire facility?

- Sub-metered
- General meter
- Some areas are sub-metered

17. How often does the hotel's laundry (Sheets, towels, tablecloths, etc) is done?

- Daily
- Weekly
- Each 15 days
- Monthly
- Other

18. Is there a seasonal variation, between high season and low season, in the Hotel Water Consumption?

- Yes
- No
- I do not know

19. What metrics are used to establish the occupancy rate (daily, monthly, or annual) of the hotel? You can select more than one option.

- Per guest
- Per guest-night
- Number of guests
- Rooms occupied or sold
- Others

20. Does the hotel offer recommendations to its clients about the care of the environment? (e.g, on the water consumption, or if the client prefers or not the daily wash of the towels and sheets)

- Yes
- No

21. What is the training level of the cleaning staff regarding environmentally friendly practices?

- Very high
- High
- Moderate
- Low
- Very Low
- None

22. What is the source of water to the facility?

- Purchased
- Owned
- Other

23. What would the impact be in the hotel operation if the price of water doubled?

- Minimal (no impact)
- Low (little impact)
- Medium risk (some effect, increased cost of operation)
- Likely (significant impact, significant operation cost increase)
- High (additional costs require hotel close or relocation)

4. What level of effort has the hotel used to evaluate and identify areas where water consumption efficiency could be improved?

- Very high
- High
- Slightly high
- Medium
- Low
- No effort has been made

25. Do you follow the guidelines of some environmental management certification or something similar?

- Yes
- No
- Partially

26. If the development of a pattern of water consumption helps the hotel to manage its consumption efficiently, could you take 15 continuous days of your time, twice a year (winter and summer), to make the pattern?

- Yes, it is possible. I have the time to do it.
- It would be difficult, but possible.
- No, it is not possible. I do not have the time.
- I'm not sure.

Appendix B – Participants of the questionnaires

Appendix C – Second Stage Questionnaire Answers

Q1-What measures are taken to regulate the water consumption in the rooms?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Leaks control				■			
Low-flow Showerheads	■	■	■				■
Thermostatic controlled shower sets	■						
Auto Shut-off showers							
Electronic faucets							
Self-Closing faucets							
Faucet aerator		■					■
Low flush Toilet	■	■	■	■	■	■	■
Pressure-regulating valves	■		■				
Others		■					
None							

Q2-What measures are taken to regulate the water consumption in service areas?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Leaks control		■		■			
Flow regulators	■						
Electronic faucets							
Self-Closing faucets			■				
Faucet aerator							
Spray washers		■					
Pressure-regulating valves			■				
New energy efficiency appliances	■				■	■	■
Staff trained in efficient use of water							
Others							
Not Applicable							

Q3-How often does the hotel maintain a water consumption record?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Very frequently							
Frequently	■			■			
Infrequently		■					■
Very infrequently							
No records are made			■		■	■	

Q4-How often does the hotel check for possible water leaks?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Daily							
Fortnightly							
Monthly		■		■			
Bi-monthly							
Quarterly	■						
3 times a year							
Twice a year			■				■
Annual							
It is never done						■	
Other					■		

Q5-Is the water consumption of each space of the hotel sub-metered?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Sub-metered				■			
General meter	■	■	■		■	■	■
Some areas are sub-metered							

Q6-How often does the hotel's laundry (Sheets, towels, tablecloths, etc) is done?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Daily		■	■	■			
Weekly	■					■	■
Each 15 days							
Monthly							
Other					■		

Appendix C – (Continued) Second Stage Questionnaire Answers

Q7-What metrics are used to establish the occupancy rate (daily, monthly, or annual) of the hotel?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Per guest							
Per guest-night.				■			
Number of guests		■					
Rooms occupied or sold	■		■				■
Others.					■	■	

Q8-Does the hotel offer recommendations to its clients about the care of the environment?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Yes	■	■	■	■	■		■
No						■	

Q9-What is the training level of the cleaning staff regarding environmentally friendly practices?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Very high							
High							
Moderate		■	■	■		■	■
Low	■				■		
Very Low							
None							

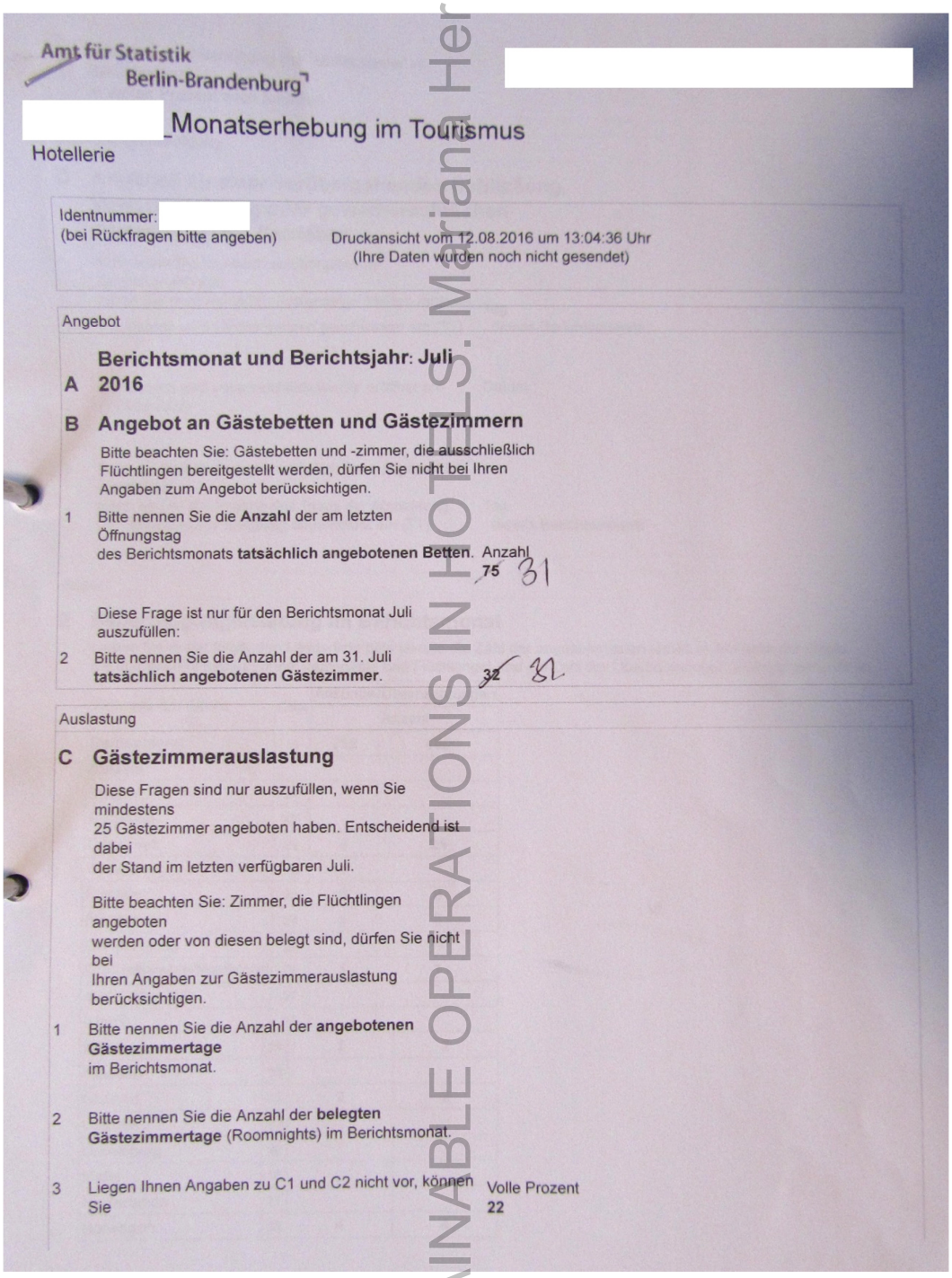
Q10-What would the impact be in the hotel operation if the price of water doubled?							
Hotel Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Minimal (no impact)	■						
Low (little impact)						■	
Still competitive				■			
Medium(increased cost of operation)			■		■		■
Likely (significant impact)		■					
High (require hotel close or relocation)							

Q11-What level of effort has the hotel used to evaluate and identify areas where water consumption efficiency could be improved?							
Hotels Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Very high							
High	■						
Slightly high				■			■
Medium		■	■				
Low					■		
No effort has been made						■	

Q12-Do you follow the guidelines of some environmental management certification or something similar?							
Hotels Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Yes							■
No		■			■	■	
Partially			■	■			

Q13-If the development of a water consumption pattern (Check the water meters every 2 hours) helps the hotel to manage its consumption efficiently, could you take 15 continuous days of your time, twice a year (winter and summer), to make the pattern?							
Hotels Sample	**QMH-1**	**QMH-2**	**QMH-3**	**QMH-4**	**QMH-5**	**QMH-6**	**QMH-7**
Hotel Location	Erfurt	Freiburg	Essen	Berlin	Berlin	Zirndorf	Munich
Yes, it is possible. I have the time to do it.							
It would be difficult, but possible.				■			■
No, it is not possible. I do not have the time.					■	■	
I'm not sure.			■				

Appendix D – Data Amend by Hand



Amt für Statistik
Berlin-Brandenburg

[redacted] Monatserhebung im Tourismus

Hotellerie

[redacted]

Identnummer: [redacted]
(bei Rückfragen bitte angeben)

Druckansicht vom 12.08.2016 um 13:04:36 Uhr
(Ihre Daten wurden noch nicht gesendet)

Angebot

A Berichtsmonat und Berichtsjahr: Juli 2016

B Angebot an Gästebetten und Gästezimmern

Bitte beachten Sie: Gästebetten und -zimmer, die ausschließlich Flüchtlingen bereitgestellt werden, dürfen Sie nicht bei Ihren Angaben zum Angebot berücksichtigen.

1 Bitte nennen Sie die **Anzahl** der am letzten Öffnungstag des Berichtsmonats **tatsächlich angebotenen Betten**. Anzahl
75 31

Diese Frage ist nur für den Berichtsmonat Juli auszufüllen:

2 Bitte nennen Sie die Anzahl der am 31. Juli **tatsächlich angebotenen Gästezimmer**.
~~32~~ 31

Auslastung

C Gästezimmerauslastung

Diese Fragen sind nur auszufüllen, wenn Sie mindestens 25 Gästezimmer angeboten haben. Entscheidend ist dabei der Stand im letzten verfügbaren Juli.

Bitte beachten Sie: Zimmer, die Flüchtlingen angeboten werden oder von diesen belegt sind, dürfen Sie nicht bei Ihren Angaben zur Gästezimmerauslastung berücksichtigen.

1 Bitte nennen Sie die Anzahl der **angebotenen Gästezimmertage** im Berichtsmonat.

2 Bitte nennen Sie die Anzahl der **belegten Gästezimmertage** (Roomnights) im Berichtsmonat.

3 Liegen Ihnen Angaben zu C1 und C2 nicht vor, können Sie Volle Prozent
22

Appendix E –Services Offered by Small and Medium-sized Hotels

N°	HOTELS - BERLIN	STARS	ECO-Label	ROOMS	CHAIN	POOL	SERVICES						
							BF	RT	LS	CR	SPA	FC	GR
1	Motel und Restaurant Avus	2	N	34	NC	N		RT					
2	Mercure Hotel Berlin Zentrum	3	Y	78	C (AccorHotels)	N			LS				
3	Mercure Hotel Berlin Mitte	3	Y	120	C (AccorHotels)	N		RT		CR			
4	Best Western. Frankfurter Allee 57-59,	3	Y	140	C	N		RT					
5	Aga's Hotel	3	N	85	C	N	BF						
6	fjord hotel berlin by LINDEMANN HOTELS®	3	N	55	SC GROUP	N	BF						
7	Dorint Hotel Berlin Adlershof	3	N	120	NC	N	BF						
8	CALMA Berlin Mitte	3	N	46	SC GROUP	N	BF						
9	design hotel LINDEMANN'S	3	N	72	SC GROUP	N	BF						
10	Boutique Hotel. Anna 1908	3	N	46	SC GROUP	N	BF						
11	Dorint Adlershof Berlin	3	N	120	SC GROUP	N		RT		CR			
12	ibis budget Berlin Alexanderplatz	1	Y	157	C (AccorHotels)	N							
13	ibis Styles Berlin Alexanderplatz Hotel	3	Y	61	C (AccorHotels)	N	BF						
14	ibis Styles Hotel Berlin Mitte Hotel	2	Y	145	C (AccorHotels)	N		RT					
15	Hotel Klassik Berlin	3	N	59	NC	N		RT					
16	Gold Hotel. Hotel Garni. 1873 BUIL.	3	N	39	NC	N				CR			
17	East Side Hotel	3	N	36	NC	N	BF						
18	Hotel Azur	3	N	18	NC	N	BF						
19	enjoy hotel Berlin City Messe	3	N	130	SC	N	BF			CR			
20	B&B Hotel Berlin-Airport	2	N	140	C	N	BF						
21	B&B Hotel Berlin-Postdamer Platz	2	N	92	C	N	BF						
22	B&B Hotel Berlin-Süd Genshagen	2	N	73	C	N	BF						
23	Comenius Hotel Garni	2	N	56	NC	N	BF						
24	Hotel Alt-Tempelhof	3	N	73	NC	N	BF			CR			
25	Hotel Albertin	3	N	20	NC	N	BF						
26	Hotel Pension KIMA	2	N	30	NC	N	BF						
27	Comfort Hotel Lichtenberg	3	Y	120	C (Choice Hotels Inter.)	N	BF						
28	MEININGER HOTEL BERLIN ALEXANDERPLATZ	3	N	90	C	N	BF						
29	MEININGER Hotel Berlin Mitte "Humboldthaus"	3	N	118	C	N	BF						
30	Hotel Augustinenhof	3	N	63	SC GROUP	N		RT		CR	SPA		
31	Hotel Allegra	3	N	76	SC GROUP	N		RT		CR			
32	Hotel Albrechtshof	3	N	98	SC GROUP	N		RT		CR			
33	Grimm´s Berlin Mitte	3	N	39	SC	N	BF				SPA		
34	Grimm's Hotel at Potsdamer Platz.	3	N	110	SC	N		RT		CR	SPA		
35	Hotel Delta	3	N	56	NC	N	BF						
36	Air in Berlin Hotel. 1886	3	N	65	NC	N	BF						
37	Arcadia Hotel Berlin	3	N	120	SC	N				CR			
38	Hotel Central INN	2	N	8	NC	N							
39	Hotel Columbia 40 YEARS BUILDING	3	N	30	NC	N	BF						
40	Hotel Ludwig Van Beethoven	3	N	67	NC	N	BF			CR			
41	Max Brown Ku'Damm	3	N	70	NC	N	BF						
42	Juncker's Hotel Garni	3	N	30	NC	N	BF						
43	Mbergs Hotel Charlottenburg	3	N	61	SC GROUP	N	BF						
44	Mbergs hotel Berlin Messe	3	N	67	SC GROUP	N	BF						
45	Hotel Aster in Berlin-Charlottenburg	3	N	15	NC	N	BF						
46	Citylight Hotel	2	N	90	NC	N	BF						
47	Hotel Atlantic (The family-run)	3	N	25	NC	N	BF						
48	REWARI Hotel Berlin (1868)	3	N	42	NC	N	BF						
49	Hotel Auberge (The family-run)	3	N	29	NC	N	BF						
50	Hotel Johann (personally run by the owners)	3	N	33	NC	N	BF						
51	Hotel-Pension Michele in Berlin Schöneberg	2	N	18	NC	N	BF						
52	City Hotel Ansbach Berlin	3	N	60	NC	N	BF						
53	Hotel Ambiente (family-run)	3	N	38	NC	N	BF						
54	Hotel Park Consul	3	N	49	NC	N	BF	RT		CR			
55	NU Hotel Berlin	3	N	28	NC	N	BF						
56	Berliner Hof Hotel Berlin	3	N	76	SC GROUP	N	BF					FC	
57	Hotel Arena Inn	3	N	33	NC	N	BF						
58	Hotel-Pension Adamshof	2	N	21	NC	N	BF		LS				
59	Hotel Sedes	3	N	38	NC	N	BF		LS	CR			
60	Hotel Seifert Berlin am Kurfürstendamm (19th ceNTURY)	2	N	52	NC	N	BF						
61	Hotel Berlin Märkischer Hof am Tacheles	2	N	6	NC	N	BF						
62	BB Hotel	3	N	48	NC	N	BF			CR			
63	Upper Room Hotel	3	N	83	NC	N	BF			CR			
64	Days Inn Berlin West	3	Y	70	C	N	BF						
65	ibis Berlin Neukoelln Hotel	3	Y	57	C (AccorHotels)	N			LS				
66	Novum Hotel Ravenna Berlin Steglitz	3	N	73	C	N	BF						
67	Novum Select Hotel Berlin Gendarmenmarkt	3	N	134	C	N	BF						
68	Novum Select Hotel Berlin Ostbahnhof	3	N	133	C	N	BF				SPA	FC	
69	Novum Hotel Franke	3	N	66	C	N	BF						
70	Novum Hotel City B Berlin	3	N	112	C	N	BF						
71	Novum Style Hotel Berlin-Centrum	3	N	135	C	N	BF				SPA		
72	Novum Hotel Lichtburg Berlin	3	N	61	C	N	BF						
73	Novum Hotel Gates Berlin	3	N	107	C	N	BF						
74	MIDI Inn - Parkhotel Mitte am Weinbergspark	2	N	7	NC	N		RT					
75	Hotel Nikolai Residence (family-run)	3	N	21	NC	N	BF		LS	CR			
76	ibis Hotel Berlin City West	2	Y	136	C (AccorHotels)	N	BF		LS				
77	City-Hotel Berlin	3	N	41	NC	N	BF						
78	Arco City-Hotel Berlin	3	N	23	NC	N	BF						
79	Hotel-Pension Spree	2	N	23	NC	N	BF						
80	Am Luisenbad	2	N	28	NC	N	BF						
81	ibis Hotel Berlin City Potsdamer Platz	2	Y	146	C (AccorHotels)	N	BF	RT	LS				

Appendix E – (Continued) Services Offered by Small and Medium-sized Hotels

82	Metropolitan Hotel (1900)	3		N	76	NC			N	BF						
83	Hotel Jurine	3		N	53	NC			N	BF			CR			
84	nordic hotel Berlin-Mitte	3		N	59		C		N	BF	RT		CR		FC	
85	Potsdamer Inn	3		N	57	NC			N	BF						
86	Hotel Quentin Design	3		N	60		SC GROUP		N	BF		LS				
87	Eden Am Zoo	3		N	25	NC			N	BF						
88	Hotel Larat	3		N	33	NC			N	BF			CR			
89	Hotel Arrival	3		N	57		SC		N	BF						
90	AZIMUT Hotel Kurfuerstendamm Berlin	3		N	135		C		N	BF						
91	Hotel Astrid am Kurfürstendamm	3		N	28	NC			N	BF						
92	Queen's Garden Hotel	3		N	79		SC		N	BF			CR			
93	Queen's Park Hotel	2		N	24		SC		N	BF						
94	Armony Hotel & Business Center	3		N	36				N	BF	RT		CR			
95	Hotel Panorama Am Adenauerplatz	3		N	126				N	BF		LS	CR			
96	Hotel Villa Konstanz (FAMILY RUN)	3		N	20	NC			N	BF						
97	Hotel Pension Classic Berlin (19th century)	2		N	15	NC			N	BF						
98	Riverside Hotel	3		N	30	NC			N	BF						
99	Hotel-Pension Gribnitz	2		N	21		SC		N	BF						
100	Steps Hotel Berlin	2		N	22	NC			N	BF						
101	Adele Designhotel Berlin	3		N	16	NC			N	BF			CR			
102	Hotel Bongard	1		N	40	NC			N							
103	Bornholmer Hof	3		N	31	NC			N	BF						
104	Smart Stay Hotel Berlin City	3		N	50		SC GROUP		N	BF						
105	Hotel Lindenufer	3		N	34	NC			N	BF						
106	Hotel Alexander	3		N	18	NC			N	BF						
107	Concorde Hotel am Studio	3		N	87				N	BF			CR			
108	HSH Hotel Albergo	3		N	38	NC			N	BF						
109	Hotel Augusta	3		N	46	NC			N	BF						
110	Arktur City Hotel Hotel	3		N	30	NC			N	BF						
111	Hotel MANI	3		N	63		SC GROUP		N		RT		CR			
112	Hotel ZOE	3		N	88		SC GROUP		N	BF			CR			
113	Hotel Gasteiner Hof	2		N	22	NC			N	BF						
114	HW Hotel Haus am Niederfeld	3		N	13	NC			N				CR			
115	Arta Lenz Hotel (19th century)	3		N	25	NC			N	BF						
116	Hotel de France	3		N	48	NC			N	BF						
117	Hotel LebensQuelle	3		N	25	NC			N	BF						
118	Hotel Pension Messe	2		N	18	NC			N	BF						
119	Artemisia Hotel	3		N	19	NC			N	BF						
120	Plus Berlin	3		N	133		C	Y		BF						
121	Central-Hotel Tegel	2		N	74	NC			N							
122	Hotel Elba	3		N	27	NC			N	BF						
123	Alex Hotel	2		N	27	NC			N	BF						GR
124	Hotel Zarenhof Berlin-Mitte	3		N	20		SC GROUP		N							
125	Al Königshof	3		N	44	NC			N	BF						
126	Bonverde Restaurant Hotel Wannsee	2		N	21	NC			N		RT					
127	Hotel Berlin Plaza	3		N	131	NC			N	BF						
128	A&O Berlin Mitte	2		N	434		C (A&O)		N	BF						
129	Hotel-Pension Kleist	2		N	16	NC			N	BF						
130	Hotel Haubach	2		N	30	NC			N							
131	Hotel-Pension Cityblick	3		N	29	NC			N	BF						
132	Alecsa Hotel am Olympiastadion	3		N	50	NC			N	BF						
133	Hotel Hansablick	3		N	36	NC			N				CR		FC	
134	Hotel City Gallery Berlin	3	Y		46	NC			N	BF						
135	mk|hotel berlin	2		N	23		SC GROUP		N	BF						
136	Come Inn Berlin Kurfürstendamm Opera	3		N	83	NC			N	BF						
137	LANDMARK eco Hotel	3		N	31	NC			N	BF						
138	The Circus	3	Y		56	NC			N	BF					FC	
139	Hotel Boelsche 126	3		N	20	NC			N	BF						
140	Gat Point Charlie Hotel	3			140				N	BF	RT					
141	Orion Hotel Berlin	3		N	34	NC			N	BF	RT					
142	Tom's Hotel	3		N	19	NC			N	BF						
143	Hotel Sachsenhof	3		N	60	NC			N	BF		LS				
144	Days Inn Berlin City South	3			70		C (Wyndham)		N	BF						
145	Hotel Nova	3		N	42	NC			N	BF						
146	Hotel Kaiser	3		N	34	NC			N	BF			CR			
147	CHECK IN HOTEL	3		N	16	NC			N	BF			CR			
148	Hotel Prens Berlin	3		N	30	NC			N	BF						
149	Hotel Pension Fasanenhaus	2		N	11	NC			N	BF						
150	Hotel 38	3		N	32	NC			N	BF						
151	Hotel Die Schule	3		N	50	NC			N							GR
152	Airporthotel Berlin - Adlershof	3		N	110	NC			N	BF			CR			
153	Hotel Novalis	2		N	9	NC			N	BF						
154	Hotel Dietrich-Bonhoeffer-Haus	3		N	75	NC			N	BF	RT		CR			
155	Arte Luise Arthotel	3		N	50	NC			N	BF	RT					
156	Hotel De Ela Berlin	3		N	15	NC			N	BF		LS				
157	Hotel Amadeus ROYAL Berlin	3		N	50		SC GROUP		N	BF		LS				
158	Hotel Aquino	3		N	40	NC			N		RT					GR
159	Park Inn By Radisson Berlin City West Hotel	3	Y		94		C (Radisson)		N	BF						
160	SensCity Hotel Berlin Spandau	3		N	62	NC			N	BF						
161	Hotel Amelie Berlin	3		N	20	NC			N	BF	RT					
162	Hotel Friedenau - Das Literaturhotel Berlin	3		N	17	NC			N	BF	RT					
163	Kastanienhof	3		N	44	NC			N	BF	RT	LS	CR			

Appendix E – (Continued) Services Offered by Small and Medium-sized Hotels

164	Linnen	3		N	10	NC			N	BF						
165	Park Plaza Berlin Kudamm	3	Y		133		C (CARLSON REZIDOR)		N	BF			CR			
166	Apple City Hotel	3	Y		48	NC			N	BF						
167	Hotel Pankow	3		N	43	NC			N	BF						
168	Hotel Atlas Berlin	3		N	25	NC			N	BF						
169	Hotel Schöneberg	3		N	33	NC			N	BF						
170	Hotel Bernstein	3		N	18	NC			N	BF						
171	Hotel Les Nations	3		N	35	NC			N	BF						
172	Mittendrin Boutique Hotel Berlin	3		N	4	NC			N	BF		LS				
173	Hotel Carolinenhof	3	Y		60	NC			N	BF			CR			
174	ArtHotel Connection GmbH	3		N	14	NC			N	BF						
175	Energie Hotel	3		N	60	NC			N	BF						
176	Arco Hotel	3		N	23	NC			N	BF						
177	Olivaer Apart Hotel	3		N	84	NC			N	BF		LS				
178	Hotel Europa City	3		N	65	NC			N	BF						
179	TRYP by Wyndham Berlin am Ku'Damm	3		?	81		C (Wyndham)		N	BF			CR			
180	Hotel Parkidyll	3		N	12	NC			N	BF						
181	Hotel Tiergarten Berlin Mitte	3		N	64	NC			N	BF						
182	Citadines Kurfürstendamm Berlin	3		N	118	NC			N	BF		LS				
183	Hotel Comet	3		N	37	NC			N		RT					
184	Hotel Pension Savoy	3		N	18	NC			N	BF						
185	Hotel Vivaldi Berlin am Kurfürstendamm (vormals Hotel Aida)	3		N	28	NC			N	BF			CR			
186	Hotel Mikon Eastgate	3		N	30	NC			N	BF						
187	Hotel Lützow	3		N	72	NC			N	BF		LS				
188	GOLD INN Alfa	3		N	34	NC			N	BF		LS				
189	Hotel Spreewitz	3		N	31	NC			N	BF						
190	Alper Hotel	3		N	50	NC			N	BF						
191	Hotel Art Nouveau	3		N	21	NC			N	BF			CR			
192	Hotel Wittelsbach Am Kurfürstendamm	3		N	36		SC GROUP		N	BF						
193	Hotel Brandies Berlin	3		N	35	NC			N	BF						
194	Hotel Amelie Berlin West	3		N	20	NC			N	BF						
195	Hotel Alt Tegel	3		N	24	NC			N	BF						
196	Hotel Benn	3		N	23	NC			N	BF						
197	Sarotti-Höfe	3		N	32	NC			N			LS				
	SUB-TOTAL SMS HOTELS - BERLIN		**17**	**178**	**11033**	**133**	**60**	**1**	**196**	**168**	**26**	**19**	**38**	**5**	**5**	**3**

N°	HOTELS - BONN	STARS	ECO-Label	ROOMS	CHAIN	POOL		SERVICES						
								BF	RT	LS	CR	SPA	FC	GR
1	Haus Daufenbach	3	N	10	NC		N	BF	RT	LS				
2	Beethoven Hotel	3	N	19	NC		N	BF						
3	Hotel Baden	3	N	24	NC		N	BF			CR			
4	AKZENT Hotel AM HOHENZOLLERNPLATZ	3	N	20	NC		N	BF		LS		SPA		GR
5	Villa Esplanade	3	Y	17	NC		N	BF						
6	Hotel Bonn City	3	N	16	NC		N	BF			CR			
7	Hotel Europa Bonn	3	Y	63	NC		N	BF						
8	Hotel Aigner	3	Y	40	NC		N	BF						GR
9	Consul Hotel Bonn	3	N	90		SC GROUP	N	BF			CR			
10	Hotel Savoy	3	N	23	NC		N	BF						
11	Hotel Rheinland	3	Y	27	NC		N	BF	RT					
12	Hotel Kurfürstenhof	3	N	32	NC		N	BF						
13	Hotel Astoria	3	Y	39	NC		N	BF						
14	Hotel Bonn Voyage	3	N	17	NC		N			LS				
15	Hotel My Poppelsdorf	3	N	45		SC GROUP	N	BF						
16	Villa Flora Hotel	3	N	9	NC		N	BF						
17	Park Hotel Nichtraucherhotel	3	N	40	NC		N	BF						
18	Hotel Deutsches Haus	3	Y	26	NC		N	BF						
19	Hotel Zum Löwen Freckmann	3	N	40	NC		N	BF	RT					
20	Hotel zum Adler	3	N	39	NC		N	BF						
21	Hotel Garni Am Römerhof	3	Y	29	NC		N	BF						
22	Hotel Willkens	3	N	34	NC		N	BF						
23	Hotel Kronprinzen	3	N	17	NC		N	BF						
24	Hotel Nettekoven	3	N	15	NC		N	BF						
25	Hotel Alexander	3	N	16	NC		N	BF	RT					
26	Hotel Haus Berlin Garni	3	N	13	NC		N	BF						
27	Hotel Burgblick	3	N	13	NC		N	BF	RT		CR			
28	City-Hotel Bonn / Meckenheim	3	N	90	NC	Y		BF	RT	LS	CR			
29	Hotel Ambassador	3	N	36	NC		N	BF						
30	Baynunah Hotel Drachenfels	3	N	33	NC		N	BF						
	SUB-TOTAL SMS HOTELS - BONN	**7**	**23**	**932**	**28**	**2**	**1**	**29**	**29**	**6**	**4**	**5**	**1**	**0**	**2**

Appendix E – (Continued) Services Offered by Small and Medium-sized Hotels

N°	HOTELS - COLOGNE	STARS	ECO-Label		ROOMS	CHAIN		POOL		SERVICES						
										BF	RT	LS	CR	SPA	FC	GR
1	Königshof The Arthouse	3		N	82	NC			N	BF						
2	Hotel Breslauer Hof am Dom	3		N	26	NC			N	BF						
3	Hotel Cristall	3		N	97	NC			N	BF			CR			
4	Hotel Coellner Hof	3		N	70	NC			N	BF						
5	Hotel Casa Colonia	3		N	16	NC			N	BF						
6	Centro Hotel Royal	3		N	34		SC GROUP		N	BF			CR			
7	Hotel Drei Kronen	3		N	20	NC			N	BF	RT					
8	Hotel Stern am Rathaus	3		N	10	NC			N	BF						
9	Rhein-Hotel St.Martin	3		N	21	NC			N	BF	RT					
10	Senats Hotel	3		N	59	NC			N	BF			CR			
11	Sonata Hotel	3		N	59	NC			N	BF						
12	Centro Hotel Ariane	3		N	40		SC GROUP		N	BF						
13	Hotel Conti	3		N	49	NC			N	BF			CR			
14	Hotel Windsor	3		N	29	NC			N	BF						
15	Callas Hotel am Dom Köln	3		N	26	NC			N	BF						
16	Hotel Müller	3		N	16	NC			N	BF						
17	Hotel Esplanade	3		N	36	NC			N	BF						
18	CERANO Hotel	3		N	18	NC			N	BF						
19	Hotel Weber	3		N	23	NC			N	BF						
20	hotel friends Köln	3		N	74		SC GROUP		N	BF						
21	Hotel Chelsea	3		N	39	NC			N	BF	RT	LS	CR			
22	Hotel Lorien	3		N	55	NC			N	BF						
23	Merian Hotel	3		N	31	NC			N	BF						
24	Classic Hotel Harmonie	3		N	74	NC			N	BF			CR			GR
25	Mauritius Komfort Hotel	3		N	43	NC			N	BF				SPA		
26	Hotel Hayk	3		N	13	NC			N	BF						
27	Drei Könige	3		N	28	NC			N	BF						
28	Buchholz Downtown Hotel	3		N	16	NC			N	BF						
29	Holiday Inn Express Cologne - Troisdorf	3	Y		110		C (IHG-Holiday Inn)		N	BF		LS	CR			
30	Hotel Boulevard	3		N	26	NC			N	BF						
31	Hotel Domblick Garni	3		N	23	NC			N	BF		LS				
32	Hotel Servatius	3		N	38	NC			N	BF		LS				
33	Hotel Domspatz	3		N	12	NC			N	BF						
34	Art of Comfort Hotelgarni Haus Ingeborg	3		N	30	NC			N	BF		LS				
35	Hotel Römerhafen	3		N	12	NC			N	BF						
36	Hotel Lemp	3		N	41	NC			N	BF						
37	Ars Vivendi Hotel	3		N	17	NC			N	BF						GR
38	Hotel Sandmanns	3		N	21	NC			N	BF						
39	Hotel zur Malzmühle Köln	3		N	37	NC			N	BF		LS				
40	Hotel Germania	3		N	23	NC			N	BF	RT					
41	Novum Hotel Leonet Köln Altstadt	3		N	78		C (Novum)		N	BF				SPA		
42	Hotel Domspitzen	3		N	30	NC			N	BF						
43	Günnewig Kommerz Hotel	3		N	77		SC GROUP		N	BF		LS		SPA	FC	
44	ACHAT Comfort Köln/Monheim	3		N	83		SC GROUP		N	BF	RT		CR			
45	Hotel Regina	3		N	17	NC			N	BF						
46	Hotel Ludwig	3		N	54				N	BF						
47	Hotel Insel	3		N	42	NC			N	BF		LS				
48	Hotel Glockengasse	3		N	12	NC			N	BF						
49	City Hotel Storch	3		N	13	NC			N							
50	Hotel Ibertz	3		N	26	NC			N	BF		LS				
	SUB-TOTAL SMS HOTELS - BONN		**1**	**49**	**1926**	**42**	**7**	**0**	**50**	**49**	**5**	**9**	**8**	**3**	**1**	**2**

N°	HOTELS	ECO-Label		ROOMS	CHAIN		POOL		SERVICES						
		Y	N		NC	C / SC	Y	N	BF	RT	LS	CR	SPA	FC	GR
277	**TOTAL SMS HOTELS**	**25**	**250**	**13891**	**203**	**69**	**2**	**275**	**246**	**37**	**32**	**51**	**9**	**6**	**7**
	PERCENTAGES %	**9.03**	**90.3**		**73.29**	**24.91**	**0.72**	**99.3**	**88.8**	**13.4**	**11.6**	**18.4**	**3.25**	**2.17**	**2.53**

Service Abbreviations: BF=Buffet breakfast; RT=Restaurant; LS=Laundry service; CR=Conference room; SPA; FC=Fitness center; GR=Garden.
Chain Abbreviations: NC = Non-chain; SC = Small; C = Chain
ECO-Label & Pool Abbreviations: Y= Yes; N= No
Source: The information of each hotel was obtained from its official web pages, and from the page https://www.hrs.de. (HRS - HOTEL RESERVATION SERVICE)

Source: Author's own elaboration

EINGEGANGEN AM 27. FEB. 2017

Berliner Wasserbetriebe

Berliner Wasserbetriebe · 10864 Berlin

[redacted]

www.clabox.com

28704748

Service
Telefon: 0800.292 75 87
(kostenfrei)
Fax: 030.8644-6606
service@bwb.de
www.bwb.de

Hausanschrift
Neue Jüdenstraße 1
10179 Berlin

Datum
24. Februar 2017

Seite
1 von 6

Vertragskonto **Rechnungsnummer** **Leistungsempfänger siehe Rückseite**

[redacted]

Grundstück: [redacted]

Turnusrechnung

Sehr geehrte Damen und Herren,

für unsere Leistungen im Zeitraum 25.02.2016 - 16.02.2017 berechnen wir Ihnen:

	Menge	Betrag
Trinkwasserlieferung (incl. 7% USt.)	7.001 m³	13.149,54 €
Schmutzwasserentsorgung	7.001 m³	16.552,90 €
Niederschlagswasserentgelt	353,088 m²	636,97 €
Mahngebühren vom 09.05.2016		1,20 €
Gesamtbetrag		30.340,61 €
Summe erhaltene Abschlagzahlungen		- 28.545,00 €
Rechnungsbetrag		1.795,61 €

Wir bitten Sie, den genannten Forderungsbetrag bis zum 13. März 2017 auf unser Konto zu überweisen.

Die detaillierten Berechnungen entnehmen Sie bitte den folgenden Seiten.

Für den neuen Abrechnungszeitraum ergibt sich aus den oben aufgeführten Leistungen ein Abschlagsbetrag in Höhe von **6.322,00 €.**
Die Abschläge werden fällig am **25.04.2017, 26.06.2017, 25.08.2017, 25.10.2017 und 27.12.2017.**

Berliner Wasserbetriebe, Anstalt des öffentlichen Rechts
Vorstand: Jörg Simon (Vorsitzender), Frank Bruckmann,
Kerstin Oster, Vorsitzende des Aufsichtsrates:
Senatorin Ramona Pop

Registergericht:
Amtsgericht Charlottenburg
Registernummer: HRA 30951 B
USt-IdNr. DE136630247

Bankverbindung: Berliner Sparkasse
IBAN DE54 1005 0000 2970 0094 90
BIC BELADEBEXXX

Berliner Wasserbetriebe

Berliner Wasserbetriebe · 10864 Berlin

Service
Telefon: 0800.292 75 87
(kostenfrei)
Fax: 030.8644-6606
service@bwb.de
www.bwb.de

Hausanschrift
Neue Jüdenstraße 1
10179 Berlin

Datum
26. Februar 2016

Seite
1 von 6

Vertragskonto **Rechnungsnummer** **Leistungsempfänger siehe Rückseite**

[redacted]

Grundstück: [redacted]

Turnusrechnung

Sehr geehrte Damen und Herren,

für unsere Leistungen im Zeitraum 15.02.2015 - 25.02.2016 berechnen wir Ihnen:

	Menge	Betrag
Trinkwasserlieferung (incl. 7% USt.)	1.336 m³	2.711,27 €
Schmutzwasserentsorgung	1.313 m³	3.299,03 €
Niederschlagswasserentgelt	510,948 m²	895,66 €
Gesamtbetrag		6.905,96 €
Summe erhaltene Abschlagzahlungen		- 4.610,00 €
Rechnungsbetrag		2.295,96 €

Den genannten Forderungsbetrag werden wir zum Fälligkeitstermin 14. März 2016 von Ihrem Konto per SEPA-Lastschrift einziehen:

[redacted]

Die detaillierten Berechnungen entnehmen Sie bitte den folgenden Seiten.

[redacted]

Berliner Wasserbetriebe, Anstalt des öffentlichen Rechts
Vorstand: Jörg Simon (Vorsitzender), Frank Bruckmann,
Kerstin Oster, Vorsitzender des Aufsichtsrates:
Senator Dr. Matthias Kollatz-Ahnen

Registergericht:
Amtsgericht Charlottenburg
Registernummer: HRA 30951 B
USt-IdNr. DE136630247

Bankverbindung: Berliner Sparkasse
BLZ 100 500 00 · Konto-Nr. 29 70 00 94 90
SWIFT - BIC BELADEBEXXX
IBAN DE54 1005 0000 2970 0094 90

EINGEGANGEN AM 27. MRZ. 2017

HAMBURG WASSER

Ihre Vertragskontonr.: [redacted]
Bei Zahlungen/Rückfragen bitte immer angeben

Hamburger Wasserwerke GmbH, Postfach 26 14 65, 20504 Hamburg

[redacted]

Auskunft erteilt: Kundenbetreuung
Mo-Fr von 08:00-18:00 Uhr
Telefon: **040 7888 - 2222**
Fax: 040 7888 - 185996
E-Mail: Servicecenter@hamburgwasser.de
Internet: www.hamburgwasser.de
Rechnungs-Nr.:
Datum: [redacted]

Seite 1 von 6

Sehr geehrte Damen und Herren,

Verbrauchsstelle: [redacted]

HAMBURG WASSER liefert Ihnen Trinkwasser und entsorgt Ihr Abwasser. Wir bedanken uns für Ihr Vertrauen.

Vielen Dank, dass Sie selbst abgelesen haben. Ihren Verbrauch haben wir damit berechnet. Sie erhalten hier einen Überblick über die wichtigsten Daten. Einzelheiten entnehmen Sie bitte den Folgeseiten.

Abrechnung	Verbrauchszeitraum	Verbrauch m³	Gesamt EUR	davon Umsatzsteuer EUR
Wasser	03.03.16 - 01.03.17	8.020	15.038,14	983,80
Abwasser	03.03.16 - 01.03.17	8.020	16.788,26	0,00
Zahlungen berücksichtigt bis 20.03.2017			-33.900,00	-1.047,24
			-2.073,60	-63,44
Ihr Guthaben: überweisen wir am 03.04.2017 auf das Konto IBAN: DE47 10XX XXXX XXXX XX56 00			**2.073,60**	
Ihr weiterer monatlicher Gesamtabschlagsbetrag (16.04.17-16.03.18)			**2.786,00**	86,22

Verbrauchsvergleich: Im Abrechnungsjahr 8.020 m³ in 364 Tagen = 22,033 m³ täglich
Im Vorjahr 8.245 m³ in 364 Tagen = 22,651 m³ täglich

Auch weiterhin steht HAMBURG WASSER für eine sichere Versorgung mit bestem Trinkwasser und für eine umweltschonende Abwasserentsorgung.

Mit freundlichen Grüßen

Hamburger Wasserwerke GmbH

www.ciabox.com
28698580

Vorsitzender des Aufsichtsrates: Senator Jens Kerstan
Geschäftsführer: Dr.-Ing. Michael Beckereit, Nathalie Leroy

Die Hamburger Wasserwerke und die Hamburger Stadtentwässerung sind Unternehmen von HAMBURG WASSER

Besucheranschrift
KundenCenter HAMBURG WASSER
Ballindamm 1, 20095 Hamburg Innenstadt

000536

RheinEnergie

RheinEnergie AG, Parkgürtel 24, 50823 Köln
672//0000003/19//51149 04.16 0,85 EUR

Firma
[redacted]

Kundenservice
Telefon: 0221 34645-300
Telefax: (02 21) 178-33 22
service@rheinenergie.com

Wir sind telefonisch für Sie da
Mo. - Fr. 7:00 bis 20:00 Uhr
Sa. 9:00 bis 20:00 Uhr

18. April 2016

ABRECHNUNG
vom 28.02.2015 - 29.02.2016
Rechnungs-Nr. 38009750434 - Seite 1/9

Kundennummer
[redacted]

Lieferstelle:
[redacted]

Sparte	Verbrauch	Vorjahr	Nettobetrag EUR	USt. EUR	Bruttobetrag EUR
Erdgas	[redacted] kWh	382.354 kWh	19.794,51	3.760,96	23.555,47
Wasser	4.492 m³	4.771 m³	7.181,99	502,74	7.684,73
		Rechnungsbetrag	26.976,50	4.263,70	31.240,20
		abzüglich gezahlte Abschläge	29.598,03	4.743,97	34.342,00
		verbleibender Restbetrag	-2.621,53	-480,27	-3.101,80

Ihr Guthaben in Höhe von **3.101,80 EUR** wird auf Ihr Bankkonto ****297, BLZ 10070024 Deutsche Bank Privat und Geschäftskunden F 700 erstattet.

Ihr neuer Abschlagsplan: Der künftige Abschlag beträgt **2.900,00 EUR** und wird zu folgenden Terminen abgebucht: 09.05.2016; 27.05.2016; 27.06.2016; 27.07.2016; 29.08.2016; 27.09.2016; 27.10.2016; 28.11.2016; 27.12.2016; 27.01.2017; 28.02.2017.

Die detaillierten Berechnungen entnehmen Sie bitte den Folgeseiten.

www.ciabox.com
22827612

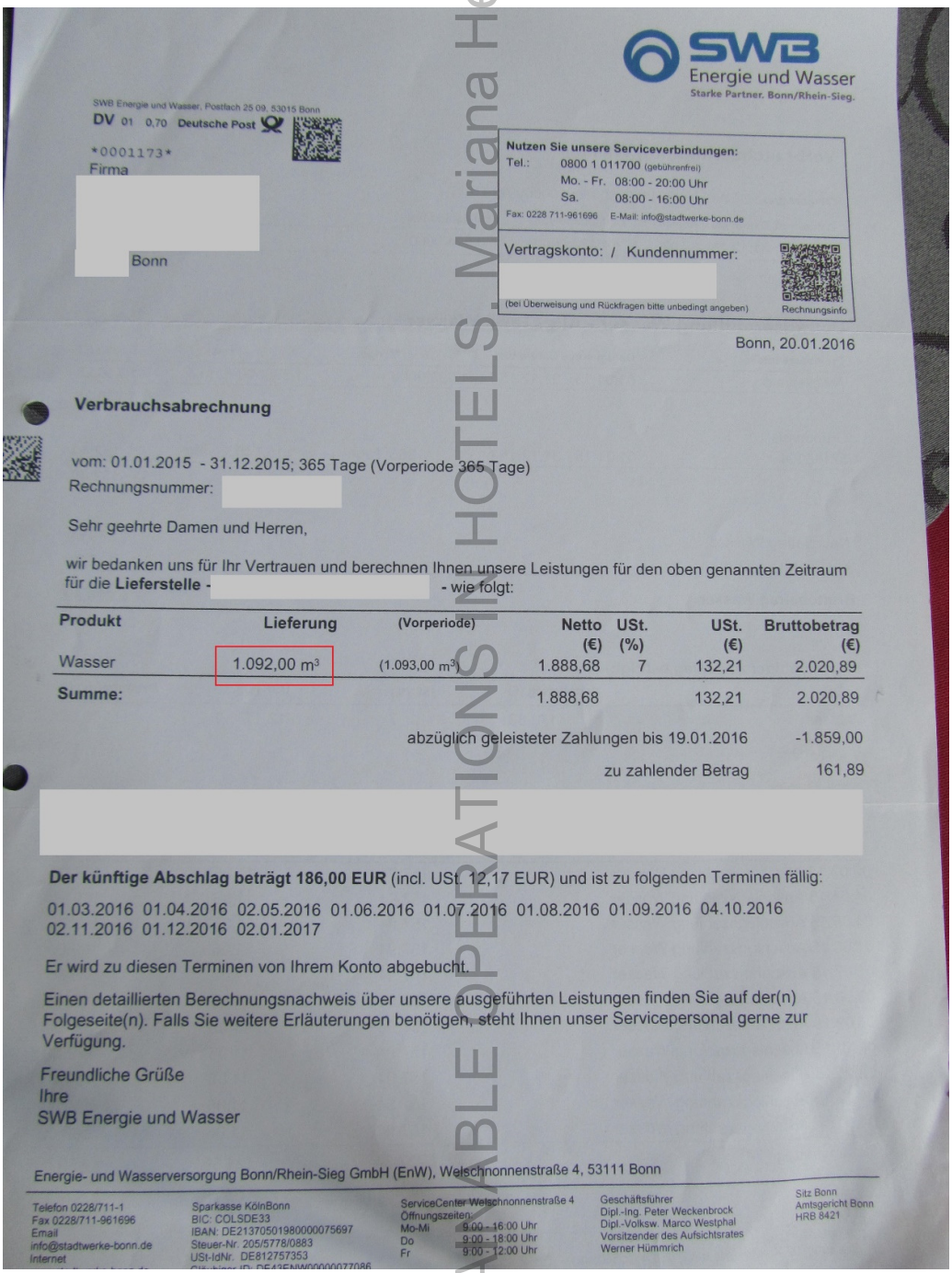
RheinEnergie AG
www.rheinenergie.com

Sparkasse KölnBonn * BIC COLSDE33
IBAN DE74 3705 0198 0004 0029 52

Kreissparkasse Köln * BIC COKSDE33
IBAN DE33 3705 0299 0000 0001 10

Postbank Köln * BIC PBNKDEFF
IBAN DE20 3701 0050 0001 9255 00

Appendix F – (Continued) Water Bills of the Hotels of the Case Study



SWB Energie und Wasser

Starke Partner. Bonn/Rhein-Sieg.

SWB Energie und Wasser, Postfach 25 09, 53015 Bonn

DV 01 0,70 Deutsche Post

0001173

Firma

Bonn

Nutzen Sie unsere Serviceverbindungen:
Tel.: 0800 1 011700 (gebührenfrei)
Mo. - Fr. 08:00 - 20:00 Uhr
Sa. 08:00 - 16:00 Uhr
Fax: 0228 711-961696 E-Mail: info@stadtwerke-bonn.de

Vertragskonto: / Kundennummer:

(bei Überweisung und Rückfragen bitte unbedingt angeben)

Rechnungsinfo

Bonn, 20.01.2016

Verbrauchsabrechnung

vom: 01.01.2015 - 31.12.2015; 365 Tage (Vorperiode 365 Tage)

Rechnungsnummer:

Sehr geehrte Damen und Herren,

wir bedanken uns für Ihr Vertrauen und berechnen Ihnen unsere Leistungen für den oben genannten Zeitraum für die **Lieferstelle -** - wie folgt:

Produkt	Lieferung	(Vorperiode)	Netto (€)	USt. (%)	USt. (€)	Bruttobetrag (€)
Wasser	1.092,00 m³	(1.093,00 m³)	1.888,68	7	132,21	2.020,89
Summe:			1.888,68		132,21	2.020,89

abzüglich geleisteter Zahlungen bis 19.01.2016 -1.859,00

zu zahlender Betrag 161,89

Der künftige Abschlag beträgt 186,00 EUR (incl. USt. 12,17 EUR) und ist zu folgenden Terminen fällig:

01.03.2016 01.04.2016 02.05.2016 01.06.2016 01.07.2016 01.08.2016 01.09.2016 04.10.2016 02.11.2016 01.12.2016 02.01.2017

Er wird zu diesen Terminen von Ihrem Konto abgebucht.

Einen detaillierten Berechnungsnachweis über unsere ausgeführten Leistungen finden Sie auf der(n) Folgeseite(n). Falls Sie weitere Erläuterungen benötigen, steht Ihnen unser Servicepersonal gerne zur Verfügung.

Freundliche Grüße
Ihre
SWB Energie und Wasser

Energie- und Wasserversorgung Bonn/Rhein-Sieg GmbH (EnW), Welschnonnenstraße 4, 53111 Bonn

Telefon 0228/711-1
Fax 0228/711-961696
Email info@stadtwerke-bonn.de
Internet

Sparkasse KölnBonn
BIC: COLSDE33
IBAN: DE21370501980000075697
Steuer-Nr. 205/5778/0883
USt-IdNr. DE812757353

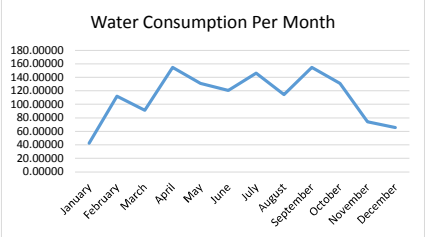
ServiceCenter Welschnonnenstraße 4
Öffnungszeiten:
Mo-Mi 9:00 - 16:00 Uhr
Do 9:00 - 18:00 Uhr
Fr 9:00 - 12:00 Uhr

Geschäftsführer
Dipl.-Ing. Peter Weckenbrock
Dipl.-Volksw. Marco Westphal
Vorsitzender des Aufsichtsrates
Werner Hümmrich

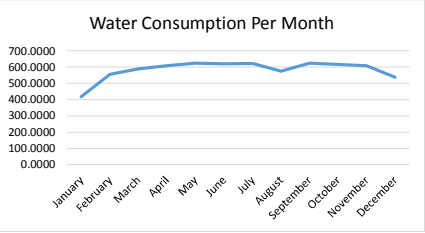
Sitz Bonn
Amtsgericht Bonn
HRB 8421

Appendix G – Calculation of Water Consumption per Month

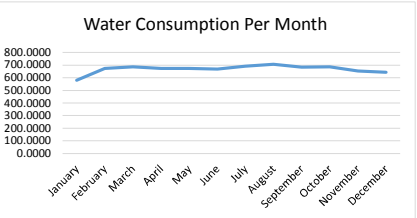
HOTEL		CSH-1 ***			
N° of Guest Rooms		31			
Months	Year	Occupancy rates	Rooms Available per month 31*365 = 11.315	Proportion Occupancy / Cumulative	Water Consumption per month
January	2015	20	2263	3.16%	42.27848
February	2015	53	5996.95	8.39%	112.03797
March	2015	43	4865.45	6.80%	90.89873
April	2015	73	8259.95	11.55%	154.31646
May	2015	62	7015.3	9.81%	131.06329
June	2015	57	6449.55	9.02%	120.49367
July	2015	69	7807.35	10.92%	145.86076
August	2015	54	6110.1	8.54%	114.15190
September	2015	73	8259.95	11.55%	154.31646
October	2015	62	7015.3	9.81%	131.06329
November	2015	35	3960.25	5.54%	73.98734
December	2015	31	3507.65	4.91%	65.53165
Cumulative		**632.00**	**5,959.233**	**100.00%**	**1336.00**
WATER CONSUMPTION 2015 in m³					**1336**



HOTEL		CSH-2 ***			
N° of Guest Rooms		90			
Months	Year	Occupancy rates	Rooms Available per month 90*365 = 32,850	Proportion Occupancy / Cumulative	Water Consumption per month
January	2017	63.3	20794.05	5.98%	418.3272
February	2017	84.01	27597.285	7.93%	555.1922
March	2017	89.1	29269.35	8.41%	588.8302
April	2016	92.3	30320.55	8.71%	609.9779
May	2016	94.37	31000.545	8.91%	623.6578
June	2016	93.89	30842.865	8.86%	620.4857
July	2016	94.27	30967.695	8.90%	622.9969
August	2016	87.1	28612.35	8.22%	575.6130
September	2016	94.37	31000.545	8.91%	623.6578
October	2016	93.19	30612.915	8.80%	615.8596
November	2016	92.11	30258.135	8.69%	608.7223
December	2016	81.36	26726.76	7.68%	537.6793
Cumulative		**1059.37**	**29000.254**	**100.00%**	**7001**
WATER CONSUMPTION 2016 in m³					**7001**

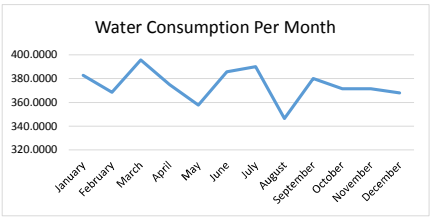


HOTEL		CSH-3 ***			
N° of Guest Rooms		116 Rooms			
Months	Year	Occupancy rates	Rooms Available per month 116*365 = 42,340	Proportion Occupancy / Cumulative	Water Consumption per month
January	2017	76.92	32567.928	7.22%	579.0625
February	2017	89.62	37945.108	8.41%	674.6695
March	2017	91.3	38656.42	8.57%	687.3167
April	2016	89.4	37851.96	8.39%	673.0133
May	2016	89.49	37890.066	8.40%	673.6908
June	2016	88.88	37631.792	8.34%	669.0987
July	2016	91.74	38842.716	8.61%	690.6291
August	2016	93.88	39748.792	8.81%	706.7393
September	2016	90.8	38444.72	8.52%	683.5527
October	2016	91.27	38643.718	8.57%	687.0909
November	2016	86.58	36657.972	8.13%	651.7840
December	2016	85.46	36183.764	8.02%	643.3525
Cumulative		**1065.34**	**37588.75**	**100.00%**	**8020**
WATER CONSUMPTION 2016 in m³					**8020**

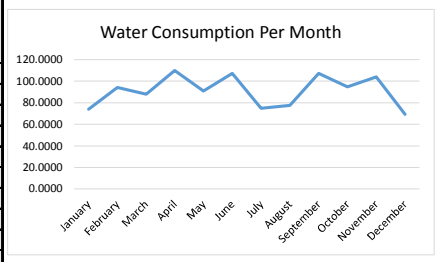


Appendix G – (Continued) Calculation of Water Consumption per Month

HOTEL		CSH-4 **			
N° of Guest Rooms		52			
Months	Year	Occupancy rates	Rooms Available per month	Proportion Occupancy / Cumulative	Water Consumption per month
			52*365 = 18,980		
January	2017	89.70	17025.06	8.52%	382.6882
February	2017	86.40	16398.72	8.21%	368.6094
March	2017	92.74	17602.052	8.81%	395.6578
April	2016	87.88	16679.624	8.35%	374.9235
May	2016	83.87	15918.526	7.97%	357.8156
June	2016	90.38	17154.124	8.58%	385.5893
July	2016	91.38	17343.924	8.68%	389.8556
August	2016	81.20	15411.76	7.71%	346.4245
September	2016	89.04	16899.792	8.46%	379.8724
October	2016	87.03	16518.294	8.27%	371.2971
November	2016	87.05	16522.09	8.27%	371.3825
December	2016	86.23	16366.454	8.19%	367.8841
Cumulative		**1052.9**	**16653.37**	**100.00%**	**4492**
WATER CONSUMPTION 2016 in m³					**4492**



HOTEL		CSH-5 ***			
N° of Guest Rooms		17 Rooms			
Months	Year	Occupancy rates	Rooms Available per month	Proportion Occupancy / Cumulative	Water Consumption per month
			17*365 = 6205		
January	2016	57.87	3590.8335	6.78%	74.0090
February	2016	73.63	4568.7415	8.62%	94.1642
March	2016	68.69	4262.2145	8.04%	87.8465
April	2016	85.88	5328.854	10.06%	109.8305
May	2016	71.16	4415.478	8.33%	91.0053
June	2016	83.73	5195.4465	9.81%	107.0809
July	2016	58.44	3626.202	6.84%	74.7379
August	2016	60.72	3767.676	7.11%	77.6538
September	2016	83.92	5207.236	9.83%	107.3239
October	2016	74.19	4603.4895	8.69%	94.8803
November	2016	81.37	5049.0085	9.53%	104.0627
December	2016	54.27	3367.4535	6.36%	69.4050
Cumulative		**853.87**	**4415.22**	**100.00%**	**1092**
WATER CONSUMPTION 2016 in m³					**1092**



Source: Author's own elaboration

Appendix H – Spreadsheet Model to Register the Water Flow Rates

	Day	Month	Year
Date:	15	5	2017
Hotel Name			
Bucket Volume	1100 ml.		

Guest Bathrooms Water Flow Rate	Time in sec.	units / min
Taps Grohe	12,46	
1st. Measure	11,95	
2nd. Measure	11,97	
3rd. Measure	12,42	
4th Measure	12,26	
5th Measure		
Showerhead		
1st. Measure	14,65	
2nd. Measure	11,89	
3rd. Measure	10,70	
4th Measure	10,88	
5th Measure	~~13,25~~ 10,75	

Toilet Specs.	WC Keramag 4.5L.

Kitchen Water Flow Rate	Time in sec.	ml / min
Taps		
1st. Measure	9.03	
2nd. Measure	8,98	
3rd. Measure	8,76	
4th Measure	9,01	
5th Measure	8,75	

Dishwasher Specs.	winterhalter.
Other appliances specs.	
1	AEG Lavamat.
2	
3	

Source: Author's own elaboration

Appendix I – Spreadsheet model for calculations of water flows rates

			Scheme used.		
Water Flow Rates of Guest bathroom fittings.	**Hotel Consumption per min.**		**Decisions (EU) 2017/175**		
			EU Ecolabel criteria for tourist accommodation		
	Litres / min	**m³ / min**	**Fittings**	**Litres / min**	**m³ / min**
Taps	①	①/1000 = ④	Taps	6 litres/minute	⑦/1000 = ⑩
Showers	②	②/1000 = ⑤	Showers	7 litres/minute	⑧/1000 = ⑪
Toilet	③	③/1000 = ⑥	Toilet	≤ 4,5 Litres	⑨/1000 = ⑫

Kitchen Water Flow Rate	**Hotel Consumption per min.**		**Scheme used.**
			Green Key hotel
Dishwasher Lt/per basket	**Litres / basket**	**m³ / basket**	**Criterion 4. Cover dishwashers**
	⑬According to manufacturer	⑬/1000 = ⑮	3.5 litres per basket.
Taps	**Litres / min**	**m³ / basket**	**Decision (EU) 2013/250. Criterion 1. Kitchen Taps**
	⑭	⑭/1000 = ⑯	8 litres/minute

Daily use of the bathroom fittings per guest by The Seattle Public Utilities *		**Daily Water consumption per guest in m³**	
		HOTEL	**Decisions (EU) 2017/175**
Sink	1 min	④x 1 minute = ❶	⑩x 1 minute = ❹
Shower	12 min	⑤ x 12 minutes = ❷	⑪ x 12 minutes = ❺
Toilet	7 flushes	⑥ x 7 flushes = ❸	⑫ x 7 flushes = ❻
TOTAL Daily Water consumption per guest in m³		❶+❷+❸=❼	❹+❺+❻=❽

Daily use of the kitchen taps and appliances.		**Total Daily Water consumption in kitche in m³**
Dishwasher	**N° Baskets used daily**	
	❾	❾ x ⑮ = ⓫
Taps	**Time of tap use daily in min**	
	❿	❿ x ⑯= ⓬
TOTAL Daily Water consumption in the kitchen in m³		⓫ + ⓬= ⓭

Berlin Water Tariff		**Daily total consumption of water in the guest bathroom and the kitchen of the Hotel**	**Daily total consumption of water in the guest bathroom and kitchen according to the scheme**
Drinking Water	**Quality Rate**	1.813 x (❼+⓭) = ⓮	1.813 x (❽+⓭) = ⓯
	1.813 €/m³		
Sewage Water	**Quality Rate**	2.3073 x (❼+⓭) = ⓰	2.307 x (❽+⓭) = ⓱
	2.307 €/m³		
TOTAL Daily Water costs per guest in €		⓮ + ⓰ = ⓲	⓯ + ⓱= ⓳

Hotel & Scheme	**Daily Water costs per guest in €**	**Daily Water consumption per guest in m³**	**Possible savings for hotel CSH-1.**
HOTEL	⓲	❼	%
Decision (EU) 2017/175	⓳	❽	

Source: Author's own elaboration

Appendix J – Dishwashers Specifications

AM Select Model	AM Select	AM Select F (Front loading)	AM Select T (Tall)
Door opening	17"	27"	27"
ENERGY STAR rated	Yes	Yes	Yes
Water usage: Gallons per rack	.74	.74	.74
Racks per hour (hot water/ chemical sanitizing)	58/65	41/45	58/65
Dishes per hour (hot water/ chemical sanitizing)	1,450/1,625	1,025/1,125	1,450/1,625
Glasses per hour (hot water/ chemical sanitizing)	2,610/2,925	1,845/2,025	2,610/2,925

HOBART
Proud supporter of you."

Source: Hobart. (2017)

winterhalter

Winterhalter GS 502

With its high performance, the **double skinned, electronic rack pass through dishwasher** is designed for straight through or corner operation and can be used in conjunction with ancillary tabling. The **language-neutral self explanatory colour coding** prevents mistakes - a big advantage when the turnover of untrained personnel is high. The GS 502 is a highly effective machine, fitted with **anti blocking, component free wash jet system** completed with collision technology and a one piece deep drawn tank. The collision wash jets provide **maximum washing power** and guarantee the best cleaning results. Due to the "**invisible**" wash tank heater and the deep drawn tank lime scale and dirt don't have a chance. The self-cleaning programme keeps dirt and deposits away. These features make **cleaning simple**. The **developed rinse system saves real money** during every wash cycle. With its **rinse water consumption** of 2.4 litres per wash cycle, low operating costs will be guaranteed.

Max. theoretical capacity		Cycle duration
Racks / h:	60 / 30 / 15	60 / 120 / 240 sec.
Plates / h:	960 / 480 / 240	
Glasses / h:	1500 / 750 / 375	

Dishwashers

Technical data		Standard
Theoretical capacity, washing programmes 1/2/3*1	[racks/hr.]	40/28/24
Short programme	[racks/hr.]	66
Rinse water requirement per cycle*2	[l]	2.4
Rinse water temperature	[°C]	85
Tank temperature	[°C]	62

Source: CKW Services. (2017); Winterhalter. (2017)

Appendix K – Water Meter Readings

	May 15th	Meter Readings in m³		
Afternoon - Evening	14:00	24825.895		
	16:00	24826.773	4.371 Consumption in m³	Segment selected for future monitoring
	18:00	24828.606		
	20:00	24829.802		
	22:00	24831.144		
	0:00:00	24835.139		

	May 16th	Meter Readings in m³
Morning	03:00	24836.592
	07:00	24837.778
	08:00	24841.982
	09:00	24843.554
	11:00	24846.076
	12:00	24846.804

	May 16th	Meter Readings in m³		
Afternoon - Evening	14:00	24847.422		
	16:00	24849.762	5.62 Consumption in m³	
	18:00	24851.358		
	20:00	24853.43		
	22:00	24855.382		
	24:00:00	24858.196		

	May 17th	Meter Readings in m³
Morning	03:00	24859.516
	07:00	24860.152
	08:00	24863.27
	09:00	24865.425
	11:00	24868.102
	12:00	24868.782

Source: Author's own elaboration

Source: Hotel CSH-2 Water Meters

Appendix L – Spreadsheet Model for Water Meter Readings

Day		Day		Day		Day		Day	
Water Meter Number		Water Meter Number		Water Meter Number		Water Meter Number		Water Meter Number	
Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³
06:00	24837.778	06:00		06:00		06:00		06:00	
08:00	24841.982	08:00		08:00		08:00		08:00	
10:00	24843.554	10:00		10:00		10:00		10:00	
12:00	24846.804	12:00		12:00		12:00		12:00	
14:00	24847.422	14:00		14:00		14:00		14:00	
16:00	24849.762	16:00		16:00		16:00		16:00	
18:00	24851.358	18:00		18:00		18:00		18:00	
20:00	24853.43	20:00		20:00		20:00		20:00	
22:00	24855.382	22:00		22:00		22:00		22:00	

Day		Day		Day		Day		Day	
Water Meter Number		Water Meter Number		Water Meter Number		Water Meter Number		Water Meter Number	
Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³
06:00		06:00		06:00		06:00		06:00	
08:00		08:00		08:00		08:00		08:00	
10:00		10:00		10:00		10:00		10:00	
12:00		12:00		12:00		12:00		12:00	
14:00		14:00		14:00		14:00		14:00	
16:00		16:00		16:00		16:00		16:00	
18:00		18:00		18:00		18:00		18:00	
20:00		20:00		20:00		20:00		20:00	
22:00		22:00		22:00		22:00		22:00	

Day		Day		Day		Day		Day	
Water Meter Number		Water Meter Number		Water Meter Number		Water Meter Number		Water Meter Number	
Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³	Hour	Meter Readings in in m³
06:00		06:00		06:00		06:00		06:00	
08:00		08:00		08:00		08:00		08:00	
10:00		10:00		10:00		10:00		10:00	
12:00		12:00		12:00		12:00		12:00	
14:00		14:00		14:00		14:00		14:00	
16:00		16:00		16:00		16:00		16:00	
18:00		18:00		18:00		18:00		18:00	
20:00		20:00		20:00		20:00		20:00	
22:00		22:00		22:00		22:00		22:00	

Selected segment		Average volume of water consumed in the selected segment
From	to	

Source: Author's own elaboration

Appendix M – Evaluation of Alternatives for Water-Saving Fittings

Water-Efficient Fittings	Price in €/Unit of Product	Manufacturing guarantee	Water Rate	Daily Water consumption per guest in L		
Grohe modes 27588001*	40.63 €	5	9.5l/min	1 min	Sink	9.5
Grohe model 33552002*	71.53 €	5	5.7l/min	12 min	Shower	68.4
TOTAL OPTION A	112.16 €					77.9

Water-Efficient Fittings	Price in €/Unit of Product	Manufacturing guarantee	Water Rate	Daily Water consumption per guest in L		
Grohe model 28793000*	50.54 €	5	5 l/min	1 min	Sink	5
Grohe model 33552002*	71.53 €	5	5.7l/min	12 min	Shower	68.4
TOTAL OPTION B	122.07 €					73.4

Operating costs (Water Costs)	Berlin Water Tariff		Daily water consumption costs in one guest bathroom of the Hotels	
			OPTION A → 77.9 L = 0,0779 m³	OPTION B → 73.4 L = 0,0734 m³
	Drinking Water (VAT included)	Quality Rate 1.813 €/m³	0.14 €	0.13 €
	Sewage Water	Quality Rate 2.307 €/m³	0.18 €	0.17 €
	TOTAL Daily water costs in €		0.32 €	0.30 €
	TOTAL Annual water costs in €		117.15 €	110.38 €

$$PVF = \frac{(1+D)^n - 1}{D\,x(1+D)^n}$$

n (Time)	5 years
D (Discount Rate)**	0.25%
PVF (Present Value) factor	4.9627

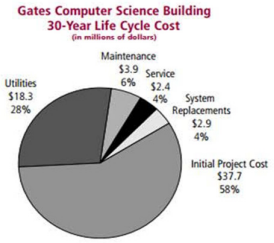
Maintenance Costs	
OPTION A	OPTION B
	16.17 €

It was taken as reference the square meters (m²) of the guest bathroom (3.8 m²) of the hotel CSH-2.

	OPTION A	OPTION B
Initial Cost (PV)	112.16 €	122.07 €
Annual operating costs x time	585.73 €	551.89 €
Annual maintenance costs x time	80.84 €	80.84 €
Operating & maintenance costs (PV)	3,307.98 €	3,140.07 €
TOTAL COSTS	3,420.14 €	3,262.14 €

Estimation of Maintenance Costs per m² ***	Hotel Martinshof	Area in m²	Utility costs 28% total costs	Estimated Maintenance costs (6%)	
				Total	per Area €/m²
		2350	46,660.00 €	9,998.57 €	4.25 €

***For the purpose of estimating a value of maintenance costs per m², the total utility costs of the Martinshof hotel were taken as reference, and from the proportions determined by Stanford University Land and Buildings (2005), a cost per m² was estimated.



Source: Stanford University Land and Buildings, (2005).

* Reuter onlineshop (2017).
** IndexMundi (2017).
*** Stanford University Land and Buildings (2005).

Source: Author's own elaboration