Adoption of Greywater Reuse Systems in Hotels in Abu Dhabi

تبني أنظمة إعادة استخدام المياه الرمادية في فنادق أبوظبي

by

AREEJ AHMAD JABER HAMMAD

Dissertation submitted in fulfilment

of the requirements for the degree of

MSc SUSTAINABLE DESIGN OF THE BUILT ENVIRONMENT

at

The British University in Dubai

October 2020

DECLARATION

I warrant that the content of this research is the direct result of my own work and that any use made in it of published or unpublished copyright material falls within the limits permitted by international copyright conventions.

I understand that a copy of my research will be deposited in the University Library for permanent retention.

I hereby agree that the material mentioned above for which I am author and copyright holder may be copied and distributed by The British University in Dubai for the purposes of research, private study or education and that The British University in Dubai may recover from purchasers the costs incurred in such copying and distribution, where appropriate.

I understand that The British University in Dubai may make a digital copy available in the institutional repository.

I understand that I may apply to the University to retain the right to withhold or to restrict access to my thesis for a period which shall not normally exceed four calendar years from the congregation at which the degree is conferred, the length of the period to be specified in the application, together with the precise reasons for making that application.

____

Signature of Student

COPYRIGHT AND INFORMATION TO USERS

Abstract

Availability of water resources has become a global issue that is imperative to resolve to achieve sustainable growth for generations to come. Various solutions have been launched to conserve the environment in all its aspects and the availability of clean water is one of the most challenges facing humanity today. The UAE is ranked in the top 10 countries in regards to high baseline of water stress. Innovative approaches need to be taken by authorities, businesses, and people alike to work together to conserve water resources. One such solution is the reuse of treated greywater. Greywater is the effluent from wash basins, showers, laundry, and kitchens. Treating and reusing greywater for purposes of irrigation and toilet flushing could relieve strain on water resources. The study examined the factors that can contribute to greywater adoption in hotels in Abu Dhabi. Abu Dhabi is an attractive destination with 168 hotels. A survey was designed and distributed to hotel professionals in Abu Dhabi. The survey was designed around the Theory of Planned Behaviour in order to identify the factors that will impact the behaviour in question in this case, greywater adoption. Greywater adoption in existing and new hotels was examined and results were obtained and analyzed using SPSS. The results showed that management perception, government support and risk associated with greywater impacted decisions to adopt greywater in existing hotels while customer perception and government support were the main factors that impacted adoption of greywater in new hotels according to hotel professionals in Abu Dhabi and the conducted statistical analysis. The study concludes by providing recommendations for future research.

Keywords: Greywater, Abu Dhabi, Hotels, Water Treatment

نبذة مختصرة

يواجه العالم مأزقًا حقيقيًّا في تأمين الموارد المائية، التي بدأت تشحُّ وتنضب تدريجيًّا لعوامل عديدة، أهمها ندرة الموارد المائية الطبيعية، وقلة هطول الأمطار وتزايد الطلب المائي ، فقد تمّ تصنيف دولة الامارات العربيه المتحده ضمن اعلى ١٠ دول في الاجهاد والشح المائي. تصدياً لهذه الازمه ، على السلطات والشركات والافراد ان يتخذوا حلول مبتكره للحفاظ على الموارد المائيه ، تُعدُّ إعادة استعمال المياه الرمادية إحدى أفضل البدائل التي ينبغي أن يوصي بها للمحافظه على الموارد المائيه وتخفيف الضغط عليها. المياه الرمادية هي المياه المجمعة من الاستعمالات المنزليه مثل احواض الغسيل والاستحمام والمغاسل والمطبخ باستثناء تلك الناشئة عن المراحيض ، حيث يتم معالجه هذه المياه واعادة استخدامها في ري النباتات و تنظيف المرحاض.استخدام المياه الرماديه يخفف الضغط على موارد المياه بشكل ملحوظ. في هذه الدراسه تم التركيز على العوامل التي تشجع الفنادق في مدينه ابوظبي على استعمال المياه الرماديه حيث ان ابوظبي هي وجهة سياحيه جذابه تحتوي مدينه ابوظبي على ١٦٨ فندق. في هذه الدراسه تم توزيع استبيان على العاملين المتخصصين في فنادق مدينه ابوظبي وذلك لدراسه مدى تقبل الفنادق لاستخدام المياه الرماديه وبناءا على نتائج الاستبيان تم تحديد العوامل المؤثره على استخدام المياه الرماديه. من اهم العوامل المؤثره على استخدام المياه الرماديه في الفنادق القائمه هي دعم الحكومة وتشجيعها لاستخدام هذه المياه و المخاطر الناتجه من استخدام المياه الرماديه و القطاع الاداري في هذه الفنادق. في الفنادق الجديده التى ستبنى ، كان رأي وتقبل العملاء والدعم الحكومي من اهم العوامل التي تؤثر على استخدام المياه الرماديه.

الكلمات الأساسية: المياه الرمادية ، أبو ظبي ، الفنادق ، معالجة المياه

Acknowledgments

I would like to thank my advisor Prof. Bassam Abu-Hijleh for his continuous support throughout my master’s journey. His guidance has been key to my succeeding through the modules and research. I would also like to thank my professors and the British University in Dubai team for all their support.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1. Background

Water scarcity is an important issue worldwide and governments have been constantly seeking for innovations in water management to alleviate water scarcity and availability issues. According to recent data from the World Resources Institute there are 17 countries that are experiencing severely high levels of baseline water stress (Cassella, 2019). Data analyzed by the WRI present the highest water-stressed countries. The UAE ranked as number 10 on the list for Extremely High Baseline Water Stress (Cassella, 2019). This comes as no surprise since the UAE has developed significantly in all aspects and industries including infrastructure and economy increasing water strain.

Abu Dhabi is the largest Emirate in the UAE with a total land mass of around 87% of the country. Abu Dhabi is home to Masdar the world's first zero carbon city and is also the host of the internationally acclaimed World Future Energy Summit which brings water and energy leaders from around the world to discuss various issues and challenges for present and future.

A report published in 2017 by to the Environmental Agency Abu Dhabi contributed water stress in Abu Dhabi to construction projects, farms, population increases, and increases in local produce. The UAE population consumes an average of 550L per person, one of the highest water consumers per capita in the world. To further put this number into context, the global average lies between 170-300 L daily per person. The report added this rate of consumption could deplete ground supplies within 55 years (Underwood, 2012).

According to a recent report published by the Environmental Agency Abu Dhabi in 2017, Abu Dhabi utilizes most of its water for Agriculture, Forestry and Parks at over 70%. The full breakdown is presented in Figure 1.

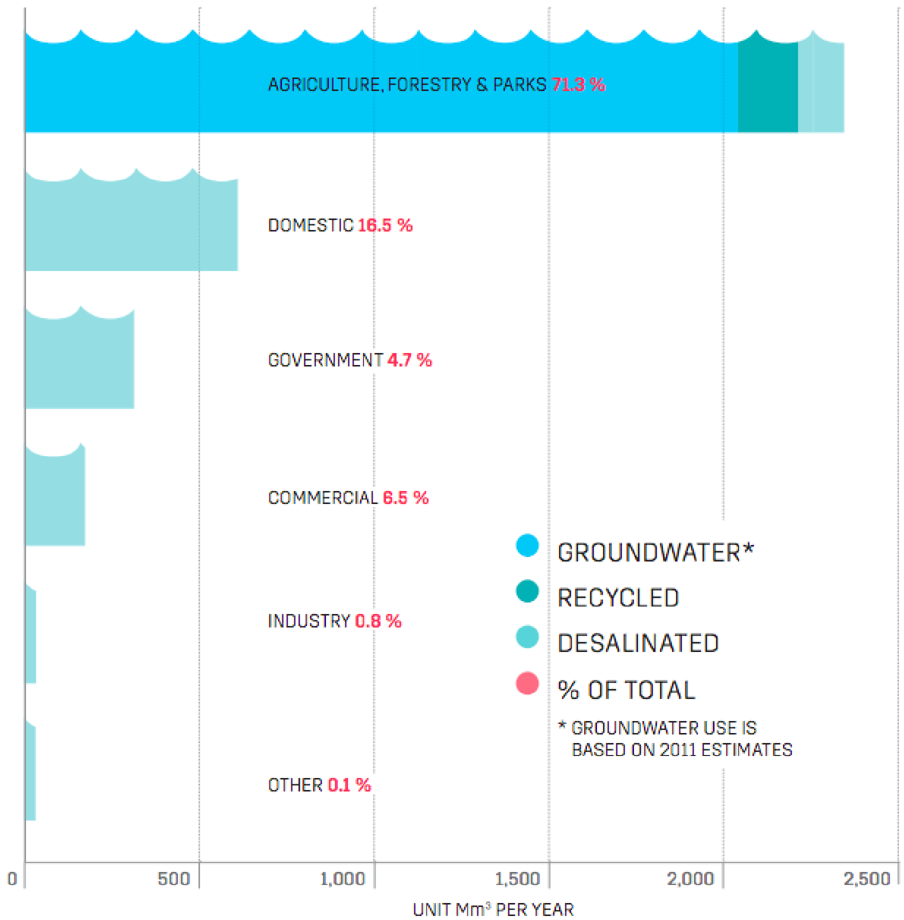


Figure 1 – Water Consumption in the Emirate of Abu Dhabi (EAD, 2017)

Demand for water in the UAE over the coming years is expected to grow further due to various initiatives. In Dubai, the World Expo is planned in 2020 and significant growth has been seen in both Abu Dhabi and Dubai in preparation for this. The expo alone will mean more construction projects, more visitors, and so more strain on water resources. Future growth is an important factor that must be taken into account when planning for water resources and in fact, it is the water resources that should dictate the pace of growth.

As seen in Figure 1, Abu Dhabi's main sources of water are ground water, desalinated water, and recycled or treated water from sewage. The majority is split between ground water and desalinated water as the use of treated water has for years been debatable and not well understood.

Novel processes, and technologies are needed to diversify the water supply in Abu Dhabi to ensure that it can further grow sustainably in ways that can increase fresh water, maximize on reserves, create sustainable solutions for desalination, and increase adoption of recycled or Greywater. Greywater is defined as the effluent water from household and commercial applications that has not come in contact with pathogens. This includes water from wash basins, showers, and washing machines. When treated, greywater can be reused in toilet flushing, irrigation and other applications (Radin Mohamed, Al-Gheethi and Mohd Kassim, 2019). The Abu Dhabi Government set a target of 100% use of treated water by the year 2030 as opposed to the baseline of 51% taken in 2010. It also developed Abu Dhabi's Environmental Vision 2030 which tackles many issues regarding the environment in Abu Dhabi including water production and consumption. Abu Dhabi is heavily dependent on desalinated water but the methods for desalination are mostly non sustainable using machinery that are dependent on fossil fuels and hence adding to the carbon footprint. The ideal scenario is a combination of sustainable solutions that can promote sustainable desalination, increase in greywater adoption, and increase in freshwater reserves. The Abu Dhabi Distribution Company's 5-year strategic plan forecasts a significant increase in water demand which requires innovative solutions such as greywater reuse to alleviate the strain on water resources (ADDC, 2019). Figure 2 presents the projections.

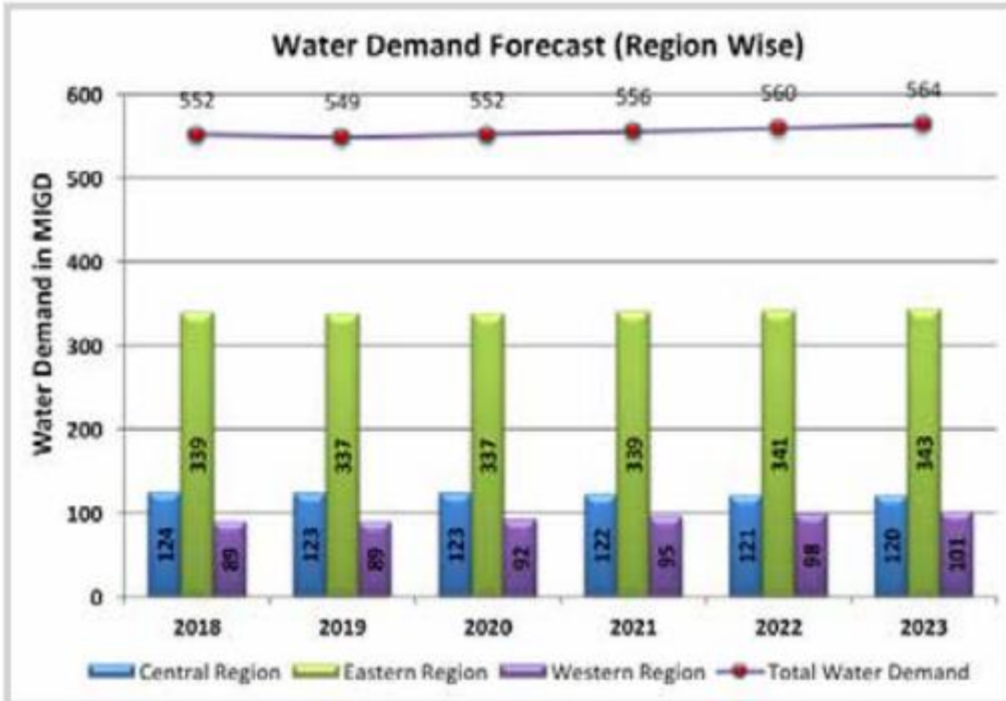


Figure 2 – Water Demand Projections in Abu Dhabi (ADDC, 2019)

Abu Dhabi has also become a popular tourist destination with over 5 million visitors staying in hotels in 2019 (Tourism and Culture Authority, 2019) adding to the water consumption requirements in Abu Dhabi. A report published by the Emirates Green Building Council published in 2016 stated that UAE hotels typically use 225% more water and energy than their counterparts in Europe (EGBC, 2016). This shows the potential that hotel establishments have to improve their water consumption rates. Abu Dhabi is home to 168 hotels as of 2019 according to the Tourism and Culture Authority (2019). AS mentioned earlier with 5.1 million hotel guests in average adding to the existing population, hotels can put a significant strain on water resources due to the high consumption for irrigation, laundry, swimming pools, bathrooms, kitchens, and housekeeping. Hotels also operate for profit and so water conservation can create savings opportunities increasing overall profit.

1.2. Research Objectives

The aim of this research study is to examine greywater use and adoption in hotels in Abu Dhabi. Water is the most vital resource on earth and Abu Dhabi has already set strategies to conserve it. Reaching environmental sustainability is vital to Abu Dhabi's overall longevity and to ensuring a bright future for generations to come as a healthy environment is a major contributor to achieving economic and social sustainability as well. Through a scientific research framework, this study examines the adoption of greywater reuse systems in the hotels in Abu Dhabi gauging their readiness and willingness for greywater reuse. People today are more conscious of the global environmental issues including global warming, increases in carbon emissions, pollution, and most importantly water scarcity.

To achieve the above-mentioned objective the following was investigated:

- Conduct a comprehensive literature review to better understand the capabilities and outcomes of using greywater and its possible applications
- Perceptions of greywater by hotel professionals in Abu Dhabi
- Research current water consumption trends in hotels in Abu Dhabi
- Research available greywater technologies and propose the best one for use in hotels based on results
- Examine applications and greywater regulations in Abu Dhabi and globally
- Investigate current installations in hotels around the world

1.3. Research Questions and Hypotheses

The study aims to assess perceptions and willingness to adopt greywater reuse in the hotels in Abu Dhabi. The following research questions are posed as a basis for the study:

R1: Are hotel managers in Abu Dhabi willing to adopt treated greywater usage in their hotels?

R2: Do hotel professionals believe that customers be willing to stay in hotels that use treated greywater?

R3: Are cost savings an important factor in deciding whether to invest in greywater technologies in hotels in Abu Dhabi

Examining the previously presented questions, the following hypotheses are developed:

H_o1: Management Perception will not have an effect on adopting greywater systems in existing hotels

H1: Management Perception will have an effect on adopting greywater systems in existing hotels

H_o2: Customer Perception will not have an effect on adopting greywater systems in existing hotels

H2: Customer Perception will have an effect on adopting greywater systems in existing hotels

H_o3: Having a positive impact on the environment will not have an effect on adopting greywater systems in existing hotels

H3: Having a positive impact on the environment will not have an effect on adopting greywater systems in existing hotels

H_o4: Additional costs in installation, maintenance and operations will not have an effect on adopting greywater systems in existing hotels

H4: Additional costs in installation, maintenance and operations will have a positive effect on adopting greywater systems in existing hotels

H_o5: Cost savings in water bills will not have a positive effect on adopting greywater systems in existing hotels

H5: Cost savings in water bills will have a positive effect on adopting greywater systems in existing hotels

H_o6: Government Incentives will not have a positive effect on adopting greywater systems in existing hotels

H6: Government Incentives will have a positive effect on adopting greywater systems in existing hotels

H_o7: Higher perception of risk in will have no impact on adopting greywater systems in existing hotels

H7: Higher perception of risk will have an impact adopting greywater systems in existing hotels

H_o8: Management Perception will not have an effect on adopting greywater systems in new hotels

H8: Management Perception will have an effect on adopting greywater systems in new hotels

H_o9: Customer Perception will not have an effect on adopting greywater systems in new hotels

H9: Customer Perception will have an effect on adopting greywater systems in new hotels

H_o10: Having a positive impact on the environment will not have an effect on adopting greywater systems in new hotels

H10: Having a positive impact on the environment will not have an effect on adopting greywater systems in new hotels

H_o11: Additional costs in installation, maintenance and operations will not have an effect on adopting greywater systems in new hotels

H11: Additional costs in installation, maintenance and operations will have a positive effect on adopting greywater systems in new hotels

H_o12: Cost savings in water bills will not have a positive effect on adopting greywater systems in new hotels

H12: Cost savings in water bills will have a positive effect on adopting greywater systems in new hotels

H_o13: Government Incentives will not have a positive effect on adopting greywater systems in new hotels

H13: Government Incentives will have a positive effect on adopting greywater systems in new hotels

H_o14: Higher perception of risk in will have no impact on adopting greywater systems in new hotels

H14: Higher perception of risk will have an impact adopting greywater systems in new hotels

1.4. Significance of Research

This is the first type of research study that specifically examines greywater reuse in the hotels in Abu Dhabi. Other research as presented earlier in the literature mainly targeted either public perception or was experimental in nature. No such study has been conducted in the UAE and specifically Abu Dhabi. The Abu Dhabi and UAE governments have put in place various plans and strategies for water conservation and have also developed guidelines for adoption at a federal and local government level led by the Ministry of Energy and Infrastructure, the Abu Dhabi Municipality, Abu Dhabi Environmental Agency, and more throughout the UAE. This is specifically true with the Estidama Pearl rating system which rates buildings on specific sustainability criteria. This will be examined further later in the study. This study will offer new insights on greywater reuse in hotels in Abu Dhabi and will pave the way for future similar research at both the UAE and regional level.

1.5. Outline of the Thesis

The study is divided into six chapters. Chapter 1 provided the background and significance of the study presenting the research questions and research hypotheses. Chapter 2 will include a detailed and comprehensive literature review that will support the objectives of the study. Chapter 3 presents the methodologies used to support this study including the data collection methodologies, type of research, and tools used. Chapter 4 presents the results and data analysis including the testing of the hypotheses posted in Chapter 1. Chapter 5 concludes the study and provides recommendations for future research.

Chapter 2 - Literature Review

2.1. Introduction

Chapter 2 presents a critical review of available literature which starts by stating the research paradigm assumptions and continues to give a background of greywater and greywater systems and technologies. The chapter also describes reuse applications focusing on various industries. The chapter also reviews various greywater technologies available in the market. The discussion continues with a critical review of similar and related research which has been conducted globally, in the Middle East and the UAE. The chapter further presents the advantages and disadvantages of various greywater systems. Furthermore, the literature review examines risks of greywater reuse and provides examples of its use globally. The chapter also presents various case studies of hotels which have installed greywater systems and builds a complete theoretical framework to support the research objectives.

2.2. Research Paradigm Assumptions

Research paradigms are an essential part of research as they provide a philosophical framework to guide how scientific research should be conducted (Hussey, 2009). Since perceptions can change over time for various reasons, various assumptions including ontological, epistemological, axiological, rhetorical, and methodological have been developed (Creswell, 2003). Since this study is quantitative, a positivistic paradigm is assumed as this study aims to gauge adoption of greywater in hotels in Abu Dhabi amongst hotel professionals. This quantitative study will address the five mentioned research assumptions as set forth by Creswell (2003) namely ontological, epistemological, axiological, rhetorical, and methodological.

The ontological assumption describes the nature of reality. Positivists accept only one reality, because it is external and objective to the researcher (Hussey 2009). The researcher in this case is independent of the research and aims to objectively deduce outcomes based on gathered data.

The epistemological assumption deals with what is approved as valid knowledge. Positivists think that only phenomena that can be measured and observed are counted as knowledge (Hussey, 2009). From the perspective of this study, knowledge will be obtained through the critical review of various research studies and data that is obtained through the research instrument mentioned in the research methodology.

The axiological assumption has to do with values. Positivists believe that the process of research is free of values, because they consider themselves as independent of the study. The interest here lies in the interrelationship between the objects being studied implying that research would not affect these objects in any way (Hussey, 2009). In the case of this study the object being considered is greywater adoption where it can be assumed that various factors can impact the degree and willingness for adoption.

The rhetorical assumption has to do with the language of research. The style used throughout this study is formal and in passive voice. This creates the impression that the research is objective from what is being researched (Hussey, 2009).

Finally, the methodological approach deals with the process of research. Since this research is a positivist oriented quantitative study, the concept of greywater adoption and factors that may impact it are presented and explained in a way that can be measured. Larger samples are utilized, and the study focuses on objective facts and phrased hypotheses (Hussey, 2009).

2.3. Greywater

Countries around the world are facing water shortages and thus water scarcity has become one of the biggest issues that is being faced this century (Oteng-Peprah, 2018). The main contributors to this include population growth, climate change, and excessive industrial applications. According to a recent study by the WHO, by 2025 half of the world's population will be living in water-stressed areas (WHO, 2019). One important method to minimize water stress is greywater reuse. Greywater as a common definition refers to wastewater that is derived from laundry, bathrooms (excluding toilets) and kitchens. According to the World Health Organization (2019), greywater contains significantly less pathogens although some may argue that kitchen sink waste could include pathogens due to the higher organic content. There has been much debate regarding greywater and its reuse given the potential risks if proper filtration is not employed. Treated greywater can be a practical solution to provide potable and non-potable water for use in different applications. Throughout the world, treated greywater is already in use to relieve strain on water supplies mostly in irrigation and toilet flushing (Radin Mohamed, Al-Gheethi and Mohd Kassim, 2019). To assess the purity of greywater, factors including biological oxygen demand, total nitrogen, turbidity, total suspended solids, ammonia, and chemical oxygen demand (Samayamanthula, 2019). Table 1 summarizes these characteristics.

Table 1 – Greywater Characteristics (Samayamanthula, 2019).

Characteristic	Summary
Total Suspended Solids	TSS are defined as particles that are larger than 2 microns found in the water.
Turbidity	Turbidity is an optical determination of water clarity and is correlated with TSS.
BOD	BOD is defined as the amount of dissolved oxygen used by microorganisms while metabolizing organic matter as such a high BOD content signals the presence of organic matter increasing toxicity of greywater.
COD	Similar to BOD, COD measures the required oxygen for the oxidizing of soluble and particulate organic matter in greywater. Similarly, an increase in COD refers to higher toxicity.
Ammonia	Ammonia is a gas signified under the NH3 which when dissolved in water increases alkalinity and toxicity.
Total Nitrogen	Measures the nitrogen content of greywater giving an indication whether or not there is organic content in the water.

Greywater is also attractive because it makes up the largest volume in terms of flow from commercial and residential dwellings (Oteng-Peprah, 2018). Additionally, greywater has a nutrient content that could be beneficial for crops and irrigation purposes. According to a report from the WHO, the average household wastewater flow is 586 L per household (WHO, 2006). In terms of greywater the number was identified as 356 L/day per household. This is divided between hand basin, bath, and laundry. The study added that greywater represented 60% of all wastewater. In the Middle East specifically in Muslim countries a major source of greywater is ablution where introducing a greywater reuse system could conserve ablution resources minimizing the water strain experienced in these countries. A study conducted in Malaysia showed that wastewater due to ablution had lower impurities due to the nature of ablution which can also contribute to using lesser expensive greywater filtration and treatment systems (Al Mamun et. al, 2014).

Table 2 summarizes the main areas in a household that can generate greywater and aspects of greywater quality from each.

Table 2 – Greywater Sources (Redi, 2020)

Location	Characteristics
Kitchen	Greywater from kitchens can contain food residues, oils and fats and detergents. In addition, it occasionally contains drain cleaners and bleach. Greywater from kitchens is typically has a higher nutrient content and suspended solids.
Bathroom	Greywater from bathrooms mainly contains soaps, shampoos and other body care products making it the least contaminated. There may still be traces of organic content including shaving waste, skin, hair and urine. In some cases, traces of feces may also be observed meaning pathogenic microorganisms may be present.
Laundry	Laundry greywater contains high concentrations of chemicals due to laundry detergents, bleach and any suspended solids due to the dirt in the clothing. It may also contain non-biodegradable material, paints, and other things that may increase the toxicity of the water. Laundry greywater can contain high amounts of pathogens if reusable diapers are washed as well.

The details presented in the table show the importance of diligence in designing greywater systems bearing into account the habits of people within their homes and offices.

Figure 3 presents a typical greywater system installation.

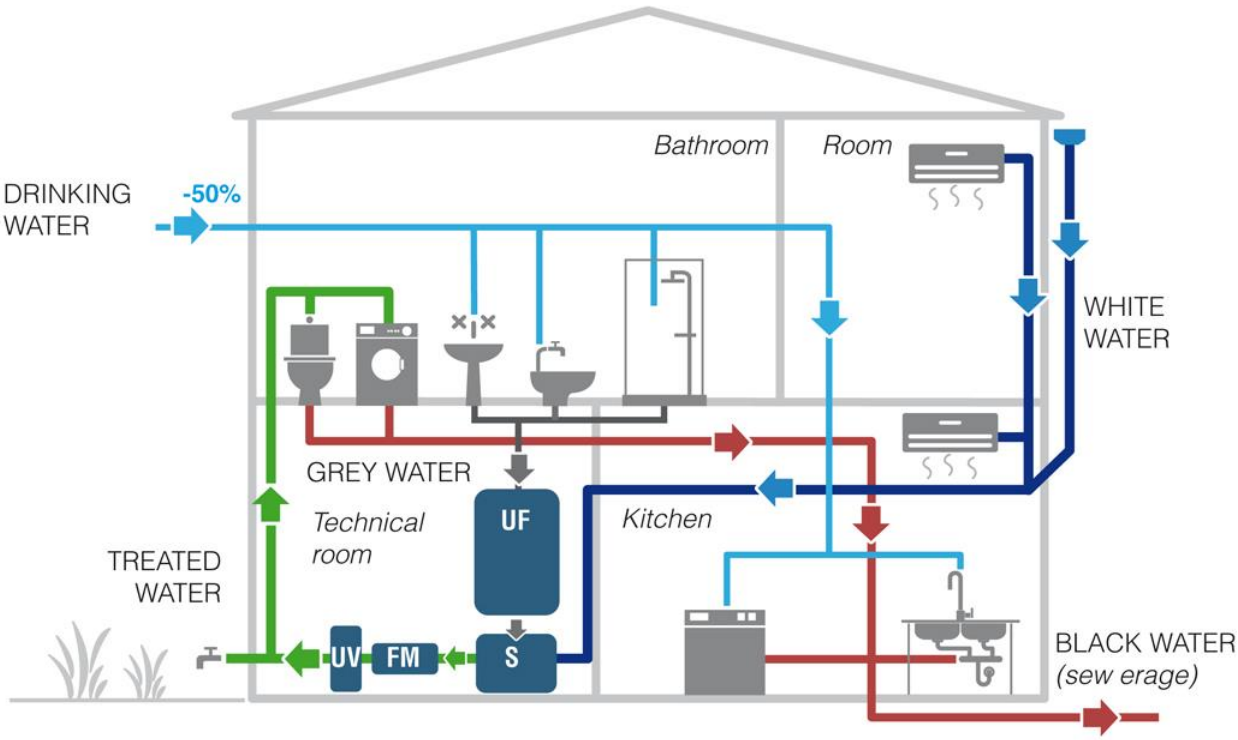


Figure 3 – Conventional Greywater Reuse System (Redi, 2020)

2.4. Greywater Systems

2.3.1. Background

Greywater systems can be simple or complex and categorized into three types known as bucketing, diversion systems, and treatment plants. Bucketing systems are made up of large buckets that collect greywater from wash basins. This method does not usually include filtration and the collected water is typically used for manual irrigation. Bucketing has its risk though due to the lack of filtration and possibility of contaminants. Diversion systems are bucketing systems that use plumbing arrangements and pumps that create channels to directly route greywater to the intended use (Samayamanthula et al, 2019). It is typically used for irrigation purposes or toilet flushing. Since no water is treated in this method as well, the same risks as bucketing apply. Treatment plants are the most common greywater systems and employ an elaborative filtration process. A typical treatment plant is presented in Figure 4.

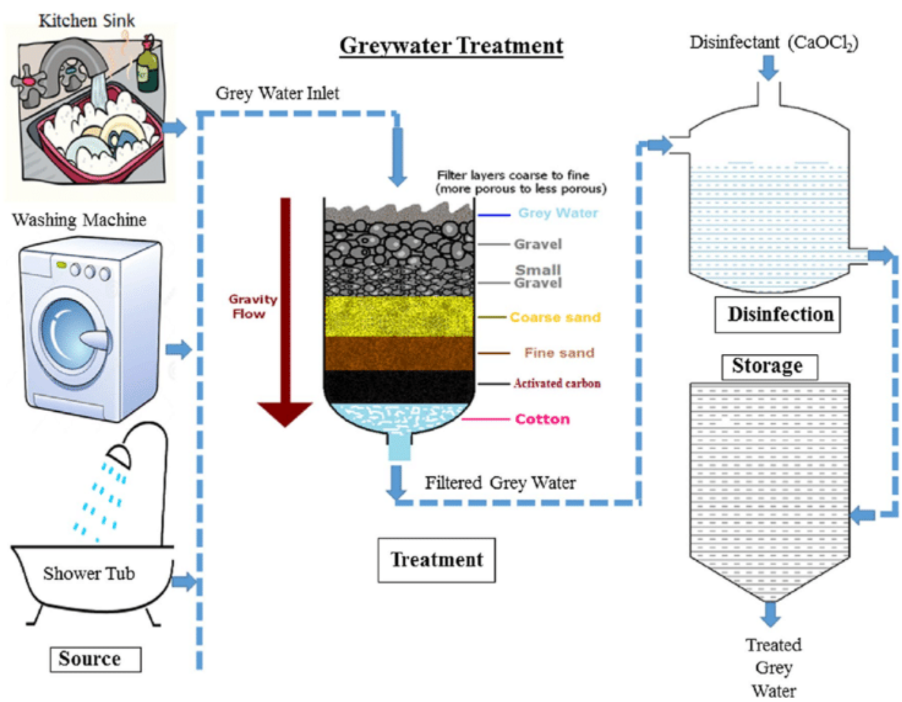


Figure 4 – Greywater Treatment System (Samayamanthula et al, 2019)

Specialized filters that can include sand, gravel, bark or charcoal are typically used in greywater systems (Samayamanthula et al, 2019). Each of the types can achieve certain performance depending on the application. This section discusses in detail the various types of systems.

2.3.2. Centralized Systems

Centralized greywater systems are those which allow for treatment and distribution for large areas. This is a one-time installation that is most likely done by a municipality and is connected to homes and establishments through dedicated piping. Centralized greywater systems have various benefits including the reliability, uniformity, and safety of the water supply leading to overall improved public health due to the controls in place for it. Centralized systems have a low risk of overflow and flooding since the tanks for storage and treatment are built to cover the area in question with an additional buffer to take into account peak times. The main concern with centralized systems is the construction cost. The cost does not only include that to build the facility but also the cost of piping to all homes in the vicinity. This is typically the biggest factor in not investing in centralized systems (Koottatep, 2019).

2.3.3. Decentralized Systems

Decentralized systems are those which are developed on a smaller scale and are not connected to a major municipal system. Decentralized systems are able to collect, treat and reuse different sources not limited to greywater including rain, storm, and wastewater. These systems are flexible in a sense that they can be applied at different scales covering single homes, small communities or independent buildings (Koottatep, 2019). Decentralized systems are also financially viable solutions and can be scaled according to the required. They can also be installed in rural and remote areas without the need of centralized support. These decentralized applications can be ideal for use in the hospitality industry specifically in hotel buildings and resorts where water usage is typically very high saving on operational costs and being sustainably responsible for the impact on the environment. Figure 5 presents an example of a typical decentralized greywater system.

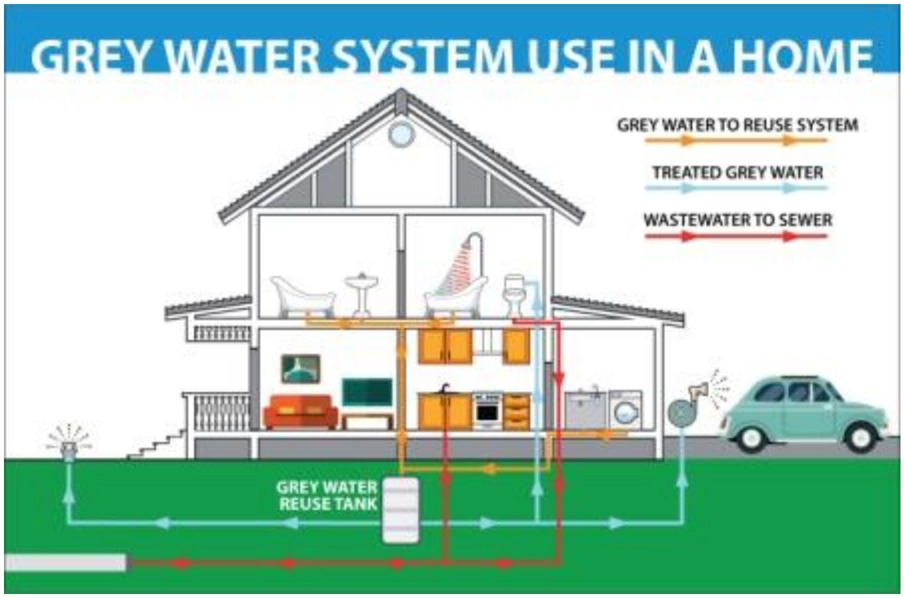


Figure 5 – Sample decentralized greywater system (City of Markham, 2020)

Decentralized systems are more affordable and accessible for homes, commercial buildings, and hotels. The monetary savings that will be achieved can be considered offsets for the investments made to install these systems. The systems provide clean water for use within the establishment while having a low impact on the environment and water supply. Decentralized systems also offer distributed risk as opposed to centralized systems which are risky on a larger scale. An accidental contamination in a decentralized system can be contained within the dwelling while in a centralized system, a contamination could reach a substantial amount of community members.

In hotels and commercial buildings, Water Co. Inc. a company that manufactures waterless urinals has presented guidelines to use greywater. Greywater should first not be stored for more than 24 hours as a general rule of thumb. Greywater should also never be touched since although it is lightly used, pathogens may still exist. Greywater also if pooled on the surface of a tank can become breeding grounds for insects namely mosquitos. Also, irrigation using greywater should be done using the same amount as that of fresh water. Systems also should be designed to allow for the switching between fresh water and greywater in case the greywater tank runs dry due to usage. One last consideration is the use of environmentally friendly products for soaps, cleaning solutions and detergents to simplify the treatment process and minimize the environmental impact (Bradley, 2018).

2.3.4. Treatment Systems

Greywater treatment systems can be simple and complex in setup. The simplest is using a septic tank design while the more complex designs can include various treatment processes including membrane filtration, biological filtration, and ultra-violet disinfection. The choice of the design will depend on the application required considering environmental, health, and economic factors. Essentially, Greywater systems can be classified into the types namely physical and chemical systems and biological systems.

2.3.4.1. Physical and Chemical Systems

Physical and Chemical systems bring together the processes of filtration, the physical, and the process of disinfection, the chemical. This is one of the most common and basic setups in greywater systems. Physical filters are used to remove larger waste and particles from the greywater while chemicals like chlorine and others are used for disinfection while the water is being stored before recirculation. Generally, the physical side of the system can substantially remove waste particles from the water which leads to a significant decrease in the pollutants. Sand and membrane filtration are often used to increase not only the aesthetics of the greywater, but also to achieve unrestricted use of non-potable water for irrigation and other purposes. The more filters are applied in their different types, the better the quality of the output water. The more complex the system is though, the higher the cost, however physical systems are known for their cost effectivity and a typical payback period of approximately 8 years. Physical systems though do not remove any of the chemical and biological pollutants and so this creates additional risks to use. This is where the use of additional chemical means is required. Chemical processes are able to reduce total suspended solids by employing chemical processes like coagulation where particles are removed to ease the disinfection process in the following stage. Figure 6 presents a typical coagulation procedure. Notice how the impurities are trapped by adding a coagulate substance, typically aluminum, and how impurities settle to the bottom of the tank. Other processes include photocatalytic oxidation and use of granular carbon.

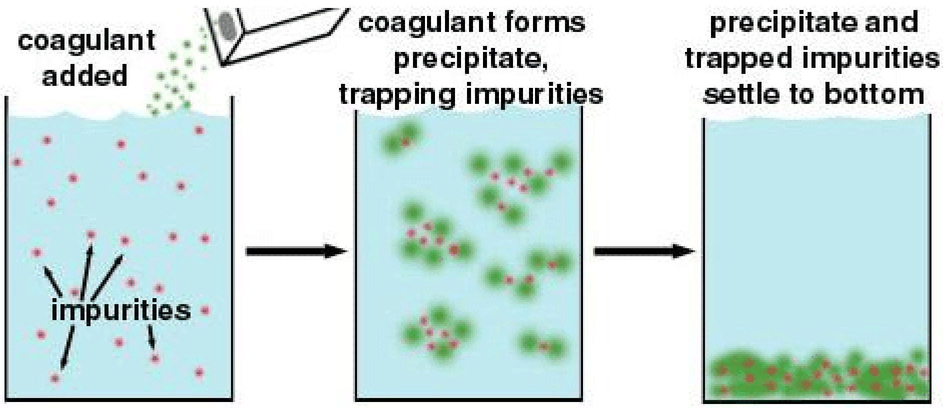


Figure 6 – Coagulation Process in Water Treatment (Olanrewaju et al, 2012)

It is important to note that Chemical processes must be coupled with other processes that will make the water safe for reuse or even to release it to natural water bodies. One such process is polishing. Polishing removes any remaining suspended solids and BOD post the chemical treatment to increase the greywater’s hygiene characteristics and make it more environmentally friendly before it is released/reused. Polishing starts with filtration over sand or charcoal filters where the particulate matter in the water attaches to filter media. This makes the greywater practically free of most matter in it. Next is lagooning where the water is stored in ponds or tanks for a short period to aid in the natural sedimentation of non-degraded and degraded particles at the bottom. Depending on the application, for example if the water was going to be realised into nature, aquatic plants and weed eating fish are introduced where they consume some of the particulate matter or in the case of plants absorb it. The last step is to add chlorine to disinfect the water and kill microbes within safe limits (Chokhavatia, 2020). Every application is different, but the chemical processes and sequences are more or less the same.

2.3.4.2. *Biological Systems*

Biological systems are different from physical and chemical mainly because they use organic methods to clean greywater. Biological methods specifically use bacteria, protozoa, and other microbes. These microorganisms create a sludge effect by breaking down organic pollutants after which they stick together creating flocculation which allows the organic matter to evidently become independent of the solution. This sludge is then dewatered and disposed of as solid waste. Biological systems can be broken down into three main categories namely aerobic, anaerobic, and anoxic. Aerobic is when microorganisms need oxygen to break down the organic matter releasing carbon dioxide and microbial biomass. Anaerobic is the opposite where oxygen is not required to breakdown organic matter but here methane is added as a by-product in addition to that mentioned in the aerobic processes (Marshall, 2019). Anoxic is when microorganisms use molecules other than oxygen to grow to remove sulfates, nitrates, and senates to name a few. The decomposed molecules are measure in BOD as presented earlier which is the amount of dissolved oxygen aerobic organisms need to break down the organic matter (Marshall, 2019). Figure 7 shows the different levels of BOD and what they mean in terms of pollution status (Hocking, 2005).

Dissolved oxygen (% of saturation)	River pollution status[b]	BOD loading (mg/L)[c]
90 or more	very clean	1 or less
ca. 90	Clean	2
75–90	fairly clean	3
50–75	moderately polluted	5
25–50	heavily polluted	10 to 20
<25	severely polluted	20 or more

Figure 7 – BOD Levels (Hocking, 2005).

As the figure presents, higher levels of BOD will mean a higher concentration of biodegradable material in the wastewater. This is typically due to industrial discharge, fertilizer runoff into the water and possibly domestic fecal waste. The risk of high levels of BOD is that it can kill other organic organisms which need oxygen to survive. High BOD means there will not be enough oxygen to be consumed by all aquatic organisms. This is why many treatment facilities treat their water biologically before releasing (Samco, 2019).

A big advantage of biological wastewater treatment systems is that they complement and optimize microbial decomposition which is a naturally occurring process and can often replace physical and chemical treatment systems but in most cases are used in tandem with them. Biological systems are also cheaper than physical and chemical systems. Figure 8 presents a modern biological treatment system design using the main principles presented in this section.

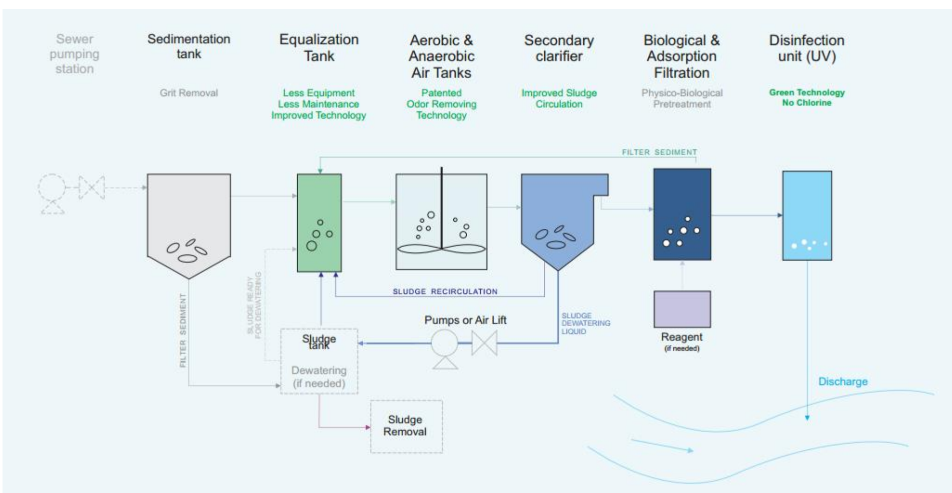


Figure 8 – Biological System Design (Bioxica, 2020).

Regardless of the type of system used, the required result is the same, cleaner water that can be reused with minimal risk to the environment and health of the community.

2.3.4.3 Advantages and Disadvantages of Greywater Systems

Every type of greywater system has its advantages and disadvantages. Septic Systems for example typically use domestic wastewater (UNESCO, 2017). They are simple to install, durable and easy to maintain. Adversely, this solution has low treatment efficiency, will most likely require secondary treatment, effluent may not be odorless, and content must be removed frequently. Septic Tanks typically only remove COD, BOD, TSS, and grease. Additionally, Anaerobic filters can filter domestic and industrial wastewater. They are simple to install and also durable. They also occupy less space for installation. The filtration material though can be high in cost and filtration may not be fully effective due to clogging (UNESCO, 2017). The anaerobic filters are able to remove BOD, TDS, TSS. Additionally, Anaerobic treatment systems take filtration a step further by reusing resources. Gases generated are typically used for power generation, cooking, and lighting purposes. The issue with anaerobic treatment though is the complexity of the system, safety risks in terms of gas leaks, and little removal of nutrients from the effluent. Anaerobic treatment systems can remove COD, BOD, TSS, and grease (UNESCO, 2017).

Aerobic biological treatment can be very good in removing BOD and provides for an odor free effluent. The disadvantages with it include the higher maintenance requirements and is ineffective in deep water and cold condition which also cause high sludge production which can impact system performance. These systems remove BOD, SS, TN, and TP (UNESCO, 2017).

Lastly membrane systems are the most advantageous in terms of yielding the highest water purity since they completely close the water cycle, but this comes with higher cost, higher maintenance requirements, and higher power consumption (UNESCO, 2017).

Every type of system has its advantages and disadvantages and hotels in Abu Dhabi may be able to leverage the right system based on their requirements, the desired customer experience, cost, and risk. This is further examined later in the study.

2.4. Greywater System Costs

To further put greywater adoption into perspective, it is important to explore the costs associated with installing a greywater system in general and what the cost to a hotel would be. Various studies have been conducted to identify the overall cost of adding a greywater system from the capital and operational perspectives. Olanjewaru & Olubanjo (2016) conducted a study to evaluate the cost and feasibility of installing a greywater system in a university academic and residential building. Olanjewaru & Olubanjo (2016) argued that the total cost would be broken down into design, permits, purchase, installation, operations, and maintenance costs. The cost of the simple system was 39,241 Rand which is the equivalent of $2,802 USD (Olanjewaru & Olubanjo, 2016). It is worth noting that the system is not complex and was only used a pilot. A campus wide system would cost significantly higher. Similarly, a study conducted by the Malta Business Bureau in 2013 presented the potential savings in installing a greywater system by hotel category. The study made estimates based on current installations of greywater in hotels in Malta and explored both complex and basic systems (Cremona & Saliba, 2013). The cost for a system for a 5-star hotel ranged between 40,000 euros and 115,000 euros which was dependent on the technology used. The average cost for a 5-star hotel was 75,000 euros. For 4-star hotels, the cost ranged from 20,000 to 60,000 euros with an average installation cost of 40,000 euros. For 3-star hotels the cost of system installation ranged from 12,500 to 15,000 euros averaging at 13,500 euros. Lastly a 2-star hotel's installation cost ranged from 8,000 euros to 10,000 euros averaging at 9,000 euros for each installed system. The study did not only look at the cost of the system though, it highlighted the anticipated cost of materials, piping, labor and other elements (Cremona & Saliba, 2013). The study showed that the total cost for a 5-star hotel would be 1,125,000 euros, a 4 star would be 1,760,000, a 3-star estimated at 742,000 euros, and finally a 2 star is estimated at 189,000 euros (Cremona & Saliba, 2013). More importantly was the payback period of 4 years which was identified through the savings that these systems would yield. The costs presented in the Malta study are more in line with that of Abu Dhabi's ecosystem (Cremona & Saliba, 2013).

Also, according to the Greywater and Wastewater Industry Group (GWIG) the cost of a greywater installation for a typical home ranged between 10,990 USD and 18,240 USD which included systems cost, installation, and piping. Their system is designed solely for use in irrigation and claims saving up to 60% on potable water (GWIG, 2020).

As mentioned in the literature, Australia is widely known as an initial adopter of greywater due to water scarcity. Various Australian companies offer greywater solutions for homes and those range from 800 AU dollars to 2,950 AU dollars. This is the cost of the system only and not of installation, piping (Grey Flow, 2020).

2.5. Risks of Greywater Reuse

Greywater reuse has been increasing in popularity globally specifically for applications of irrigation for gardens in homes, agriculture and in water scarce locations. Water scarcity is a global issue as discussed earlier and greywater has become one of the solutions to ease the strain on water resources. The fact that greywater can originally contain pathogens and contaminants though does immediately raise the flag in terms of risk on health and the environment. Various factors need to be considered and assessed in terms of risk accordingly. To start untreated greywater may still contain harmful pathogens which can have negative effects on the environment and community. This increases the possibility of transmitting disease especially if raw vegetables are consumed post irrigation with untreated greywater. Introduction of various filtration methods can mitigate this risk and create healthier water for reuse. Another important task is to raise awareness of using greywater to ensure that the community understands the risks and benefits. When designing systems as well, it is essential to ensure that ground water is not contaminated during the process and that the fresh water supply be completely segregated. The use of chemicals needs to also be controlled and monitored as greywater in irrigation can negatively change the hydro-chemical characteristics of the soil. The topsoil can also deteriorate if the levels of saline are high.

Another dimension that needs to be considered is the local conditions in each country and region where greywater reuse is planned. Different characteristics of each region including climate, water demand, and greywater characteristics will dictate the required design of the greywater setup. The best way to avoid any of these risks is to no irrigate using untreated greywater. This significantly minimizes or reduces the risk of contamination. Blanky (2017) developed a Greywater reuse risk assessment methodology which includes Hazard Identification, exposure assessment, dose-response modeling, and finally the risk identification. The process is summarized in Figure 9.

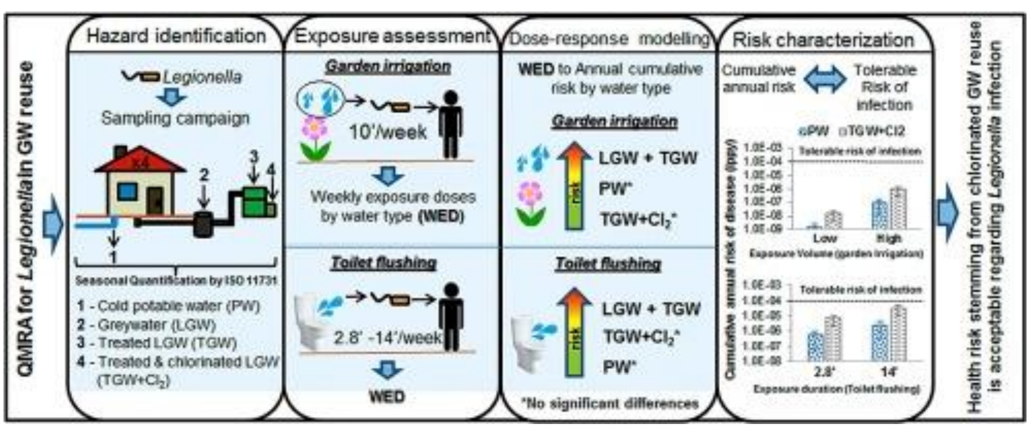


Figure 9 – Greywater Reuse Risk Assessment Methodology (Blanky et al., 2017)

Risk will exist regardless but the employing of proper risk management procedures, water quality testing, and localizing the design would minimize the risk and overall impact on the environment and community.

2.6. Previous Research on Perceptions

Various research studies have been published regarding greywater reuse. In the UAE, a study conducted by Al Dehaim Al Ameri (2014) to examine greywater treatment and reuse benefits in a specific area in Al Ain, Al Wagan (Al Ameri, 2014). The study used a mixed methodology to uncover the potential of using greywater which was a result of ablution, wash basins, and showers. The results showed that 40% of the waste in the Al Wagan area at the time the study was conducted was from greywater totaling 480,000 gallons of water per day. From a cost perspective, calculating the savings proved to be significant according to Al Ameri. The study recommended the installation of a greywater treatment plant to further conserve the environment in Al Ain and relieve water strain (Al Ameri, 2014).

Another study conducted in 2009 by Chung Khong (2009) examined perceptions and use of greywater specifically in Berkley, California. Similar to this study, Khong's (2009) research aimed to gauge the perception of greywater within the community and identify factors that affect greywater reuse. Khong (2009) conducted a survey that was distributed to 800 Berkley residents. The results he obtained showed that 28% of respondents have either already used or were familiar with greywater. A fair number of respondents also showed interest in retrofitting and replumbing their homes to use treated greywater. The results also showed that in Berkley greywater mostly came from bathtubs, sinks, and showers. Lastly Khong's study also identified landscape irrigation as the primary use for greywater.

Similarly, a study was conducted that targeted students at the University of Reading in the UK aiming to uncover perceptions of greywater reuse amongst students on campus. The study aimed to gauge students understanding of greywater reuse and their perspectives regarding use on campus. According to the study conducted by Hyde, Smith, and Adeyeye (2016), 95% of all respondents fell into four different categories, those who support greywater reuse for all applications, those who support it in most applications, support for non-drinking applications, and those who will support it if it is safe to use according to government standards. The data showed that students had relatively good knowledge of greywater reuse and welcomed the idea of introducing greywater on a larger scale (Hyde et al, 2015).

Additionally, a study gauging public perception of water practices including greywater was conducted in the UAE by Maraqa & Ghoudi (2015). The study targeted UAE Nationals who were 18 years and older. The study found that 70% of respondents had never heard of greywater prior to the administration of the survey. Although this was still the case, 41% still responded favorably towards using greywater in their homes. The results also showed that respondents would be willing to use greywater for car washing, toilet flushing, landscaping/irrigation, and outdoor cleaning.

Although most studies examine treated greywater, Nel and Jacobs (2019) conducted a study regarding the use of untreated greywater. The study that was conducted in Capetown was prompted by the stringent water restrictions that were implemented in 2018. The research indicated that untreated greywater reuse was relatively common for irrigation and toilet flushing purposes. The results also indicated a high level of risk for this use especially if the water had previously come in contact with pathogens that could impact human health (Nel & Jacobs 2019)

Lemee et al conducted a greywater perception reuse study targeting the city of Nantes in France. The study examined the perceptions of greywater associated with the prospect of droughts and water shortages. According to Lemee et al (2019) greywater usage in Europe is limited and often misunderstood. This seems to be true in other places around the world according to the literature presented so far in this study. Lemee's study uncovered through statistical analysis that personal exposure to greywater was a major factor to adoption. The study also found that residents that had fears of drought and water shortages were more likely to accept greywater reuse. Lemee's research added that risk of greywater use was also directly linked to greywater adoption and reuse (Lemee et al., 2018).

Additionally, a study conducted in South Africa by Bakare et al (2016), explored greywater perception in low-cost housing amongst the public in Durban. The study received a total of 344 completed surveys whose results mainly showed that there was widespread acceptance to using greywater for toilet flushing and irrigation. Their study also found that respondents would be more inclined to use greywater in times of drought and water scarcity but generally they were not against the use of greywater (Bakare et al, 2016).

Various research studies have been reviewed to further support the purpose and aim of this study which is to examine and gauge perceptions of greywater reuse in Hotels in Abu Dhabi and to understand the willingness of greywater adoption be it in existing or future hotels. It is imperative to support existing research with what has been conducted in previous studies. This provides for opportunities in current research, uncovers limitations, and provides better insight for data analysis.

2.7. Greywater Use Globally

The reuse of graywater is being increasingly practiced in in various countries around the world including those who may not have significant strain on water resources. Some of these countries have conducted assessments and studies regarding greywater putting in place guidelines and legislation bearing in mind environmental and health implications. This section explores various practices around the world for Greywater reuse. In the United States, there are no specific national guidelines as each state is responsible for their own regulations when it comes to water (McIllwaine, 2003). California for example was the first state to allow the usage of Greywater reuse issuing their greywater reuse code in 1977 (McIllwaine, 2003). Also, in Arizona, a study that was conducted in the year 2001 showed that greywater was already being reused for irrigation purposes before any legislation was in place in that state (Graf, 2012).

In Australia various studies have been published in the 90's to assess greywater reuse potential. Australia is known for high demands in water but with lower resources depending on desalination plants. Australia is considered a leader in greywater use having developed clear guidelines for greywater reuse across the country. Australia has published a Code of Practice for the Use of Greywater which offers details, specifications, and limits for individual households and community scale applications. For example, the standard stipulated that untreated greywater cannot be stored for longer than 24 hours versus treated greywater which can. The code is administered and controlled by the Department of Health.

Cyprus on the other hand offers a subsidy program where households that install greywater treatment and reuse system are offered incentives specifically in irrigation and toilet flushing (McIllwaine, 2003).

Various studies have also been published in the United Kingdom specific to greywater reuse for toilet flushing and test plants were established to examine the feasibility of doing this. The plants included filtration and disinfection to increase water quality and obtaining desirable results.

In Germany, greywater was first used in 1989 in Berlin. The adoption of greywater in Berlin was a challenge due to the resistance of water suppliers who were against water reuse for commercial purposes (Nolde, 2005). Germany has advanced over the years to have clear legislation for greywater reuse. It is worth noting that Germany also heavily relies on rainwater collection to conserve water and relieve strain on water resources.

Japan on the other hand uses greywater widely from anything to simple applications like toilet flushing for smaller apartments where piping is linked from wash basins to toilets, to complex systems that cover entire buildings. They also have legislated specifically in Tokyo that all buildings with an area greater than 30,000 square meters must install greywater systems that can process a minimum of 100 cubic meters of greywater per day (Hanson 1997).

In the United Arab Emirates, Abu Dhabi and Dubai have developed guidelines and regulations specific to greywater reuse and system implementation. Dubai's green building regulations and specifications touch on resource effectiveness putting in the construction and piping guidelines for greywater reuse including dual plumbing for the collection and recycled use of greywater, a minimum air break of 25mm between sources of potable water and greywater collection systems, and that greywater cannot have any contact with the human body. The regulation adds that all new commercial car wash facilities 50% of the of the wastewater must be recovered and reused (DEWA, 2010). Before this the UAE's then Ministry of Public Works, now the Ministry of Energy and Infrastructure published the Green Building Guidelines at the Federal Level which detailed the regulations for installing greywater systems and also recommended greywater as an alternative for using desalinated water for non-domestic purposes (MOID, 2009). This clearly shows how progressive the UAE has been as a government in trying to find innovative ways to relieve strain on water resources in the country.

2.8. Regulations in Abu Dhabi

2.8.1. Regulations and Supervision Bureau

Abu Dhabi's Regulation and Supervision Bureau (RSB) published regulations that govern water, wastewater, and electricity in the Emirate of Abu Dhabi providing details for prohibitions, as well as the conditions for greywater and wastewater reuse. The standard is clear on prohibitions not allowing the use of recycled water for cooking, bathing, swimming and consumption (RSB, 2018). Table 3 presents the limits for the criteria in terms of greywater characteristics.

Table 3: Sanitary Parameters (RSB, 2018)

Standard		P1 Unrestricted Reuse	P2 Restricted Reuse
Parameter	Unit	Prescribed Concentration	Prescribed Concentration
pH		6 to 8.5	6 to 8.5
BOD_5 (ATU)	mg/l	10	10
Total Suspended Solids	mg/l	10	20
Turbidity	NTU	5	10
Residual Chlorine (total available)	mg/l	0.5 to 1	0.5 to 1
Dissolved Oxygen	mg/l	≥ 1	≥ 1

The regulation also includes tables that detail the acceptable biological parameters. These are presented in Table 4.

Table 4: Microbiological Parameters (RSB, 2018)

Standard		P1 Unrestricted Reuse		P2 Restricted Reuse	
Parameter	Unit	Geometric Mean	Prescribed Concentration	Geometric Mean	Prescribed Concentration
Faecal Coliform or E. Coli	CFU or MPN/100ml	14	23	200	800
Intestinal Enterococci	CFU or MPN/100ml	11	24	35	104
Helminth Ova	Number/l	N/A	0	N/A	0
Legionella (in circulating water)	CFU or MPN/ml	N/A	100	N/A	N/A

The regulation goes further to include parameters and limits for bio solids, and sampling frequency. The regulation has also detailed the requirements and regulations for safety in greywater reuse. A safety plan must be developed to ensure the safe handling of greywater. The

RSB has set a comprehensive safety monitoring plan that requires yearly sampling, self-audits, RSB audits, and 3rd party audits. Abu Dhabi has not only issued regulations but has also introduced the green building assessment program “Estidama” which is the Arabic word for sustainability. Building are rated through various criteria in a Pearl Rating system where newly developed buildings are required to conserve and minimize water consumption and get ratings based on the amount conserved.

2.9. Applications of Greywater Reuse

2.9.1. Premier Inn Abu Dhabi

The Premier Inn was the first hotel who installed a greywater treatment and reuse system in Abu Dhabi. It was also the first to get approval from the RSB. The building achieves 24% monthly freshwater savings totaling 735,550L recycled water per month. This breaks down to an average of 60L of water savings per hotel guest. To put this into further perspective, the savings can be compared to 110,000 baths per year totaling 8,826 m3 of water. One of the most notable achievements is that the hotel uses 100% reused and treated greywater in toilet flushing. Greywater is treated using an ultra-filtration membrane that feeds into the piping system for use in toilet flushing and irrigation. The system was designed to process 20,000L in treatment capacity minimizing and eliminating any interruption in the hotel water supply as to not impact customer experience. Figure 10 presents the design (Waterworld, 2016).

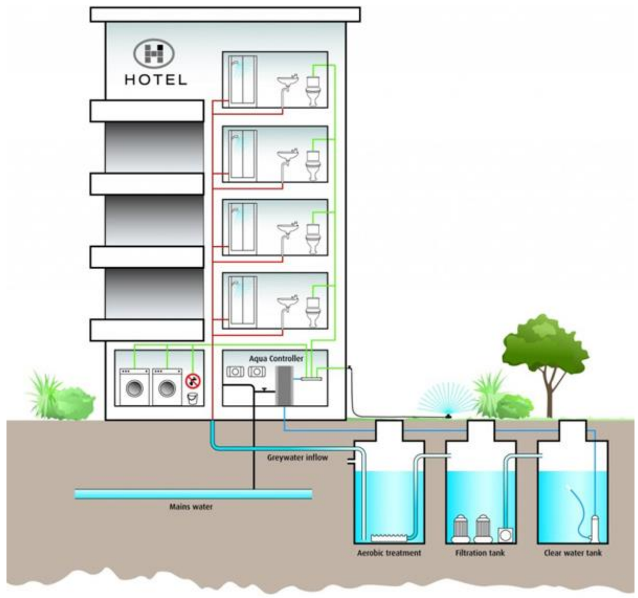


Figure 10 – Premier Inn Abu Dhabi Reuse System Design (Waterworld, 2016)

2.9.2. NH Campo di Gibraltar - Spain

The 100-room NH Campo de Gibraltar hotel in Algeciras, Spain is a 100-room hotel that was opened in 2009 has shown innovation by installing a greywater recycling system in accordance with EU standards. The recycled greywater is able to decrease the requirement for potable water by 20% and uses the recycled greywater from showers and wash basins to flush toilets. Note that the water is filtered and treated prior to recirculation (EREK, 2020).

2.9.3. Hotel Verde – South Africa

Hotel Verde in Capetown is an exceptional example as the only LEED platinum certified hotel in the world has installed a greywater recycling plant on site that recycles water from baths, showers, and condensate from ventilation fans, for us in toilet flushing. The hotel saves 6,000 L of drinking water per day that is 2.1 million liters per year (Verde Hotels, 2020).

The Literature Review provided insight on Greywater, greywater systems and explained the characteristics of greywater. It explored previous research related to greywater and highlighted the risks of greywater reuse. The review also examined greywater applications around the world.

2.10. Chapter 2 Summary

Chapter 2 presented a comprehensive literature review that introduced greywater as a concept and greywater systems. The chapter also presented a critical review of the available and related research pertaining to greywater adoption including studies that were conducted inside and outside of UAE. The chapter also presented according to the literature the risks associated with greywater reuse. Previous related research was also presented and reviewed to support the objectives of the study. Global practices in greywater adoption were also reviewed in addition to regulations in Abu Dhabi. Lastly the chapter reviewed existing applications in hotels in Abu Dhabi and around the world. Chapter 3 presents the research methodology used in the study. It explores the use of various methodologies presenting different options and the final rationale for choice of methodology. It also explores related research studies to provide for better rationale to the choice of methodology. The chapter also presents the research instruments used statistical methods that will be used to analyze the data in accordance with the literature and objectives of the research study.

Chapter 3: Methodology

3.1 Introduction

This Chapter presents the research methodology used in this study. This chapter first presents the research methodology through the review of research theory and similar research studies. The identified research instrument is then detailed and rationale of development presented. Population and sampling procedures are then presented in addition to the available statistical methods. The chapter present the rationale for chosen statistical method, variables in accordance with hypotheses, and data collection procedures.

3.2 Previous Methodologies in Research

There have been numerous research studies that have been conducted to explore different applications of greywater. The research methodologies that may be of most interest to answer the posed research questions include survey research, experimental research and literature reviews based on the posed research questions. Choosing the right methodology requires a critical review of existing research to better support the reason for choice of research methodology. This section will review the various types in question to further support the choice of methodology.

3.2.1 Surveys

Surveys are cost-effective and simple to administer research methods that focus on events that occur in the present. Surveys can be delivered and distributed using various channels including mobile phone, via the internet, mail, e-mail or through phone calls (DeFranzo, 2012). Surveys are advantageous because they can provide for more data due to widespread distribution. Furthermore, survey data can be easily manipulated through statistical software like IBM SPSS or Microsoft Excel depending on the complexity of the analysis. Surveys can be useful in providing insight regarding the adoption of greywater reuse and provide further understanding of views. A study conducted by Pinto and Maheshwari (2010) explored greywater adoption specifically for irrigation purposes in Australia. The study uncovered issues and proposed alternatives regarding water strain in the country. Pinto and Maheshwari's (2010) research methodology was survey based where they constructed and distributed an online survey that targeted residents in Western Sydney. The data was collected and organized in Microsoft Excel Sheets. The survey in this case allowed the researchers meet their objectives of uncovering the level of environmental awareness and willingness to use greywater as a solution that can provide safe irrigation while conserving water resources. Their survey uncovered that health and safety were the respondent's main concern in regards to using greywater. Similarly, a study conducted by Maraqa and Ghoudi (2015) in the UAE aimed to gauge public perception of greywater use amongst UAE Nationals. A survey was designed, tested, modified and then distributed to the identified sample. The study was able to achieve a high response rate allowing them to answer the posed research questions as presented in Chapter 2 and the research methodology supported them in answering the posed research questions which were similar to those of this study. Additionally, Hyde et al (2017) studied perceptions of students at the University of Reading. A survey was also designed aiming to answer the posed research questions. The study received 135 responses and results showed favorability towards greywater re-use on campus. The presented research studies show that survey research can be an efficient tool to obtain data that can be analyzed to draw conclusions about a sample that can be generalized to a population.

3.2.2 Experimental Research

Scientific research that requires variables to be measured, manipulated, and compared in an effort to come to conclusions to answer research questions is called experimental research (CIRT, 2019). Experimental research requires for environments to be controlled environments and must be repeatable. This hence can lead to independent result verification. Experiments are also flexible in a sense that even if there is a methodology modification or tailoring while tests are being conducted, the validity of the experiment remains true. Various research studies in regards to greywater adoption have been conducted using experimental research. A study conducted by Karibasappa (2017) for explored the use of the Canna plant to treat greywater such that it can be used domestically. The experiment examined two types of the plant in question in a controlled environment and checked whether the treatment was effective or not. The results of the study showed significant decreases in the greywater characteristics and concluded that the plant could be used as an alternative to chemical treatment. Similarly, Chowdhury and Abaya (2018) conducted an experimental research study that explored green-roof systems that are irrigated by greywater in Al Ain, UAE. Green roofs contain layers of vegetation, substrate, and drainage. The study examined through experimentation if the effluent water can be treated and used for irrigation. The study was conducted in a controlled environment over a period of 11 days and monitored greywater characteristics including COD, turbidity and others. The results of the tests showed that there was some efficiency in treating certain characteristics bit adversely did not show a decrease in bacteria. Unfavorable results are normal in any type of research as presented in this example since it can allow researchers to uncover opportunities for future research.

Additionally, experimental research has been used in the greywater domain to study the effects of different filters to identify efficiency levels in accordance with the required applications. A study conducted by Sangeetha et al (2017) experimented with sand filters. The sand was placed in drawers and the environment was prepared for the experimentation (Sangeetha et. al, 2017). The steps for experimentation included the greywater collection, pre-treatment lab analysis, sand filter treatment, post-treatment lab analysis and then the observation and deduction based on results of whether this treatment method is viable or not. The results showed that the treated greywater did not meet local regulations and hence could not be used (Sangeetha et. al, 2017). The presented research studies have shown that experimental research is a powerful and stable research method with repeatability. The choice of the methodology is dependent on the aim of the research objectives and research questions. Experiments do have limitations though as the environment is considered artificial and does not reflect the actual, the cost and facilities required to conduct an experiment can be high, and the number of variables studied can be limited (Salkind, 2009).

3.2.3 Literature Reviews

When conducting any research study, one of the main elements in the study is the conducting of a literature review. This is usually then completed with a type of research methodology that may or may not require experimentation. Adversely, some research studies use literature review and historical research as the main methodology to draw conclusions on a topic (Salkind, 2009). Various perspectives are presented in literature review methodologies from different scholars and researchers through publications including books and peer-reviewed journals (Chan, 2009). Literature reviews hence allow the development of deep and critical knowledge about a certain topic by researchers. In regards to greywater adoption, related studies that have used literature reviews as a main methodology can act as an exceptional source of information to use to support the research objectives better allowing the study to answer the posed research questions.

A study conducted by Oteng-Peprah et. al (2018) used the literature review methodology to examine characteristics of greywater, treatment systems available in the market, strategies for reuse while accounting for end-user perception. The study explored developing countries and aimed to uncover the strengths and weaknesses of available systems. The various literature that was reviewed allowed the researcher to conclude that not one system or technology available at that time could reduce all contaminants. Some systems reduced BOD significantly while the COD remained high and vice versa. This uncovered opportunities though for future research which could lead to more experiments and innovations in new systems that can aim to reduce all contaminants (Oteng-Peprah et. al, 2018). Similarly, a literature review based conducted by Ajit (2016) explored the greywater characteristics in existing greywater systems. Ajit's (2016) findings showed that the treatment and filtration methods depended on the application and added that public safety should be the primary consideration when designing or selecting a greywater reuse system. Additionally, a research study conducted by Murthy et al (2016) conducted a complete technological review of greywater reuse aiming to present advantages in reducing potable water use through greywater reuse. The study deduced based on the literature that a greywater technology should be chosen based on greywater source, demographics, population, and previous examples of successful installations. The study also concluded that any type of complexity but this is in essence dependent on the non-potable application in question (Murthy et. al, 2016).

3.3 Chosen Research Methodology

For any study to be successful and meet its objectives, the proper research methodology needs to be chosen. Figure 11 presents the Salkind (2009) guide, a method to aid in the choosing of a research methodology.

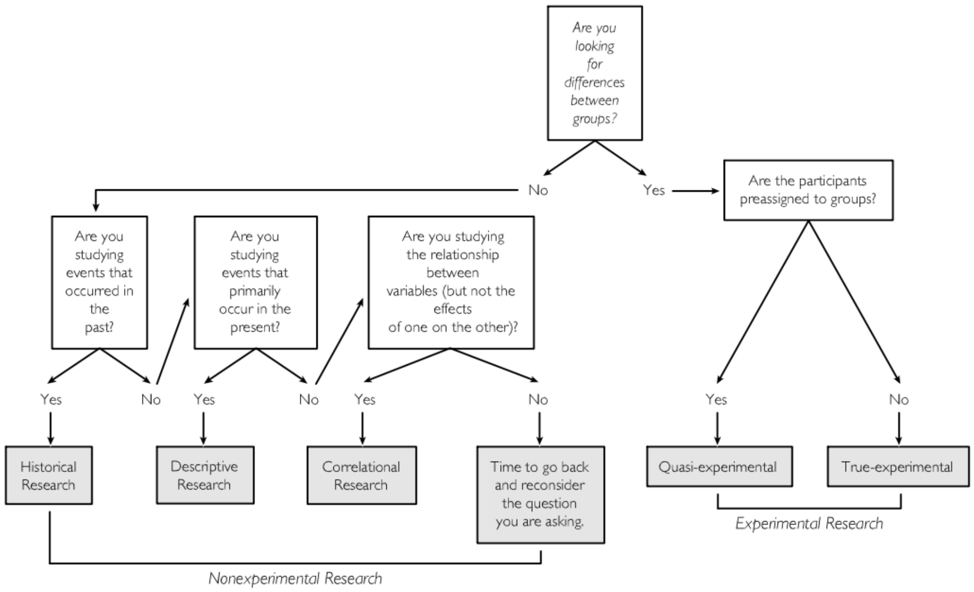


Figure 11 – Choosing a Research Methodology (Salkind, 2009)

The purpose of the study was to explore and uncover perceptions of adoption of greywater reuse systems in hotels in Abu Dhabi to provide insight as to whether they would be interested in adopting greywater systems. Doing literature and historical research would not fit the purpose intended for the study since only analysis and data from the past is used to deduce current and future events. Experimental research is applicable in controlled environments and for the purposes of this study, this type of research would not meet the intended purpose (Salkind, 2009).

Reviewing the various research papers on greywater adoption while bearing in mind the Salkind framework to choose a methodology, the most appropriate research methodology for the purposes of this study is descriptive research using surveys. Descriptive research is a research method that aims to describe the characteristics of a population. In the case of this study, the population is hotel professionals in Abu Dhabi and the purpose is to gauge their willingness to adopt greywater reuse in their hotels. Descriptive research has various advantages also including ease of data collection, obtaining unbiased data since the respondents are in their natural environment, and it is also a cost-effective method (Creswell, 2018).

Common tools that are used in descriptive research are surveys. According to Creswell (2018), surveys are instruments that collect information from a sample in an effort to describe and predict attitudes and behaviors (Creswell, 2018). To support the objectives of the study and in line with previously conducted research in this area, a survey was designed around the posed research questions to gather data and provide insights. The overall research methodology hence consisted of various phases including the conducting of an extensive literature review, designing a survey, identification of sample, survey distribution, result analysis, and providing recommendations/conclusions. This process is further detailed in Figure 12.

Figure 12 – Study Methodology Steps

3.4 Survey Design

The survey was design in accordance with the guidelines of the Organization for Economic Cooperation and Development specific to survey design. The 6-step survey design process is summarized in Figure 13 (OECD, 2012).

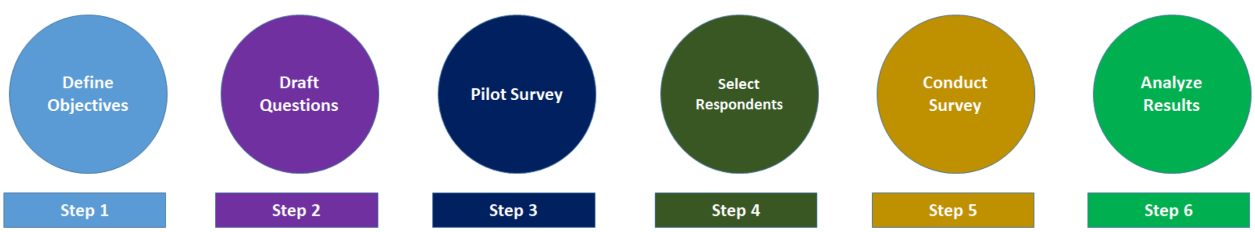


Figure 13 – OECD Survey Development Process (OECD, 2012)

Further to the OECD Survey design process, the American Association for Public Opinion Research (AAPOR) advises researchers to consider 12 criteria to ensure the quality of survey research. These criteria are presented in Table 5.

Table 5: AAPOR Criteria (AAPOR, 2019)

	AAPOR Criteria
1	Have a Specific Goal
2	Consideration Of Alternative Data
3	Samples Represent Population
4	Designs That Balance Cost With Errors
5	Format Simple
6	Pretest Of Questionnaires
7	Training Of Interviewers
8	Quality Checks At Each Stage
9	Ethical Approval Or Clearance
10	Use Of Appropriate Statistical Tools
11	Confidentiality
12	Disclose Methods For Evaluation And Replication

The survey was designed with close ended questions which allow for the standardization of the responses (Fink, 2002). The survey was also designed with time in mind with a target completion of no more than 5 minutes.

Although questions could have been drafted around the hypotheses, it was more important to find a scientific approach to ensure that the chosen factors impacting human behavior are the ones the study needs to explore. Icek Ajzen argued that behaviour is a function of three factors, attitudes, subjective norms, and perceived behavioural controls which can lead to an intention and evidently a behavior (Ajzen, 1985). Ajzen (1985) divided this three different dimensions, behavioral beliefs, normative beliefs, and control beliefs. Attitudes look at what a person might think about something specific in the case of our study greywater adoption. Subjective norms look at what others might think and in the case of this study this could include hotel guests, managers, and other stakeholders. Lastly, perceived behavioral controls look at whether the person believes that this can actually be done. The design of the survey is essential to the success of the study. This theory has been widely used to conduct behavioral questionnaires. Ajzen's theory is presented in figure 14.

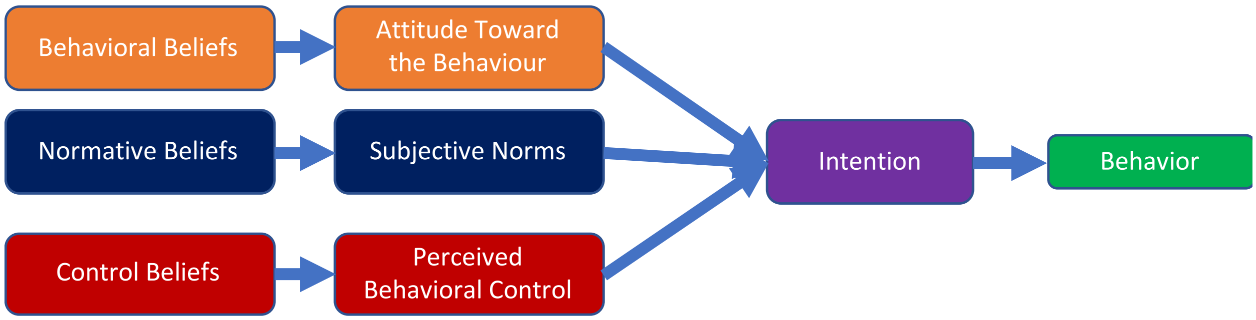


Figure 14 – The Theory of Planned Behavior (Ajzen, 1985)

Based on this model, 7 main factors or variables were identified to support in the answering of the research questions and testing of the posed hypotheses including perception of greywater by manager, perception of greywater by customers, environmental impact, additional cost, cost savings, government support, and risk.

The survey was divided into 9 sections. Sections 1 to 8 answered questions pertaining to the research while section 9 collected demographic information. Sections 2 to 5 were tailored to the factors mentioned earlier and broken down as shown in table 6.

Table 6: Survey Question Breakdown

Survey Section	Question Range	Number of Questions
Perception of Management	1-2	2
Perception of Customers	3-4	2
Environmental Impact	5-6	3
Additional Cost	7-8	3
Cost Savings	9-11	2
Government Support	12	1
Risk	13-16	4
Behavior	17-18	2
Background	19-30	12
	Total	30

Questions were mostly multiple choice and answers were presented on a five-point Likert scale. A Likert scale is a psychometric measure of attitudes and opinions where statements are provided with degrees of agreement and disagreement (Likert, 1932). This is favorable in statistics since it unifies the data collection method. This makes data easier to analyze results and draw conclusions through different statistical analysis techniques. Likert scales are considered the most universal method for collecting survey data and hence are familiar to respondents. Although options for answers for questions that ask for behaviours or opinions could be endless, Likert scales give the uniformity that can narrow down the beliefs of respondents without impacting or swaying the results of the study (Suskie, 1996). For the purposes of this study and based on previous research, research answers ranged from Strongly Disagree to Strongly Agree.

The survey was designed and published electronically using Google Forms. Google Forms is a free tool that allows for the development of surveys, distribution, and tabulation of results easily. Data can also be exported in Microsoft Excel format and can be used directly in statistical software like IBM SPSS. A copy of the Survey can be found in Appendix A.

The survey was piloted with five respondents to ensure that technical language is removed and that the survey would be understood by respondents. Updates were made based on the pilot and an introductory note was added to define the purpose of the survey. Respondents were informed through the survey that there was no risk to them completing the survey and that all data will be held confidential.

3.5 Population and Sampling

One of the first steps to conduct a research study is to identify the population that is being studied. A population is defined as a group of potential participants whom the results of a study will be generalized upon. Sampling is taking a subset of the population who will actually be part of the experiment (Salkind, 2009). Babbie (1990) indicated that sampling is necessary because of time constraints and costs. Choosing a right sample size is imperative to the success of any study. The aim of sampling is to be able to infer the results of an experiment to a population (Salkind, 2009). The population N is assumed to be facilities, engineering, and operations professionals working within hotels in Abu Dhabi. With a total of 168 hotels, a population N of 168 professionals is assumed. To obtain a confidence level of 95% with a 5% margin of error and in accordance with the tables presented by Bartlett, Kotrlik, & Higgins (2001), the sample size is assumed to be 118 professionals. The Bartlett, Kotrlik, Higgins (2001) table is presented in shown in Appendix B.

3.6 Statistical Methods

Various statistical methods can be used to analyze data. This is dependent on the purpose of statistical analysis and the obtained data. Tests can be grouped under correlational, comparison of means, regression, and non-parametric. Correlational tests look for an association between variables. Some examples include the Pearson test and Chi-Square test. The Comparison of means test looks at the difference between the means of variables. Examples of this include the paired and independent T-test. Regression assesses the dependency between variables and whether or not changes in one variable can predict or elicit a behavior in another namely the independent and dependent variables. Examples of this include simple and multiple regression. Lastly non-parametric tests are used when data does not meet the requirements for parametric tests. Examples include the Wilcoxon-Rank Sum Test and Sign Test. Based on the explained types of statistical analyses, the recommended statistical method to be used in this study to analyze the respondent data was regression analysis. The study aims to identify the relationship between different factors, the independent variables, and the adoption of greywater in existing and new hotels. Since the study aims to identify the relationship between two variables in terms of predicting the outcome of one from the other. Goldberg & Cho (2010) also argued that regression analysis should be used when researchers are trying to identify and test the relationship between different variables namely the independent and dependent variables (Goldberg, & Cho, 2010). The dependent variable is the variable that a researcher tries to understand or predict while the independent variable includes the factors that the researcher hypothesizes may have an impact on the dependent variable (Goldberg, & Cho, 2010). In the case of this study, the hypotheses look at the adoption of greywater in hotels. This is considered the dependent variable. The independent variables are perception, environmental impact, cost, and risk to using greywater as defined in the posed hypotheses.

As mentioned earlier the survey and interviews were designed using the Theory of Planned Behaviour (Ajzen, 1985). Examining this theory and based on the objectives of the research study, the independent variables were further expanded to explore the perception of management, perception of customers, perception of impact on the environment, cost savings, additional cost, government support, and risk of greywater adoption.

Table 7 summarizes the dependent and independent variables.

Table 7: Variables

Independent Variables	1. Perception of Management 2. Perception of Customers 3. Government Support 4. Environmental Impact 5. Cost Savings 6. Additional Cost 7. Risk of Greywater Adoption
Dependent Variable	Greywater Adoption

As presented in table 6, the survey was broken down into 30 questions between variable specific and demographic questions. This means that although the responses with yield 30 responses, the responses need to be grouped to be able to identify the variables that can be tested. A method to conduct this is Exploratory Factor Analysis (Fabrigar et al, 1999). Fabrigar et al (1999) conducted a study to evaluate the use of exploratory factor analysis in psychological research and found it to be a rather effective method to reduce large data sets but also highlighted that proper use of EFA in statistical analysis was vital to the success of any study. A similar study was conducted to gauge water perception in South Africa by Adewumi et al (2010) who also used exploratory factor analysis and regression analysis to successfully analyze the results of the study. The method will be used to analyze and decrease the number of variables if applicable creating a final data subset that will be used in the regression analysis. Exploratory Factor Analysis and Regression Analysis will be further explained Chapter 4 and procedures will be highlighted. Both exploratory factor analysis and regression analysis will be conducted using SPSS software.

3.7 Data Collection Procedures

The survey was sent to 118 hotels via email using Google Forms. Follow up calls were made to increase the number of respondents. The survey received 36 responses yielding a response rate of 30%. The survey was distributed electronically via the internet. Electronic surveys were provided in English through "Google Forms" and distributed to the respondents via email notifications to complete the survey. The survey distribution strategy included face to face visits to hotels in Abu Dhabi, electronic mailing, and electronic searching via popular social media website linked-in to maximize the respondent rate. The survey was distributed to professionals working in hotels in various fields including management, operations, engineering, and facilities management. The survey was completely optional and that there was no risk to the respondents. Constant follow ups were made with the attained contacts regarding the survey status.

UAE.

3.8 Assumptions

Assumptions are an important part of any research study. Assumptions are statements that are presumed true for a specific purpose. The study aims to gauge perceptions and adoption of greywater in hotels in Abu Dhabi. The study assumes the following:

1. Respondents i.e., hotel professionals have knowledge of the subject prior to engaging in the survey.
2. All responses will be answered in an honest manner.

3. The relationships between the independent and dependent variables are linear
4. Respondents have knowledge in environmental practices and sustainability policies in their hotel
5. Respondents are hotel professionals that work in management and operations positions who are inclined to answer the survey.

These assumptions create a basis for the data analysis which is conducted in Chapter 4.

3.9 Chapter Summary

Chapter 3 described the methodology employed in this research study and rationale for selection reviewing various and similar research studies to support the decision. The study employed a quantitative design using descriptive research where data was collected from hotel professionals in Abu Dhabi to gauge the interest and factors in adoption of greywater treatment methods in their hotels. The research tool that was used was a survey that was designed around the theory of planned behavior developed by Ajzen (1985) to identify the relationship between intent factors and human behavior. The chapter also reviewed the various available statistical methods and presented rationale for the selection of exploratory factor analysis to reduce the number of variables of a large data set, and regression analysis to identify relationships between the dependent and independent variables identified in the chapter.

Chapter 4 presents in detail the data and conducted analysis in line with the chosen research methodology. It presents the survey results first and then the analysis of the variables through the testing of the research hypotheses.

Chapter 4: Results and Discussion

4.1 Introduction

This chapter begins with the data analysis and findings of the conducted survey presented in Chapter 3. This is followed by a presentation of the data and findings for greywater adoption while also presenting demographic information of the respondents. The numerical results and data were gathered and organized in accordance with the processes defined in Chapter 3.

The Chapter presents survey results, analysis, hypothesis testing, and a discussion of the obtained results that is reviewed against related literature.

4.2 Survey Results

4.2.1 Introduction

Of the 118 surveys sent, 36 were returned and all were considered valid. This provided for a response rate of 30%. Michael Hamilton (2009) saw that online survey response rates averaged at 32.52% where the median survey response rate was 26.45% (Hamilton, 2009). The data Hamilton (2009) analyzed spanned 199 surveys with a total of 523,790 invitations sent to potential respondents. Based on these findings the 30% response rate for the survey is deemed acceptable for the study. It is worth noting that receiving additional survey responses was a challenge due to the ongoing Covid-19 pandemic. Various hotels which are considered part of the main population were either closed for commercial reasons, managed by the government as quarantines locations or did not allow for access for face-to-face administration of the survey.

4.2.2 General Information

In terms of gender 80.6% were male professionals and 19.4% were female professionals as highlighted in figure 15.

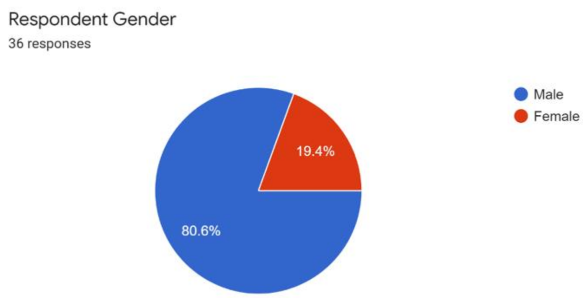


Figure 15 – Gender

The Age Range was divided into three categories as presented in Figure 16.

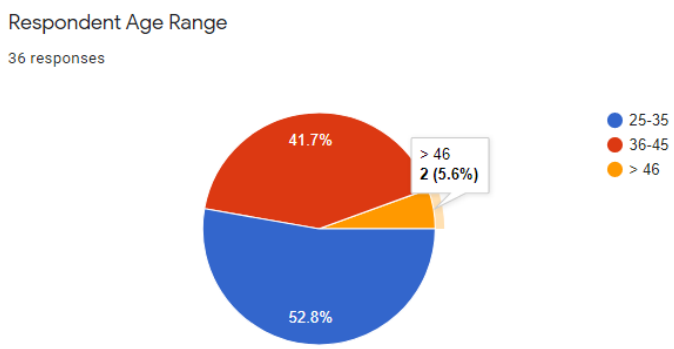


Figure 16 – Age Range

Most professionals were in the 25-35 year old category at 52.8% of respondents. 41.7% of respondents identified themselves mostly as operations staff while 27.8% identified themselves as management, and 27.8% identified themselves as engineering, as presented in figure 17.

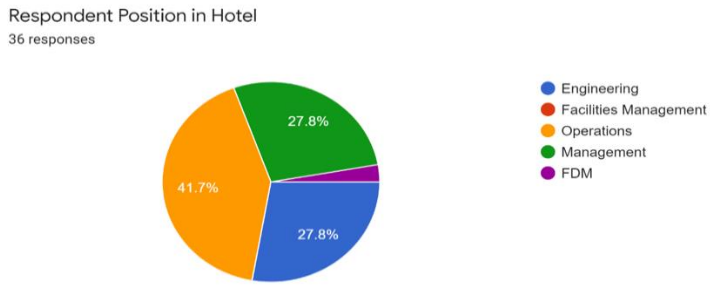


Figure 17 – Respondent Departments

In terms of hotel types, 58.3% of hotels were buildings where 41.7% were resorts as presented in Figure 18.

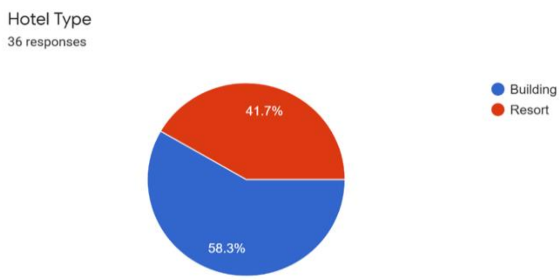


Figure 18 – Hotel Types

All respondents were from 4- and 5-star hotels where 38.9% were from 4-star hotels, and 61.1% were from resorts as presented in Figure 19. Hotels of lower than 4 stars did not respond to the survey.

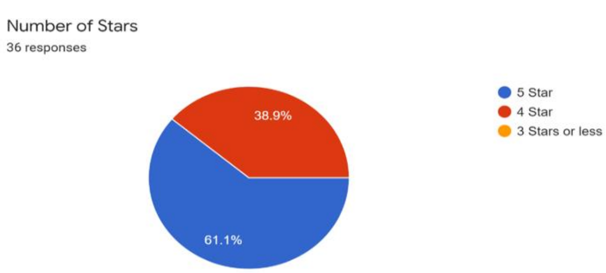


Figure 19 – Hotel Classification

In terms of hotel facilities, 100% of the hotels that conducted the survey had swimming pools while only 47.2% identified themselves as ones with landscaping as highlighted in figure 20. Typically, hotels that are classified as resort have landscaping and irrigation requirements.

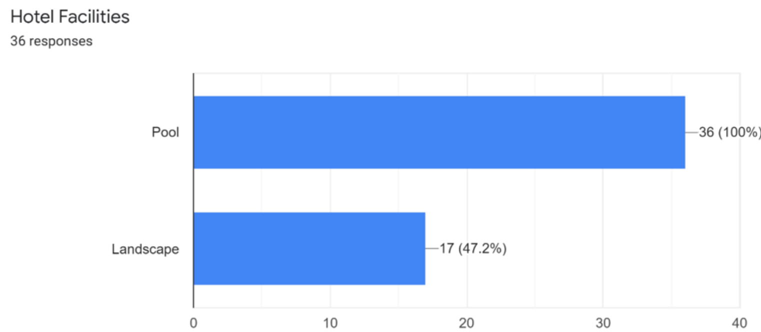


Figure 20 – Hotel Facilities

100% of all hotels who responded were from Abu Dhabi city. Hotels in Al Ain and the Western Region did not respond to the survey. This is presented in figure 21.

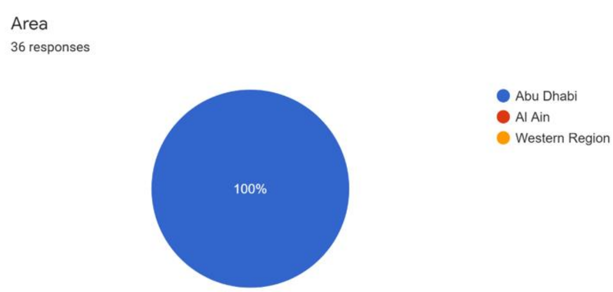


Figure 21 – Hotel Location

In terms of water bill, 27.8% was in the 25,000-50,000 AED per month range, and 25% was in the 50,000-75,000 AED range per month. 27.8% of respondents did not know this information while the rest was divided amongst the other categories as presented in figure 22.

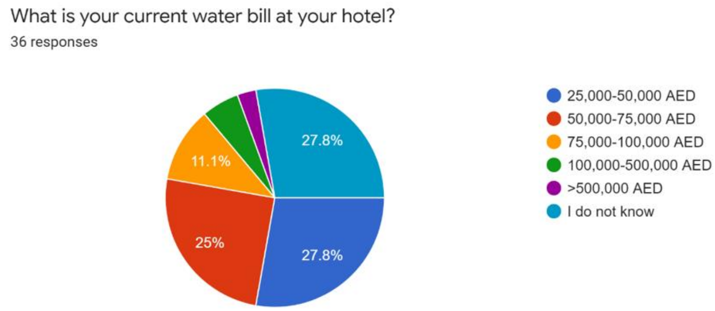


Figure 22 – Water Bill

It is worth noting that prior to the conducting of the survey, 77.8% or respondents were already familiar with greywater while 22.2% were not familiar. This is shown in figure 23.

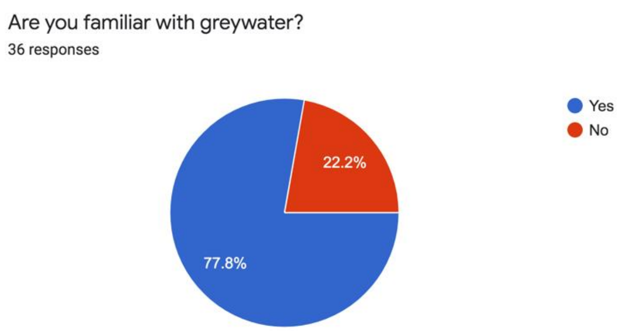


Figure 23 – Previous Knowledge of Greywater

In terms of greywater applications 55.66% of respondents expressed their willingness to use greywater for irrigation purposes while 77.8% expressed interest to use it in toilet flushing. 8.3% said they would be willing to use greywater for laundry while 2.8% were willing to use treated greywater for showers. This is presented in figure 24.

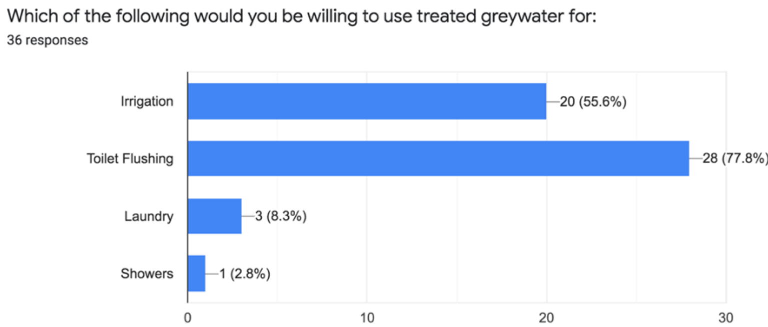


Figure 24 – Greywater applications

Based on the responses also, only 6 hotels out of the 36 mentioned that they currently use water recycle systems in their hotels as highlighted in figure 25.

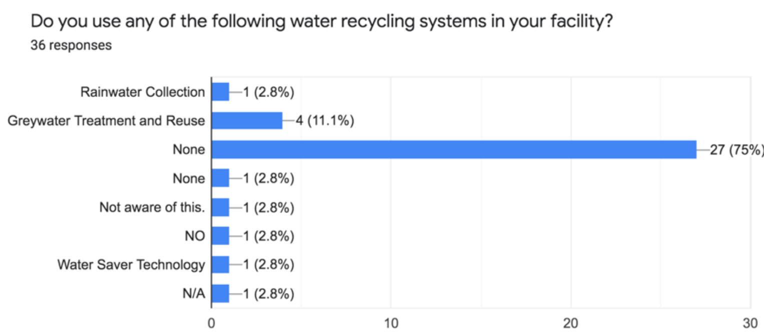


Figure 25 – Existing Water Recycling Systems

4.2.3 Survey Main Question Responses

The survey was designed around the theory of planned behavior and so certain behaviors have been identified as the independent variables. This section presents the responses received from the respondents.

4.2.3.1 Perceptions of Management

The responses presented in Figures 26 and 27 gauge the perceptions of management regarding greywater. Hotel management agreed that implementing a greywater system would relieve strain on fresh water supplies. The second question examined what hotel professionals perceived regarding customer preferences in terms of using greywater in their hotels. The results varied as presented in figure 27 where 47.2% were neutral i.e., respondents were not sure of what customers may think while equally 47.2% agreed that guests would act favorably to this.

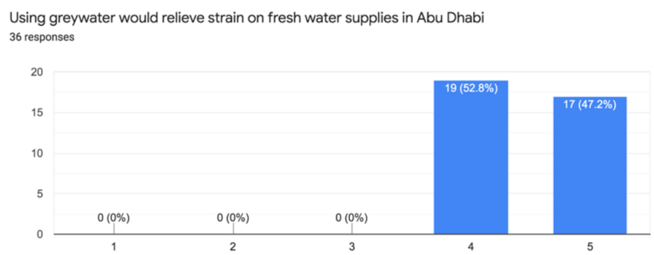


Figure 26 – Perception of Management 1

Figure 27 – Perception of Management 2

4.2.3.2 Perceptions of Customers

The responses presented in Figures 28 and 29 gauge the perceptions of customers regarding greywater. Hotel management were divided in terms of what customer perceptions would be as 55.6% of respondents felt neutral regarding customer perception while 36.1% felt that customers would be environmentally savvy and would welcome this.

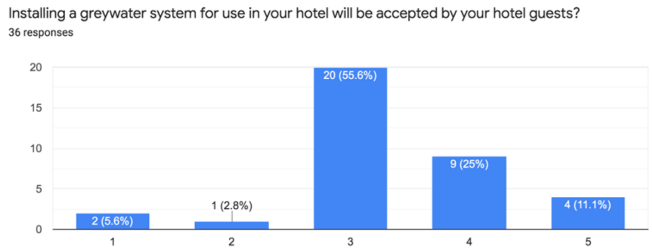


Figure 28 – Perception of Customers 1

The second question aims to gauge the perception guests may have being that this is an environmental initiative. 61.1% of respondents agreed that this would have a positive impact while 25% strongly agreed. 13.9% felt neutral.

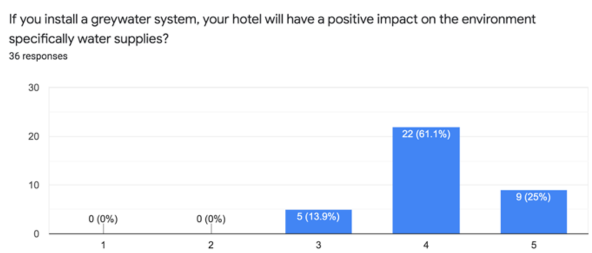


Figure 29 – Perception of Customers 2

4.2.3.3 Environmental Impact

In terms of environmental impact and as presented in figure 30, 88.9% of respondents strongly agreed to their hotel being environmentally responsible while 8.3% agreed and 2.8% were neutral. This shows how hotel professionals perceive their day-to-day operations from an environmental perspective.

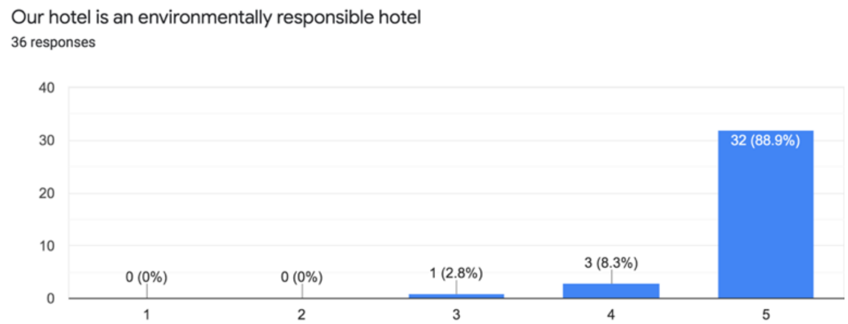


Figure 30 – Environmental Impact 1

Figure 31 examined the perceptions of hotel professionals if the environmental benefits outweighed the cost to install a new or retrofit a greywater system. The results showed the 47.2% were neutral while 50% were in agreement to the statement. This shows how divided the respondents were and that when cost becomes a factor, decisions could be immediately impacted.

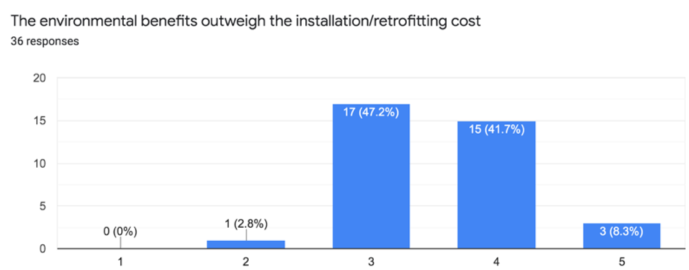


Figure 31 – Environmental Impact 2

4.2.3.4 Additional Cost

The next factor that was gauged was additional cost. Respondents were asked about the cost of retrofitting and whether they thought the cost of operations and maintenance would be higher that existing operations. This is presented in figures 32 and 33 respectively. 77.8% of respondents believed the cost to be high while 22.2% remained neutral on the topic. Although the awareness on greywater is considered high, the actual cost depending on the system may be affordable. This will be further looked at in the discussion.

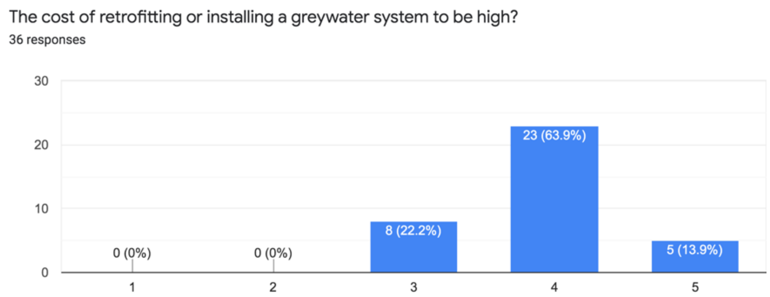


Figure 32 – Cost 1

Additionally, and as highlighted in figure 33, 86.1% of respondents believed that operational and maintenance cost would increase. Cost is typically a major factor in proceeding with new projects and is a crucial element in any business case.

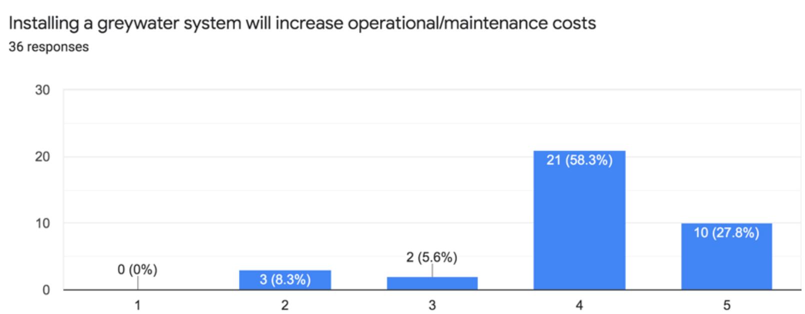


Figure 33 – Cost 2

4.2.3.5 Cost Savings

Cost savings was also identified as a factor that may impact the behavior of adoption. 88.9% of respondents felt that greywater reuse can provide significant savings on the hotel water bill as highlighted in figure 34.

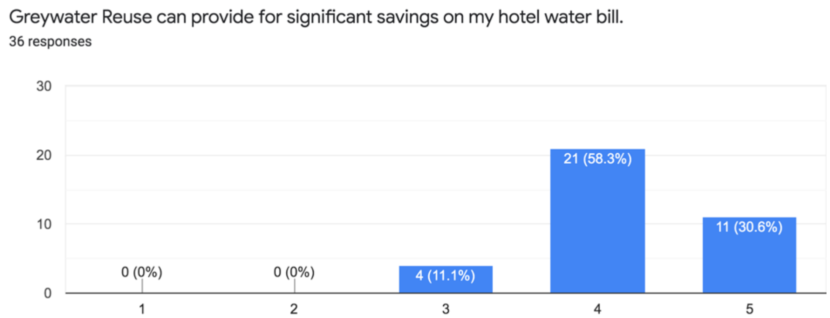


Figure 34 – Cost Savings 1

Additionally, 44% mentioned that they would be willing to recommend a greywater system if the savings were at 30% on current bills whole 33.3% would recommend the same at 20% savings. Savings were not a factor for 13.9% meaning that 13.9% felt that they would either be willing to do this for other purposes or not do it at all. Further research could be conducted to examine this.

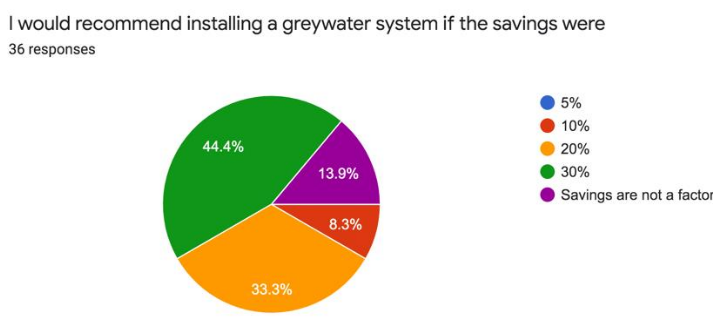


Figure 35 – Cost Savings 2

4.2.3.6 Government Support

The next variable was government support. The Abu Dhabi government is known to provide incentives for various initiatives to conserve the environment. This question aimed at seeking whether hotel professionals felt that a government incentive program to install a greywater system would increase their willingness to adopt greywater. As presented in figure 36, 83.3% of respondents felt that a government incentive program would positively impact their decision to adopt greywater. 8.3% were neutral while 8.3% disagreed and did not feel that a government incentive program would impact their decision.

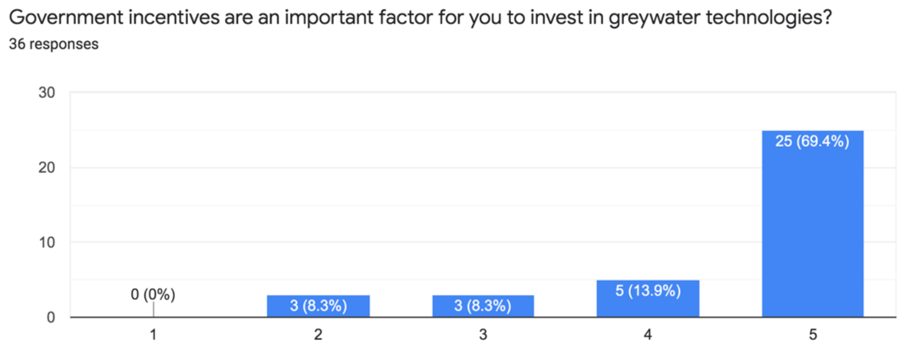


Figure 36 – Responses

4.2.3.7 Risk

Risk is an important element in decision making (Gigerenzer, 2015) and this is why a number of questions were devised to measure this. Respondents were asked if treated greywater was safe to use in their hotels. Although 63.9% we in agreement as shown in figure 37, 36.1% were either neutral or did not agree as presented in figure 37.

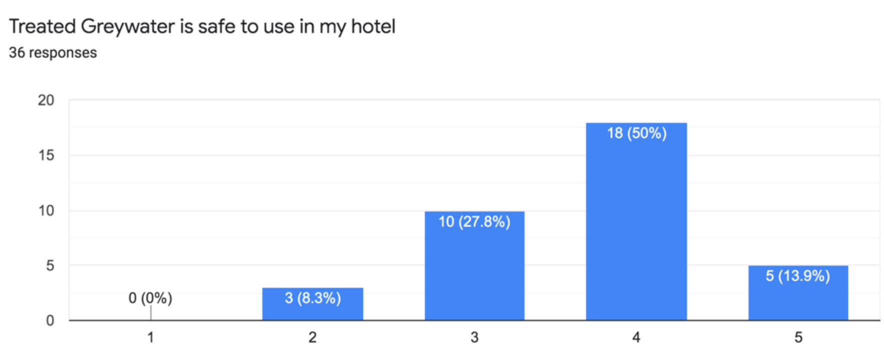


Figure 37 – Risk 1

Another question was asked regarding cleanliness of greywater. 55.5% of respondents agreed while 45% were either neutral or in disagreement as presented in figure 38. Cleanliness in hotels is the one of the first things that hotel guests look for in a hotel and so this could be a variable that impact decisions to adopt.

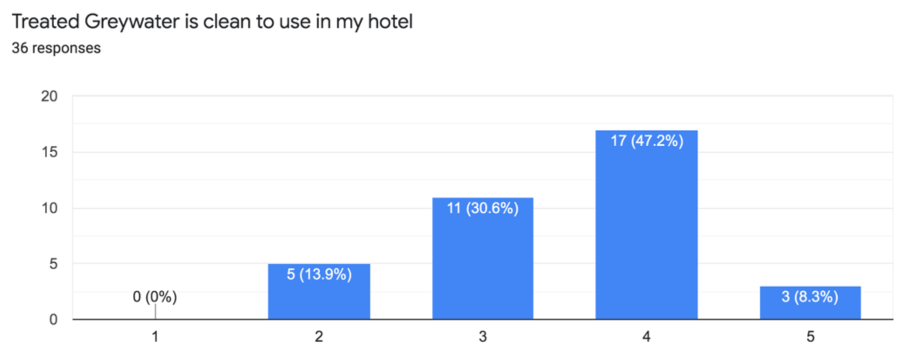


Figure 38 – Risk 2

The survey also directly asked whether the respondents felt that using greywater in their hotels would come with a risk. 44.4% responded neutrally to the question while 27.8% agreed as presented in figure 39.

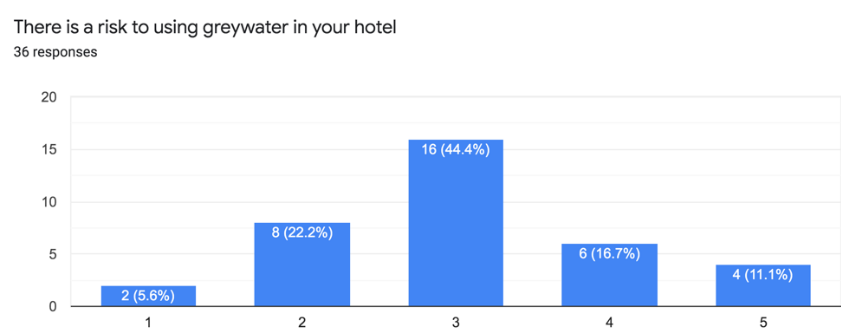


Figure 39 – Risk 3

Per the literature presented, greywater is typically known to be reused for irrigation purposes and so a question was added in this regard and grouped under risk. As presented in figure 40, 11.2% only agreed that the landscaping could be damaged by greywater while 38.9% felt neutral. 50% felt that landscaping would not be damaged.

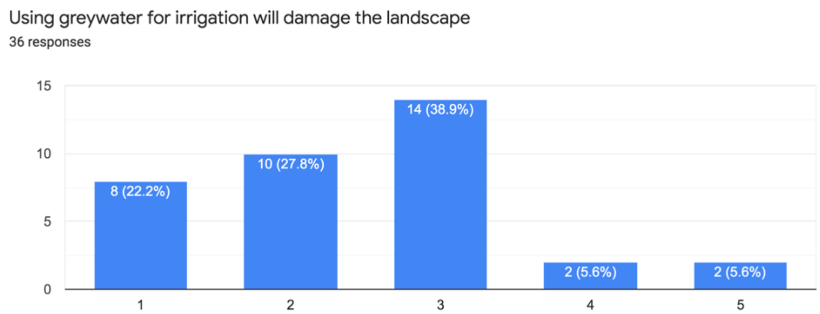


Figure 40 – Risk 4

4.2.3.8 Greywater Adoption

The final variable in accordance with the theory of planned behavior is the expected behavior. The main question the study aims to answer is whether hotels will be willing to adopt greywater in their hotels. Two questions were asked in this regard, one to gauge whether hotel professionals would be interested in adopting greywater in existing hotels and another to gauge whether they would be willing to adopt greywater in new hotels i.e., ones that are yet to be constructed. This is highlighted in figures 41 and 42 respectively.

In terms of adoption in existing hotels, 50% of respondents remained neutral while 30.5% expressed that they would be willing to adopt greywater in their existing hotels.19.4% disagreed.

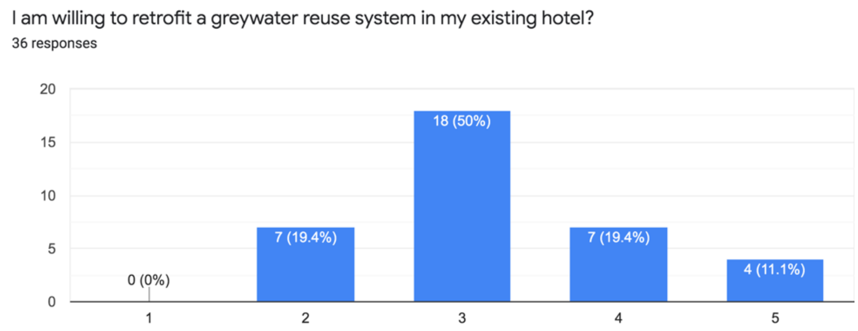


Figure 41 – Adoption in Existing Hotels

In terms of adoption in new hotels, the results we significantly different where 86.1% expressed their willingness to adopt greywater in the designs of new hotels. 5.6% of respondents remained neutral while only 8.4% disagreed.

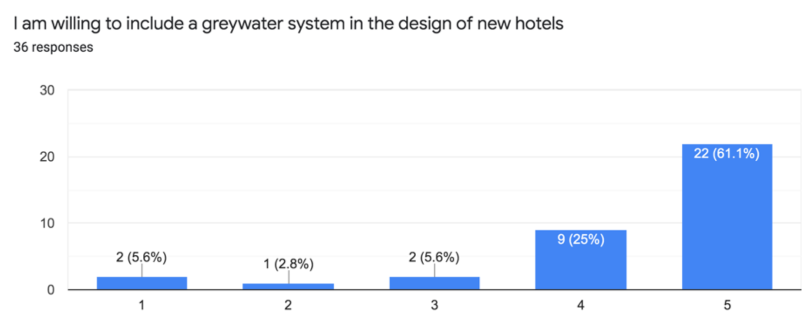


Figure 42 – Adoption in New Hotels

The survey results provide a perspective from hotel professionals regarding the adoption of greywater. It is clear that although they had some concerns in areas of safety and cleanliness, however, the data presented showed that the environment seemed to be a major factor for them. The data also shows clearly that there is a willingness and openness amongst hotel professionals working in hotels in Abu Dhabi to adopt greywater more so in new hotels.

Next the data needs to be analyzed to identify relationships between the identified variables to allow the testing of the research hypotheses to allow for the answering of the posed research questions. This analysis and results are further detailed in section 4.3.

4.3 Analysis and Results

This section presents the detailed analysis that was conducted on respondent data. The data was first organized and prepared for analysis. An exploratory factor analysis was then conducted according to the research methodology and then regression analysis conducted to test the hypotheses. The results of the hypotheses testing are then presented.

4.3.1 – Exploratory Factor Analysis

To be able to conduct the proper analysis, an exploratory factor analysis was first conducted using SPSS to reduce the number of variables. The survey had 15 main questions that represented 7 independent variables. The exploratory factor analysis technique as discussed in Chapter 3 can be used when there is a large number of variables to allow for further simplification of the variables to be able to proceed in testing hypotheses using regression analysis (Finch, 2019).

Table 8: Variables Based on Survey Questions

Correlation Matrix

		Perception of Management	Perception of Management	Perception of Customers	Perception of Customers	Environmental Impact	Environmental Impact	Additional Cost	Additional Cost	Cost Savings	Cost Savings	Government Support	Risk	Risk	Risk	Risk
Correlation	Perception of Management	1.000	.137	.203	.191	.048	.045	.226	.209	.515	-.126	.317	.288	.300	-.105	.128
	Perception of Management	.137	1.000	.356	.233	-.219	-.023	-.034	.045	-.017	.091	.198	.223	.271	-.100	-.051
	Perception of Customers	.203	.356	1.000	.579	-.170	.193	-.205	.012	-.066	.160	.180	.325	.475	-.583	-.495
	Perception of Customers	.191	.233	.579	1.000	.060	-.081	.025	.154	.163	.190	.295	.403	.489	-.407	-.500
	Environmental Impact	.048	-.219	-.170	.060	1.000	.075	.177	.023	.213	.258	.224	.121	.040	.147	-.048
	Environmental Impact	.045	-.023	.193	-.081	.075	1.000	-.023	-.404	.139	.011	-.080	.156	.097	-.242	.042
	Additional Cost	.226	-.034	-.205	.025	.177	-.023	1.000	-.162	.196	-.346	.358	.466	.364	-.083	.234
	Additional Cost	.209	.045	.012	.154	.023	-.404	-.162	1.000	.034	.154	-.067	-.353	-.164	.262	.036
	Cost Savings	.515	-.017	-.066	.163	.213	.139	.196	.034	1.000	-.026	.089	.286	.190	.115	-.132
	Cost Savings	-.126	.091	.160	.190	.258	.011	-.346	.154	-.026	1.000	-.326	-.333	-.142	.090	-.293
	Government Support	.317	.198	.180	.295	.224	-.080	.358	-.067	.089	-.326	1.000	.713	.663	-.478	.133
	Risk	.288	.223	.325	.403	.121	.156	.466	-.353	.286	-.333	.713	1.000	.884	-.581	-.197
	Risk	.300	.271	.475	.489	.040	.097	.364	-.164	.190	-.142	.663	.884	1.000	-.682	-.250
	Risk	-.105	-.100	-.583	-.407	.147	-.242	-.083	.262	.115	.090	-.478	-.581	-.682	1.000	.308
	Risk	.128	-.051	-.495	-.500	-.048	.042	.234	.036	-.132	-.293	.133	-.197	-.250	.308	1.000

Table 9: KMO and Bartlett Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.601
Bartlett's Test of Sphericity	Approx. Chi-Square	252.834
	df	105
	Sig.	.000

A KMO and Bartlett test of 0.6 or higher provides for better adequacy in the results (Mijiko, 2017). To increase this measure, the diagonal of the matrix must be examined and values below 0.5 can be excluded and the simulation can be run again. After removing the first “Environmental Impact” factor and running the simulation factor, the KMO and Bartlett test yielded an adequacy of 0.644 which is considered adequate for the purposes of this study.

Table 10: Anti Image Matrices

Anti-image Matrices

		Perception of Management	Perception of Management	Perception of Customers	Perception of Customers	Environmental Impact	Environmental Impact	Additional Cost	Additional Cost	Cost Savings	Cost Savings	Government Support	Risk	Risk	Risk	Risk
Anti-image Covariance	Perception of Management	.477	.003	-.132	.028	.002	.037	-.058	-.096	-.263	.009	-.021	.000	.001	.021	-.126
	Perception of Management	.003	.654	-.112	.009	.198	-.021	.009	-.026	.039	-.154	-.068	-.035	.002	-.136	-.027
	Perception of Customers	-.132	-.112	.301	-.117	.035	-.119	.085	-.016	.116	.004	.002	.011	-.026	.052	.109
	Perception of Customers	.028	.009	-.117	.443	.017	.057	-.055	-.109	-.051	-.095	-.032	-.027	.015	.014	.077
	Environmental Impact	.002	.198	.035	.017	.481	-.156	-.098	-.057	.019	-.230	-.156	-.026	.034	-.122	.102
	Environmental Impact	.037	-.021	-.119	.057	-.156	.533	.072	.125	-.133	.018	.135	-.027	.019	.123	-.176
	Additional Cost	-.058	.009	.085	-.055	-.098	.072	.547	.027	.018	.080	.074	-.038	-.029	.007	-.105
	Additional Cost	-.096	-.026	-.016	-.109	-.057	.125	.027	.485	-.033	.083	-.041	.099	-.083	-.061	.002
	Cost Savings	-.263	.039	.116	-.051	.019	-.133	.018	-.033	.447	-.032	.014	-.038	.005	-.094	.118
	Cost Savings	.009	-.154	.004	-.095	-.230	.018	.080	.083	-.032	.454	.064	.084	-.083	.024	.022
	Government Support	-.021	-.068	.002	-.032	-.156	.135	.074	-.041	.014	.064	.230	-.049	.002	.096	-.137
	Risk	.000	-.035	.011	-.027	-.026	-.027	-.038	.099	-.038	.084	-.049	.083	-.073	-.017	.043
	Risk	.001	.002	-.026	.015	.034	.019	-.029	-.083	.005	-.083	.002	-.073	.118	.057	-.016
	Risk	.021	-.136	.052	.014	-.122	.123	.007	-.061	-.094	.024	.096	-.017	.057	.274	-.080
	Risk	-.126	-.027	.109	.077	.102	-.176	-.105	.002	.118	.022	-.137	.043	-.016	-.080	.346
Anti-image Correlation	Perception of Management	.560[a]	.005	-.350	.060	.004	.073	-.114	-.199	-.568	.019	-.063	-.001	.006	.057	-.311
	Perception of Management	.005	.499[a]	-.252	.017	.353	-.036	.014	-.046	.071	-.282	-.175	-.152	.007	-.321	-.058
	Perception of Customers	-.350	-.252	.694[a]	-.320	.092	-.296	.211	-.042	.316	.012	.007	.068	-.138	.180	.339
	Perception of Customers	.060	.017	-.320	.816[a]	.037	.116	-.112	-.236	-.115	-.212	-.100	-.140	.064	.041	.197
	Environmental Impact	.004	.353	.092	.037	.252[a]	-.309	-.190	-.117	.041	-.492	-.468	-.129	.144	-.335	.249
	Environmental Impact	.073	-.036	-.296	.116	-.309	.296[a]	.133	.246	-.273	.036	.385	-.129	.076	.321	-.409
	Additional Cost	-.114	.014	.211	-.112	-.190	.133	.738[a]	.052	.037	.160	.209	-.179	-.116	.017	-.241
	Additional Cost	-.199	-.046	-.042	-.236	-.117	.246	.052	.451[a]	-.071	.177	-.122	.494	-.348	-.167	.005
	Cost Savings	-.568	.071	.316	-.115	.041	-.273	.037	-.071	.432[a]	-.071	.044	-.198	.020	-.270	.300
	Cost Savings	.019	-.282	.012	-.212	-.492	.036	.160	.177	-.071	.442[a]	.199	.432	-.358	.067	.055
	Government Support	-.063	-.175	.007	-.100	-.468	.385	.209	-.122	.044	.199	.632[a]	-.355	.010	.383	-.486
	Risk	-.001	-.152	.068	-.140	-.129	-.129	-.179	.494	-.198	.432	-.355	.665[a]	-.737	-.110	.256
	Risk	.006	.007	-.138	.064	.144	.076	-.116	-.348	.020	-.358	.010	-.737	.730[a]	.315	-.077
	Risk	.057	-.321	.180	.041	-.335	.321	.017	-.167	-.270	.067	.383	-.110	.315	.700[a]	-.259
	Risk	-.311	-.058	.339	.197	.249	-.409	-.241	.005	.300	.055	-.486	.256	-.077	-.259	.469[a]

a. Measures of Sampling Adequacy(MSA)

Further examining the Rotated Component Matrix presented in Table 11 shows that 5 factors have been identified in according to the simulation.

Table 11: Rotated Component Matrix

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
Perception of Management			.772		
Perception of Management					.790
Perception of Customers		.690			.538
Perception of Customers		.768			
Environmental Impact				-.880	
Additional Cost	.682				
Additional Cost				.755	
Cost Savings			.895		
Cost Savings	-.603				
Government Support	.819				
Risk	.824				
Risk	.728	.490			
Risk	-.495	-.544			
Risk		-.876			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Any factors that load in the rotated component matrix on more than one component can be excluded (Finch, 2019). This shows that the number of variables or factors can decrease by 6 variables. For factors that were considered and identified in multiple questions, the means of these questions were taken and used as one variable. In this case means were taken for the perception of management, additional cost, cost savings, and risk. Once the means were taken the exploratory factor analysis was executed in SPSS. Based on the final set of variables was identified in preparation for the regression analysis. The final set of variables identified in table 12 have been identified as sufficient for the testing of the hypotheses.

Table 12: Final Variables/Factors

Perception of Management (Mean)
Perception of Customers
Environmental Impact
Additional Cost (Mean)
Cost Savings (Mean)
Government Support
Risk (Mean)

4.3.2 – Regression Analysis

In the next step, a regression analysis was conducted to identify the any relationships and correlations between the independent variables and dependent variables. For each independent variable, the regression analysis was conducted through SPSS against each dependent variable. The dependent variable was greywater adoption with two dimensions, adoption in existing hotels and adoption in new hotels. The regression analysis details yielded various tables which were reviewed and analyzed. Table 13 summarizes the results obtained through the computer simulation. The complete details of the regression analysis can be found in Appendix C. When conducting a linear regression analysis, one of the most important factors is R^2 which is the correlation coefficient (Smith & Draper, 2011). R^2 statistically measures and explains the variance of a dependent variable that may be explained by the independent variable in the regression model. As mentioned previously in Chapter 3, regression was used because it measures that extent that one variable can impact another in this case the impact the identified independent variables (Smith & Draper, 2011). To further explain, an R^2 of 0.6 for instance means that 60% of the variation can be explained by the regression model.

The table also highlights the statistical significance of the variable. A p value of less than 0.05 is considered statistically significant.

Table 13: Variables and Statistical Results

Independent Variable	**Dependent Variable**	**Correlation (R^2)**	**Sig (p)**
Perception of Management	Adoption of Greywater in Existing Hotel	0.154	0.01
Perception of Customers		-0.017	0.531
Environmental Impact		-0.015	0.497
Additional Cost		-0.029	0.965
Cost Savings		-0.028	0.811
Government Support		0.142	0.013
Risk		0.105	0.03
Perception of Management	Adoption of Greywater in New Hotels	0.034	0.143
Perception of Customers		0.176	0.006
Environmental Impact		-0.019	0.561
Additional Cost		0.002	0.306
Cost Savings		-0.019	0.556
Government Support		0.131	0.017
Risk		-0.002	0.34

Looking at the first dependent variable, adoption of greywater in an existing hotel, Perception of Management, Government Support, and Risk had a p value of less than 0.05 and as such these three variables are considered statistically significant. The R^2 values of the three variables were 0.154, 0.142, and 0.105 respectively. Low R^2 values typically indicate lower correlation between the independent and dependent variables. This does not though imply that the statistical model is irrelevant. The reasons for low R^2 values can be attributed to various things. Abelson (1985) argued that the R^2 values regardless of how small can be significant and show a true relationship between variables. Abelson also added that lower values can indicate the need to further explore additional variables and can point researchers in the right direction to further exploring the variables in question in subsequent research (Abelson, 1985). In terms of adoption of greywater in new hotels, Perception of Customers and Government Support were considered statistically significant as their p values were less than 0.05. The R^2 values for the mentioned variables were 0.176 and 0.131 respectively. This shows that in new hotels the main factors to impact adoption are Customers and whether or not there will be government incentives. The results show lower R^2 values but are statistically significant to deduce a relationship between the independent and dependent variables. The possible reasons for the low R^2 values could be attributed to the survey respondents. The respondents were hotel employees from various backgrounds and so each of them may see greywater from their point of view. This could be a reason for the lower correlation. Another possible reason could be the wording used in the survey. The respondents may have not fully understood the survey questions which may have skewed the data. It is worth noting though that the statistical results provide for a path for future research opportunities.

4.4 Hypothesis Testing

Hypothesis testing determines the probability that a population parameter, such as the mean, is likely to be true. Hypothesis testing happens in four steps namely stating the hypotheses, setting the decision criteria, computing the test statistic and finally making the decision (Reid, 2013). The hypotheses were presented in Chapter 1 as an extension of the posed research questions and results of the testing are presented in this section.

4.4.1 – Hypothesis 1

The null hypothesis states that management perception will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.01 which is less than the assumed significance level of the study. Based on this result the null hypothesis can be rejected and it can be deduced that there is sufficient evidence to believe that perception management directly impacts adoption of greywater in existing hotels.

4.4.2 – Hypothesis 2

The null hypothesis states that customer perception will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.531 which is greater than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis deducing that customer perception does not have an impact on greywater adoption in existing hotels.

4.4.3 – Hypothesis 3

The null hypothesis states that having a positive impact on the environment will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.497 which is greater than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis deducing that environmental impact does not have an impact on greywater adoption in existing hotels.

4.4.4 – Hypothesis 4

The null hypothesis states that additional costs in installation, maintenance and operations will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.965 which is greater than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis and deduces that additional cost does not have an impact.

4.4.5 – Hypothesis 5

The null hypothesis states that cost savings in water bills will not have a positive effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.811 which is greater than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis deducing that cost savings do not have an impact on greywater adoption.

4.4.6 – Hypothesis 6

The null hypothesis states that government incentives will not have a positive effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.013 which is less than the assumed significance level of the study. Based on this result the study rejects the null hypothesis showing that there is significant evidence that government support and incentives have a positive impact on greywater adoption in existing hotels.

4.4.7 – Hypothesis 7

The null hypothesis states that higher perception of risk in will have no impact on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.03 which is less than the assumed significance level of the study. Based on this result the study rejects the null hypothesis showing that there is significant evidence that a higher perception of risk will have an impact on willingness to adopt greywater systems in existing hotels.

4.4.8 – Hypothesis 8

The null hypothesis states that management perception will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.143 which is higher than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis it can be deduced that management perception does not directly impact adoption of greywater in new hotels.

4.4.9 – Hypothesis 9

The null hypothesis states that customer perception will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.006 which is less than the assumed significance level of the study. Based on this result the study rejects the null hypothesis deducing that there is significant evidence that customer perception does have an impact on greywater adoption in new hotels.

4.4.10 – Hypothesis 10

The null hypothesis states that having a positive impact on the environment will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 12, the obtained p level is 0.561 which is greater than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis deducing that environmental impact does not have an impact on greywater adoption in new hotels.

4.4.11 – Hypothesis 11

The null hypothesis states that additional costs in installation, maintenance and operations will not have an effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.306 which is greater than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis and deduces that additional cost does not have an impact on greywater adoption in new hotels.

4.4.12 – Hypothesis 12

The null hypothesis states that cost savings in water bills will not have a positive effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.556 which is greater than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis deducing that cost savings do not have an impact on greywater adoption in new hotels.

4.4.13 – Hypothesis 13

The null hypothesis states that government incentives will not have a positive effect on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.017 which is less than the assumed significance level of the study. Based on this result the study rejects the null hypothesis showing that there is significant evidence that government support and incentives have a positive impact on greywater adoption in new hotels.

4.4.14– Hypothesis 14

The null hypothesis states that higher perception of risk in will have no impact on adopting greywater systems in existing hotels. The data for all respondents was gathered and analyzed through SPSS by conducting a regression analysis. Assuming a significance level p of 0.05 and referring to Table 13, the obtained p level is 0.34 which is higher than the assumed significance level of the study. Based on this result the study fails to reject the null hypothesis showing that there is no evidence that a higher perception of risk will have an impact on willingness to adopt greywater systems in new hotels.

4.5 Summary of Results

Table 14 summarizes the results of the hypothesis and summarizes the results of the hypothesis tests. It is worthy to note that the null hypothesis is tested in accordance with the statistical data in accordance with the significance or as previously highlighted the p-value.

Table 14: Hypothesis Test Summary

Hypothesis	p-Value	Significance p<0.5?	**Correlation (R^2)**	Result
H_o1	0.01	True	0.154	Reject Null Hypothesis, Data Favors alternative hypothesis
H_o2	0.531	False	-0.017	Data inconclusive
H_o3	0.497	False	-0.015	Data inconclusive
H_o4	0.965	False	-0.029	Data inconclusive
H_o5	0.811	False	-0.028	Data inconclusive
H_o6	0.013	True	0.142	Reject Null Hypothesis, Data Favors alternative hypothesis
H_o7	0.03	True	0.105	Reject Null Hypothesis, Data Favors alternative hypothesis
H_o8	0.143	False	0.034	Data inconclusive
H_o9	0.006	True	0.176	Reject Null Hypothesis, Data Favors alternative hypothesis
H_o10	0.561	False	-0.019	Data inconclusive
H_o11	0.306	False	0.002	Data inconclusive
H_o12	0.556	False	-0.019	Data inconclusive
H_o13	0.017	True	0.131	Reject Null Hypothesis, Data Favors alternative hypothesis
H_o14	0.34	False	-0.002	Data inconclusive

The data and results imply that for existing hotels, management perception, government support, and risk are major factors in identifying whether hotels would be willing to adopt greywater practices in Abu Dhabi while for new hotels the data suggests that only customer perception and government incentives are the main factors for adoption of greywater use in hotels in Abu Dhabi. The results though do show a consensus among hotel professionals that the environment is important to them personally and that their hotels should consider green initiatives on that basis. Further research can be conducted to further identify additional factors that can sway decisions of hotel professionals and hotels in Abu Dhabi alike.

4.6 Discussion

The data and analysis presented uncovered the perceptions of hotel professionals in Abu Dhabi in regard to adopting greywater in their hotels. Similar to Barake's (2016) study in South Africa, the research suggests that professionals are open to adopting and using greywater in their hotels whether existing or new. Additionally, the results showed that respondent age mostly ranged between 25 and 35 year of age. Barake's (2016) research indicated that younger respondents were more inclined to accept greywater than older ones. This also aligns with the results in this study. An important element to explore when it came to perception was where respondents would feel comfortable in using greywater. Maraqa and Ghoudi's (2015) survey which covered public perception in the UAE indicated that most respondents would be more inclined to use greywater even if treated for external use that does not come in contact physically with people. Lemee's (2019) study in France also showed that physical contact was a major factor in adoption of greywater. This confirms that results of this research study which showed that most respondents would only be mostly willing to use greywater for irrigation purposes and toilet flushing. This is also confirmed by Khong (2009) in their California survey. Respondents in this research study felt strongly towards government incentives to install and adopt greywater. Maraqa and Ghoudi's (2015) results also show that government incentives to decrease water consumption would be favorable.

As presented in the literature review, the cost of greywater systems can range significantly depending on the application (Cremona & Saliba, 2013). The research study suggests that there is not enough understanding regarding the actual cost of implementing greywater systems as most respondents felt that the setup and operations cost would be high. This was based more on beliefs than actual fact. It was interesting to note also that most hotels believed that they were environmentally responsible and that they took steps towards conserving the environment through their own internal programs to save water.

It is worth noting that most respondents agreed that greywater would relieve strain on water supplies in Abu Dhabi. The results are similar to those presented by Maraqa and Ghoudi (2015) whose respondents expressed that use of greywater could lead to water conservation. Examining the results, the study can now proceed to answer the research questions posed in Chapter 1. The first question as if hotel managers in Abu Dhabi were willing to adopt treated greywater usage in their hotels. The research and analysis indicate that hotel managers were willing to adopt greywater in their hotels bearing in mind customer perceptions, safety, and risk. In existing and new hotels, government incentives proved to be an important factor to greywater adoption. The research analysis also indicated that cost and savings also were of concern to hotel managers. The second research question gauged whether hotel professionals felt that customers would be willing to stay in hotels that use treated greywater. The survey data showed that hotel professionals felt mostly neutral about this as greywater may not be as well understood by their customers which can be associated with risk and fear of safety and cleanliness. This could be resolved through proper education and communication with customers. Lastly the third research question examined whether cost savings were an important factor in deciding whether to invest in greywater technologies in hotels in Abu Dhabi. The survey results showed that a combination of decreasing costs and increasing savings were of interest to hotel professionals. The survey data showed that a 20% to 30% savings was the criteria favored by most professionals in terms of savings. Government incentives in the form of savings to hotels would also be welcomed. This is also aligned with the research presented earlier. The hypotheses further tested the extent of the relationship between the identified independent and dependent variables and found clear relationships between perceptions of management, perceptions of customers, government incentives and risk as factors that have a direct impact on greywater adoption. Although cost was mentioned in the survey data, the hypotheses testing through the regression analysis proved inconclusive in regard to the additional cost and cost savings. Interestingly also, the research was also inconclusive in terms of the impact on the environment and greywater adoption in both existing and new hotels.

4.7 Chapter Summary

Chapter 4 presented and analyzed the results of the study presenting the results of the perceptions and adoption survey and highlighting the executed statistical methods including the exploratory factor analysis and regression analysis. The chapter also presented the statistical significance of the tested variables allowing and presented a detailed interpretation of the data and results. The chapter also conducted a detailed discussion of the results against related research answering also the posed research questions and summarizing the hypothesis results. The chapter built a basis for the recommendations and opportunities for future research which are presented in Chapter 5.

Chapter 5: Conclusions

5.1 Introduction

Protecting the environment to sustain natural resources specifically water has become in recent years one of the most important goals for countries and people alike. Businesses today have a responsibility to ensure that their environmental impact is minimized to ensure that resources are available and growing rather than diminishing for generations to come. The hospitality industry namely hotels are always looking for new ways to conserve water and environmental resources to minimize their impact on the environment. This has included towel reuse policies, installation of smart irrigation systems, and in some places around the world, using greywater as a means to conserve water. In the context of the UAE and based on the research and empirical data collected, most hotels in Abu Dhabi consider themselves environmentally responsible and based on the right criteria, these hotels would be willing to adopt greywater systems to minimize impact on fresh water supplies in Abu Dhabi. Similar studies like Maraqa & Ghoudi (2015) of Khong (2009) support the findings of this study and show that there is widespread acceptance for adopt greywater from a general perspective. This aimed to specifically examine the willingness of greywater adoption in hotels in Abu Dhabi examining the thoughts and ideas of hotel professionals in Abu Dhabi going a step further in the existing literature and concentrating on a specific sector. A survey was designed and distributed in accordance with the research methodology and results were tabulated and presented in Chapter 4. The results showed that management perception, government support, and risk to adoption were main factors when it came to adopting greywater in existing hotels in Abu Dhabi while for new hotels only customer perception and government support seemed to be the dominating and statistically significant factors. Although the research was inconclusive regarding certain factors, the study did provide sufficient information to answer the research questions. Hotel managers would be willing to adopt treated greywater technologies in their hotels bearing in mind certain factors as presented in the research. Hotel professionals seemed more neutral in their responses regarding the perception of customers and whether they would or would not want to stay in a hotel that uses treated greywater mainly because customers may not understand its impact on them. Finally cost albeit inconclusive was mentioned as an important factor in the survey responses. There was a perception that the cost of retrofitting an existing hotel would be higher than including the system in a new hotel and this was also something that was mentioned constantly in the responses. In conclusion, Water scarcity has become a global issue and innovative approaches must be taken to ensure longevity, sustainability, and growth for future generations to come. Greywater reuse is a versatile and robust technology that based on the research has proved to achieve this.

5.2 Recommendations

Based on the presented literature and discussion of the research results, the study can offer a number of recommendations to hotel professionals, hotels, and the government to aid them in making decisions regarding greywater adoption as follows:

1. Hotels should conduct clear business case analyses to weigh the benefits of installing greywater system, its impact on the environment, impact on cost, and present payback periods to allow leadership to make informed decisions on investments. This would provide the decision makers the tools needed to be able to weigh the advantages and disadvantages from the social, economic, and environmental perspectives which can further lead to greywater adoption and overall, more sustainable practices within hotels. This recommendation is the essential first step to adoption.

2. When deciding where to use treated greywater in their facilities, hotels should first create awareness campaigns and gauge the interest of their customers as to not impact their business operating model. Since customers may not be familiar with greywater and its impact, safety, and cleanliness, they may feel uneasy about staying in hotels that use greywater as shown in the research. Although awareness campaigns can be costly, the messages delivered would reinforce the sustainable image of the hotel and cost can be partially absorbed in existing marketing efforts. Communication is key to success which makes this another vital recommendation.
3. The results showed that most hotels would be willing to use treated greywater for irrigation purposes more so than other purposes where they come in contact with humans. It can be recommended to start with irrigation first and slowly transition to other applications.
4. The research showed that willingness to retrofit an existing hotel was significantly lower than that of a new hotel. A recommendation could be to include greywater designs as standards required by local authorities for all new hotels. This would be a recommendation that is raised to authorities in Abu Dhabi. If adopted, it would become part of the building code in Abu Dhabi. This already exists in the Estidama Pearl Rating system for sustainable building but it only optional. Also making it mandatory would may have cost implications on developers and may not be welcomed by the industry.
5. The research showed that government incentives had a direct impact on willingness to adopt greywater in hotels both existing and new. Another recommendation could be to devise a government incentive program that provides discounts on water/electricity bills, tax rebates on purchased material and systems, or provide permission to expand current or future property and increase building quota. All of these incentives and more could be

driving factors in adopting greywater reuse. Governments and private sector companies are in essence partners in development and as such the study sees this as a vital recommendation. Although this may increase government budgets, the benefits to the environments including water savings, lowering emissions from excessive desalination, and in general other elements in the environment could outweigh the costs.

6. If greywater systems were to be adopted, it is recommended that a comprehensive risk management system be implemented to ensure the safety of guests and employees. The research presented in the study shows that greywater is relatively safe to use depending on the system employed. This would add credibility to the use of the system and ensure guests and hotel employees that the highest levels of safety are employed when using greywater. This is vital for greywater adoption and should be considered a priority by the adopters.
7. Since hotels are governed by the Tourism and Culture Authority in Abu Dhabi, a recommendation to the TCA could be to create in coordination with the Environment Agency in Abu Dhabi an "Environmentally Responsible Hotel" Badge for hotels that install greywater systems. This badge could be provided in tiers where the tiers can be developed based on the % of water saved. This could be a plaque that is placed with the hotel's start rating. This could become an added incentive for the hotel to market themselves as a hotel that is environmentally friendly.
8. Based on the survey results and review of literation of available systems, the study recommends that hotels employ membrane-based systems. Membrane systems as presented in the literature yield the highest water purity and so would not compromise on customer experience since this is the primary objective for hotel professionals. Although this may come at a higher cost, and other systems may be cheaper, this will ensure that the

hotel meets the expectations of its guests. It is worth noting that the system that is currently installed at the Premier Inn in Abu Dhabi uses the membrane system and as discussed earlier is amounting to significant savings to their water bills and decreases in their overall potable water consumption.

5.3 Limitations

Limitation are important factors to note in a research study. In the case of this research study the following limitations are noted:

1. The study collected data via electronic surveys in English. As this was a multicultural study, respondent profiles as presented earlier were very diverse and from various cultural backgrounds. For most respondents English was their second language. Issues in language could provide for inaccurate data. Simple language was used in the survey but nonetheless one cannot know prior the overall proficiency.
2. . The study concentrated on a very specific population, hotel professionals in hotels in Abu Dhabi whose total number is limited. Although this was a limitation that was well known in the initial phases of the study, it was important to conduct this study to put into perspective the factors that may impact greywater adoption.
3. The study gauged opinions of hotel employees and not hotel owners. Hotel owners may have different viewpoints from their employees.
4. Data collection and sampling was difficult due to the Covid-19 pandemic at the time of data collection. The identified population was lower than previously mentioned decreasing the sample size. Also, access to the hotels to try to illicit more responses was not possible due to restrictions. A higher response rate may have yielded different results

5. The UAE has over 200 nationalities and respondents came from different backgrounds. This means that they all came from different countries, upbringings, and as such their perceptions may be different due to cultural, environmental, and experience in their own countries.

5.4 Recommendations for Future Research

In terms of recommendations for future research, the study could be expanded to cover not only Abu Dhabi but the hotel industry in the UAE. Future studies could also gauge the interest in the different greywater technologies available in the market. It would also be interesting to get direct access to hotel owners who are in the end the ultimate decision makers when it comes to investment in new technologies in their hotels. Further research to gauge the impact of additional cost and cost savings could also be conducted to further explore if these variables do have an impact on greywater adoption. Also concentrating on the environmental and water conservation element in the research may be on interest. Greywater adoption may prove to be an expensive capital investment for existing and new hotels but the benefits may outweigh the upfront cost as it could save on water bills, increase a hotel's social and environmental responsibility, and provide for good publicity for their environmental initiatives. The ultimate goal is to sustain water and essential resources for generations to come and exploring technologies like greywater not only for the hospitality industry but in offices, homes, and other establishments could lead to a path of sustainable growth and development for global water resources.

References

AAPOR (2019). *Best Practices for Survey Research - AAPOR*. [online] Aapor.org. Available at: https://www.aapor.org/Standards-Ethics/Best-Practices.aspx#best8 [Accessed 5 Jul. 2019].

Abelson, R. P. (1985). A variance explanation paradox: When a little is a lot. Psychological Bulletin, 97, 129-133.

ADDC (2019). 5-year planning statement 2019-2023(Potable Water). Available at https://www.addc.ae/content/Publications/5-Year%20Planning%20Statement%202019-2023%20(Potable%20Water).pdf [Accessed 3 Feb 2019]

Adewumi, J, Olanrewaju, O., Ilemobade, A., van Zyl, J. (2010). Perceptions towards greywater reuse and proposed model for institutional and commercial settlements in South Africa. *Water Institute of South Africa*

Ajit, K. (2016). A Review on Grey Water Treatment and Reuse. *International Research Journal of Engineering and Technology*, 3(5).

Al Mamun, A., Muyibi, S. & Abdul Razak, N. (2014). Treatment of used ablution water from IIUM masjid for reuse. *Advances in Environmental Biology*, vol. 8 (3), pp. 558-564. [Accessed 24 October 2020].

Al Wasimi, N. (2017). Lawned gardens account for half of UAE’s water consumption per capita, say experts. [online] The National. Available at: https://www.thenational.ae/uae/lawned-gardens-account-for-half-of-uae-s-water-consumption-per-capita-say-experts-1.1807 [Accessed 5 Jul. 2019].

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, vol. 50 (2), pp. 179-211. [Accessed 24 September 2020].

Bartlett, J., Kotrlik, J. and Higgins, C. (2001). Organizational Research: Determining Appropriate Sample Size in Survey Research. Information Technology, Learning, and Performance Journal, 19(1).

Bakare, B., Mtsweni, S., Rathilal, S. (2016). A pilot study into public attitudes and perceptions towards greywater reuse in a low cost housing development in Durban, South Africa. *Journal of Water Reuse and Desalination*. Vol 6 (2)

Bioxica, (2020). *Modular Wastewater Treatment System*. [online] Bioxica.com. Available at: <https://bioxica.com/Wastewater-Treatment/System/Modular> [Accessed 16 April 2020].

Blanky, M., Sharaby, Y., Rodríguez-Martínez, S., Halpern, M. & Friedler, E. (2017). Greywater reuse - Assessment of the health risk induced by Legionella pneumophila. *Water Research*, vol. 125, pp. 410-417. [Accessed 24 June 2020].

Bradley, N. (2018). "Use Grey Water Properly with These Six Rules | Waterless Co Inc.". *Waterless Co. Inc.* [online]. [Accessed 24 April 2020]. Available at: https://www.waterless.com/blog/use-grey-water-properly-with-these-six-rules

Cassella, C., (2019). *The Biggest Crisis No One Is Talking About&Quot;: 25% Of The World's Population Is Facing Water Stress*. [online] ScienceAlert. Available at: <https://www.sciencealert.com/17-countries-are-facing-extreme-water-stress-and-they-hold-a-quarter-of-the-world-s-population> [Accessed 17 June 2020].

Chan, C. (2009). *CETL- Assessment Resource Centre*. [online] Ar.cetl.hku.hk. Available at: https://ar.cetl.hku.hk/am_literature_reviews.htm [Accessed 5 Jul. 2019].

Chokhavatia (2020). *Wastewater Polishing Treatment & Process | CA*. [online] Chokhavatia Associates. Available at: <https://chokhavatia.com/skills/treatment-processes/polishing-treatment/#:~:text=Polishing%20is%20the%20tertiary%20and,left%20after%20secondary%20effluent%20treatment.> [Accessed 16 June 2020].F

Chowdhury, R. and Abaya, J. (2018). An Experimental Study of Greywater Irrigated Green Roof Systems in an Arid Climate. Journal of Water Management Modeling.

CIRT (2019). *Benefits and Limitations of Experimental Research - Center for Innovation in Research and Teaching*. [online] Cirt.gcu.edu. Available at: https://cirt.gcu.edu/research/developmentresources/research_ready/experimental/benefits_limits [Accessed 5 Jul. 2019].

City of Markham. (2020). "Grey Water Re-Use". *Markham.ca* [online]. [Accessed 13 June 2020]. Available at: https://www.markham.ca/wps/portal/home/neighbourhood-services/water-sewer/how-to-use-less-water/09-grey-water-re-use

Creswell, J. (2003). R*esearch design: Qualitative, quantitative and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Creswell, J., Creswell, J. (2018). *Research Design*. 5th edn. Thousand Oaks, USA:SAGE Publications.

Cremona, M., Saliba, G., *Greening the economy – Greywater treatment and flow rate regulation as a job generator, water, energy and CO2 saver.* Malta Business Bureau. Accessed [1

September 2020]. Available at: https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=InvestinginWater_Greening_Economy_2013.pdf

DeFranzo, S. (2012). *Advantages and Disadvantages of Surveys*. [online] Snap Surveys Blog. Available at: https://www.snapsurveys.com/blog/advantages-disadvantages-surveys/ [Accessed 5 Jul. 2019].

EGBC (2016). EmiratesGBC Energy and Water Benchmarking for UAE Hotels—2016 Report. [online] Dubai: EGBC. Available at: https://emiratesgbc.org/wp-content/uploads/2016/09/EmiratesGBC-Energy-and-Water-Benchmarking-for-UAE-Hotels-2016-Report.pdf [Accessed 5 Jul. 2019].

EREK. (2020). "Grey-water recycling in Spanish hotels". *EREK - European Resource Efficiency Knowledge Center* [online]. [Accessed 24 May 2020]. Available at: https://www.resourceefficient.eu/pl/node/193

Fabrigar, L., Wegener, D., MacCallum, R. & Strahan, E. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, vol. 4 (3), pp. 272-299.

Finch, W. (2019). *Exploratory factor analysis*. Los Angeles, (etc.):Sage.

Golberg, M. & Cho, H. (2010). *Introduction to regression analysis*. Southhampton, U.K.:WIT Press.

Graf, C. (2012). "Gray Water as a Resource in Arizona: Prospects and Challenges". *wrrc.arizona.edu* [online]. [Accessed 24 January 2020]. Available at: https://wrrc.arizona.edu/grey-water-as-resource

Grey Flow (2020) Grey Flow RRP System Costs. greyflow.net.au.

Hansen, C. (2018). Introduction to Green Roofs. [online] EcoMENA. Available at: https://www.ecomena.org/green-roofs/ [Accessed 5 Jul. 2019].

Hanson, L. (1997). Environmentally Friendly Systems and Products. Water Saving Devices. Bracknell: BSRIA, Department of Environment, Transport and the Regions.

Hocking, M., (2005). Water Quality Measurement. *Handbook of Chemical Technology and Pollution Control*, pp.105-138.

Hyde, K., Smith, M. and Adeyeye, K. (2016). Developments in the quality of treated greywater supplies for buildings, and associated user perception and acceptance. International Journal of Low-Carbon Technologies, p.ctw006.

Hussey, J. C. &. R., (2009). Business Research: A practical guide for undergraduate and postgraduate students. s.l.:Palgrave Macmillan. (Book)

Juan, Y., Chen, Y. and Lin, J. (2016). Greywater Reuse System Design and Economic Analysis for Residential Buildings in Taiwan. Water, 8(11), p.546.

Karibasappa, H., Akila, A., Dhanabal, N., Dharani, R. and Dhinesh, K. (2017). An Experimental Investigation on Recycling of Grey Water Naturally by Using Canna Plants. *International Journal of Innovative Research in Science, Engineering and Technology*, 6(13).

Khong, Chung M. (2009), "Perception and use of graywater in Berkeley, California" . *Master's Theses*.3693.DOI:https://doi.org/10.31979/etd.7qs8-xx7r https://scholarworks.sjsu.edu/etd_theses/3693

Koottatep, T., Cookey, P. and Polprasert, C., (2019). *Regenerative Sanitation: A New Paradigm For Sanitation 4.0*. 1st ed. London: IWA Publishing.

Lemee, C., Navarro, O., Bulteau, G. & Fleury-Bahi, G. (2018). Personal Involvement in Greywater Reuse: A Study within a French Context. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION*, vol. 13 (5), pp. 457-465.

Maraqa, M. & Ghoudi, K. (2015). Public Perception of Water Conservation, Reclamation and Greywater Use in the United Arab Emirates. *International Proceedings of Chemical, Biological, and Environmental Engineering*, vol. 91 (4). [Accessed 25 October 2020].

Marshall, K. (2019). "What Are Aerobic Wastewater Treatment Systems and How Do They Work?". *Samco Tech* [online]. [Accessed 16 March 2020]. Available at: https://www.samcotech.com/what-are-aerobic-wastewater-treatment-systems-and-how-do-they-work/

McIllwaine, S. (2003). "Graywater Reuse in Other Countries — Center for the Study of the Built Environment". *Center for the Study of the Built Environment* [online]. [Accessed 24 July 2020]. Available at: https://www.csbe.org/greywater-reuse-in-other-countries

Miljko, L. (2017). "Exploratory Factor Analysis - KMO and Bartlett's Test". *Statistika.co* [online]. [Accessed 8 October 2020]. Available at: https://www.statistika.co/index.php/portfolio/303-exploratory-factor-analysis-kmo-and-bartlett-s-test

Newcomer, E., Boyd, C., Nyirenda, L., Opong, E., Marquez, S. and Holm, R. (2017). Reducing the burden of rural water supply through greywater reuse: a case study from northern Malawi. *Water Science and Technology: Water Supply*, p.ws2017004.

OECD (2012). Measuring Regulatory Performance Publication. *Organization For Economic Performance and Development*.

Olanrewaju, R., Muyibi, S., Salwudeen, T. & Aibinu, A. (2012). An Intelligent Modeling of Coagulant Dosing System for Water Treatment Plants based on Artificial Neural Network. *Australian Journal of Basic and Applied Sciences*, vol. 6 (1), pp. 93-99. [Accessed 24 October 2020].

Oteng-Peprah, M., Acheampong, M. and deVries, N. (2018). Greywater Characteristics, Treatment Systems, Reuse Strategies and User Perception—a Review. Water, Air, & Soil Pollution, 229(8).

Pinto, U. and Maheshwari, B. (2010). Reuse of greywater for irrigation around homes in Australia: Understanding community views, issues and practices. Urban Water Journal, 7(2), pp.141-153.

Radin Mohamed, R., Al-Gheethi, A. and Mohd Kassim, A., (2019). Management Of Greywater In Developing Countries. 1st ed. Cham: Springer International Publishing AG.

Radin Mohamed, R., Adnan, M., Mohamed, M. and Mohd Kassim, A., (2016). Conventional Water Filter (Sand and Gravel) for Ablution Water Treatment, Reuse Potential, and Its Water Savings. *Journal of Sustainable Development*, 9(1), p.35.

Redi, 2020. *Greywater Recovery System | REDI EU*. [online] Redi.eu. Available at: <https://redi.eu/greywater-recovery-system/> [Accessed 24 September 2020].

Reid, H. (2013). *Introduction to Statistics*. 1st edn. Sage Publications.

RSB (2018). *Recycled Water and Biosolids Regulations 2018*. Abu Dhabi:RSB.

Salkind, N. (2009). *Exploring research*. 7th ed. Upper Saddle River, N.J. : Pearson/Prentice Hall.

Samayamanthula, D., Sabarathinam, C. and Bhandary, H., (2019). Treatment and effective utilization of greywater. *Applied Water Science*, 9(4).

Sangheetha, S., Nair, S. and Lakshminarayana, V. (2017). An Experimental Analysis On Grey Water Treatment Using Drawer Sand Filters. Journal of Industrial Pollution Control.

Smith, H. & Draper, N. (2011). *Applied regression analysis*. 2nd edn. New York:Wiley.

Suskie, L. (1996). Questionnaire survey research that works. 2nd edn. Tallahassee, FL.: Association for Institutional Research

Tourism and Culture Authority (2019). Abu Dhabi Hotel Report, Q4 and Full Year Report.

Underwood, M. (2012). Going grey can help ease UAE's water woes. [online] The National. Available at: https://www.thenational.ae/uae/environment/going-grey-can-help-ease-uae-s-water-woes-1.388228 [Accessed 5 Jul. 2019].

UNESCO (2017). The United Nations World Water Development Report 2017. *United Nations Educational, Scientific and Cultural Organization*

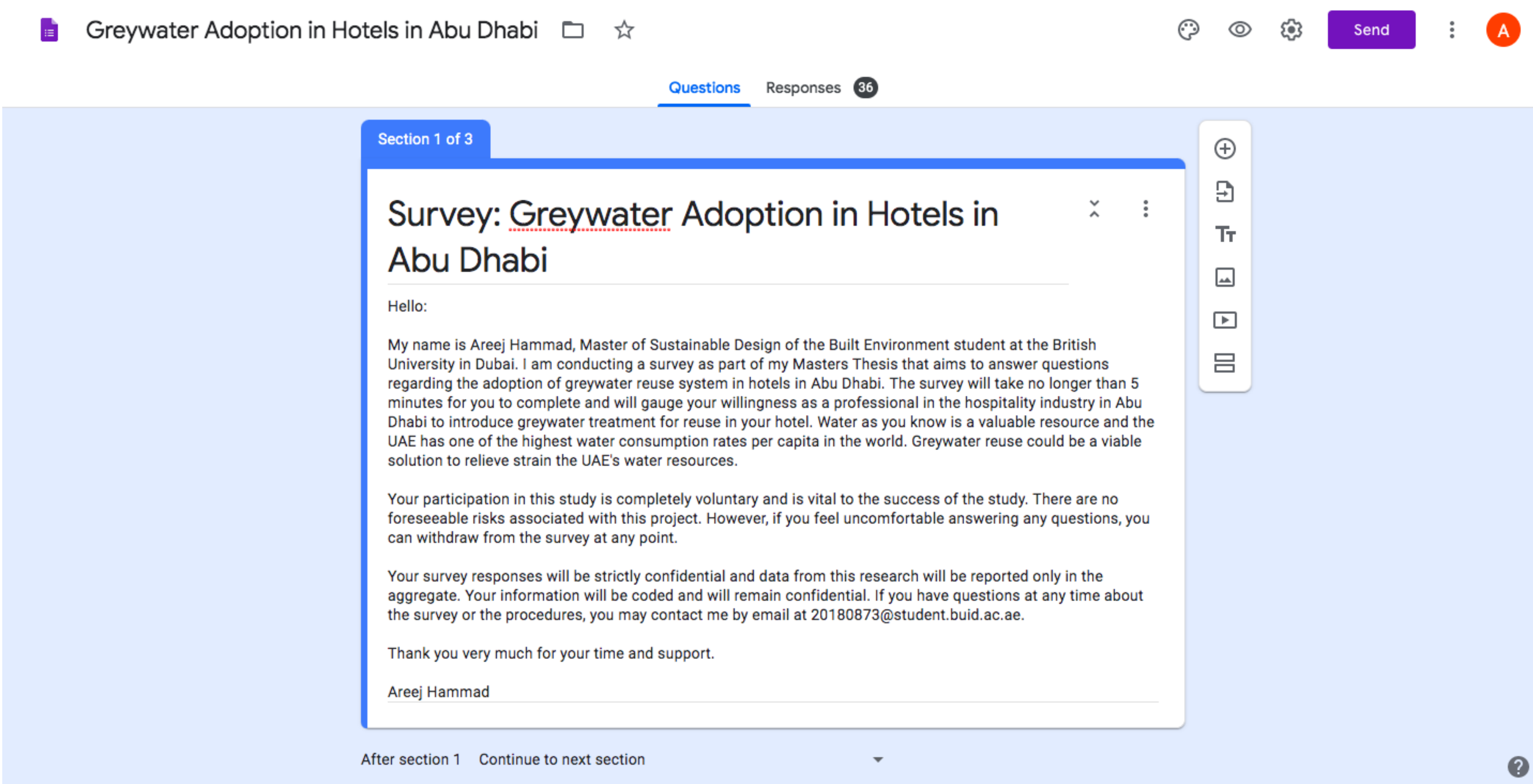
Verde Hotels. (2020). "Our green story – The Group". *Verdehotels.com* [online]. [Accessed 24 April 2020]. Available at: https://www.verdehotels.com/thegroup/our-green-story

Waterworld. (2016). "Greywater recycling helps Abu Dhabi airport hotel curb water usage". *WaterWorld* [online]. [Accessed 11 May 2020]. Available at: https://www.waterworld.com/international/wastewater/article/16202683/greywater-recycling-helps-abu-dhabi-airport-hotel-curb-water-usage

WHO, (2020). *Drinking-Water*. [online] Who.int. Available at: <https://www.who.int/news-room/fact-sheets/detail/drinking-water> [Accessed 16 July 2020].

WHO, (2006). Overview of greywater management Health considerations. Available at: https://applications.emro.who.int/dsaf/dsa1203.pdf [Accessed 25 Feb 2020]

Appendix A – Survey Questions


Greywater Adoption in Hotels in Abu Dhabi

Send

A

Questions Responses 36

Section 1 of 3

Survey: Greywater Adoption in Hotels in Abu Dhabi

Hello:

My name is Areej Hammad, Master of Sustainable Design of the Built Environment student at the British University in Dubai. I am conducting a survey as part of my Masters Thesis that aims to answer questions regarding the adoption of greywater reuse system in hotels in Abu Dhabi. The survey will take no longer than 5 minutes for you to complete and will gauge your willingness as a professional in the hospitality industry in Abu Dhabi to introduce greywater treatment for reuse in your hotel. Water as you know is a valuable resource and the UAE has one of the highest water consumption rates per capita in the world. Greywater reuse could be a viable solution to relieve strain the UAE's water resources.

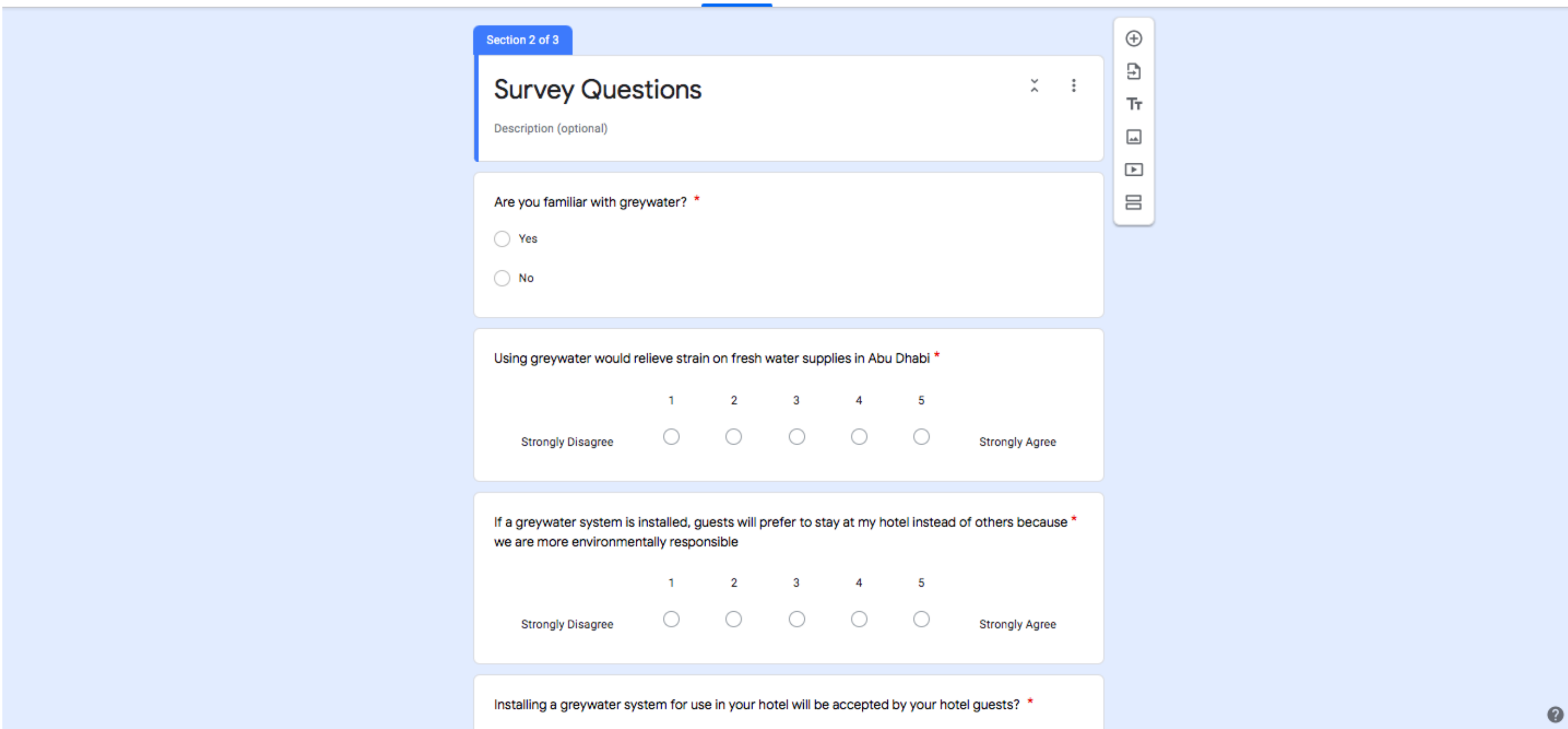
Your participation in this study is completely voluntary and is vital to the success of the study. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point.

Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact me by email at 20180873@student.buid.ac.ae.

Thank you very much for your time and support.

Areej Hammad

After section 1 Continue to next section


Section 2 of 3

Survey Questions

Description (optional)

Are you familiar with greywater? *

Yes

No

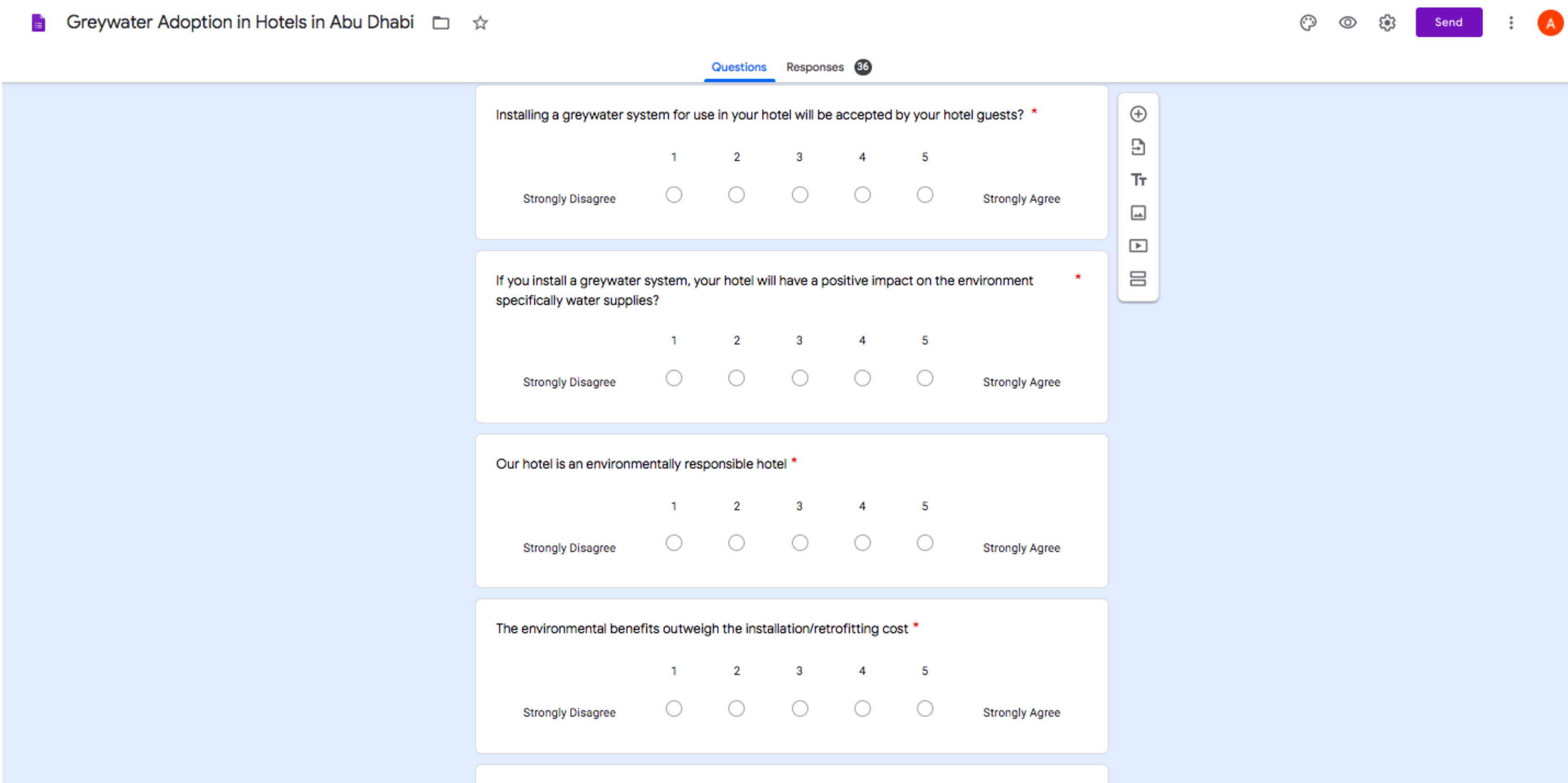
Using greywater would relieve strain on fresh water supplies in Abu Dhabi *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

If a greywater system is installed, guests will prefer to stay at my hotel instead of others because we are more environmentally responsible *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Installing a greywater system for use in your hotel will be accepted by your hotel guests? *



Greywater Adoption in Hotels in Abu Dhabi

Send

Questions Responses 36

Installing a greywater system for use in your hotel will be accepted by your hotel guests? *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

If you install a greywater system, your hotel will have a positive impact on the environment specifically water supplies? *

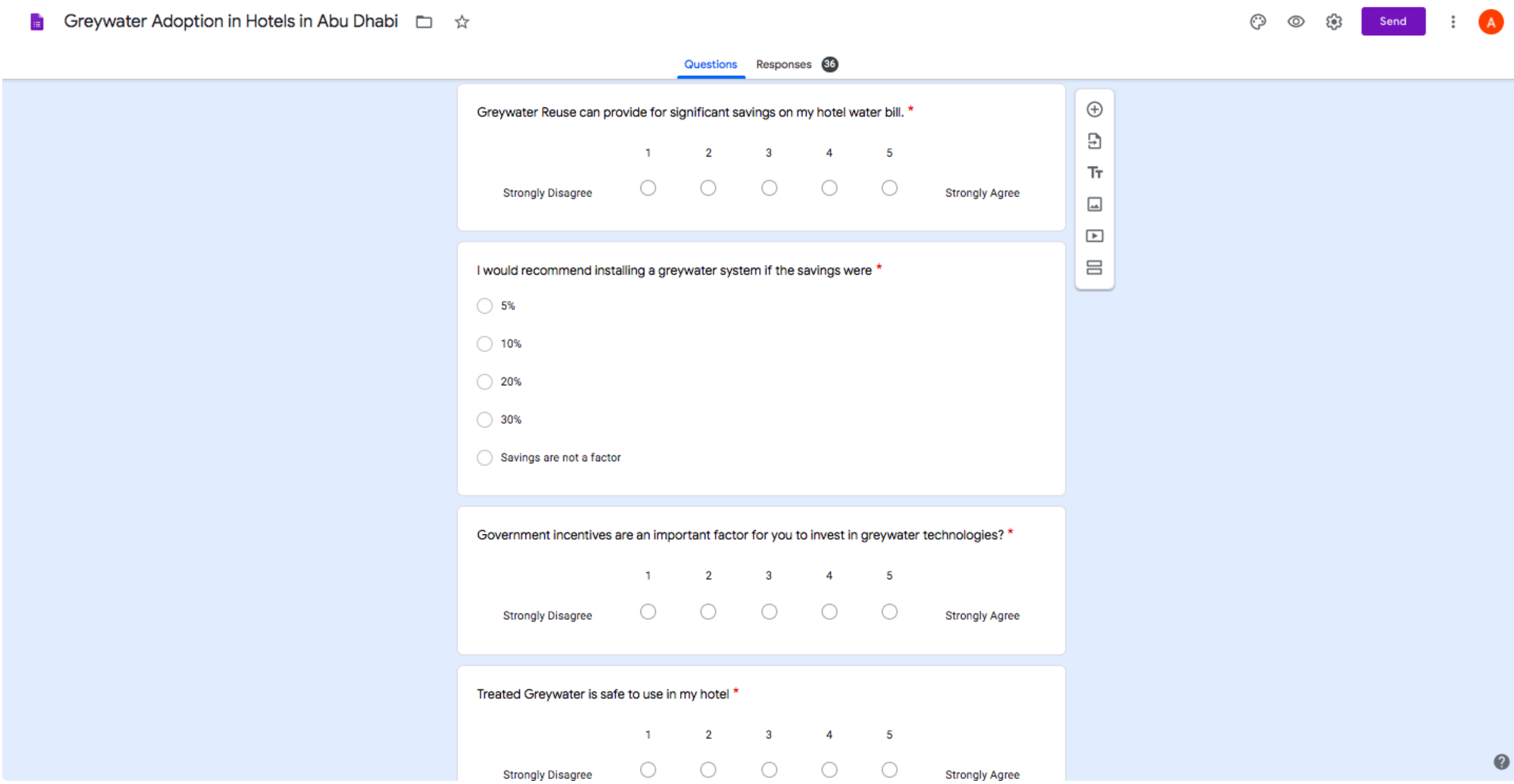
	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Our hotel is an environmentally responsible hotel *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

The environmental benefits outweigh the installation/retrofitting cost *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree


Greywater Adoption in Hotels in Abu Dhabi

Send

Questions | Responses 36

Greywater Reuse can provide for significant savings on my hotel water bill. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I would recommend installing a greywater system if the savings were *

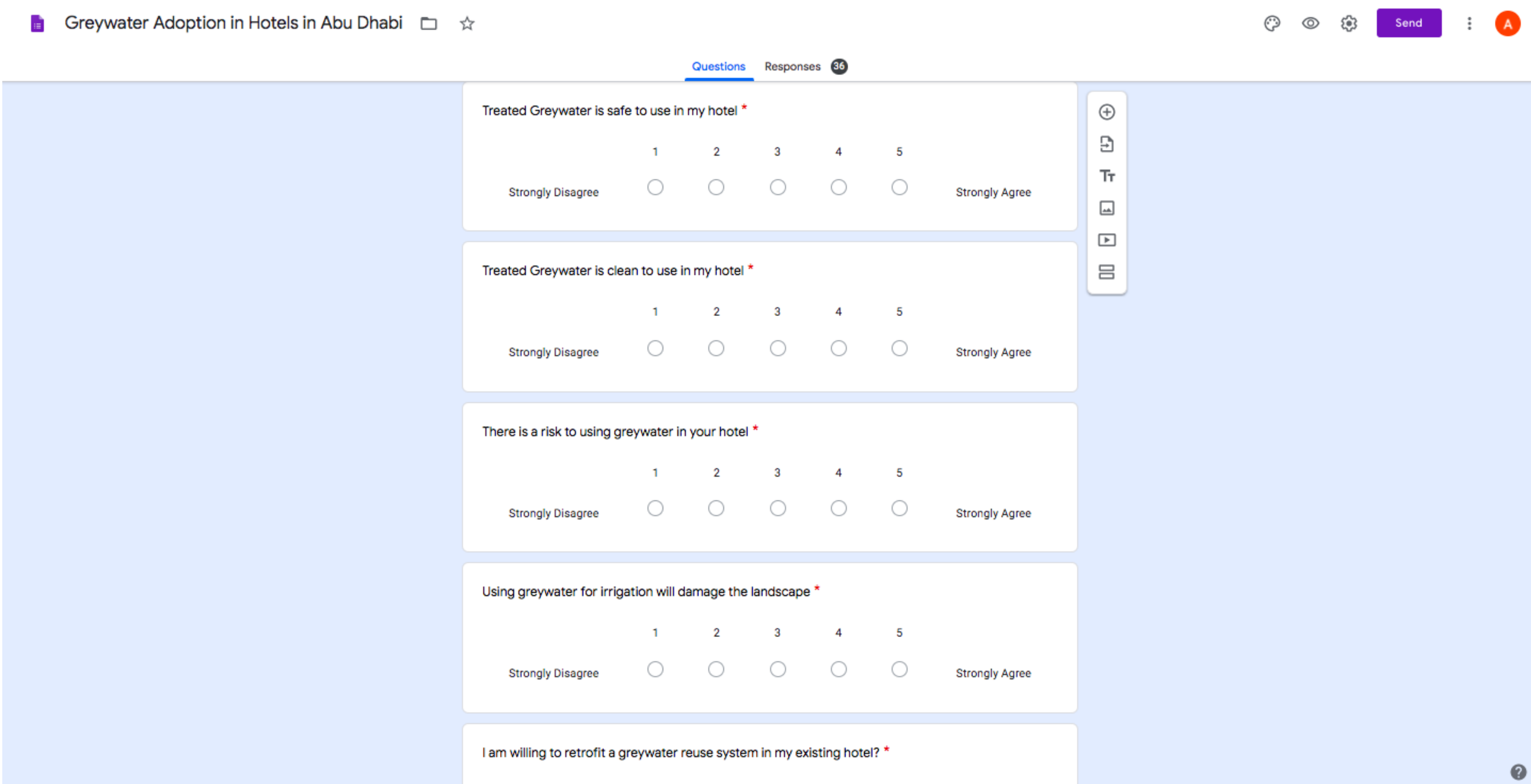
- ○ 5%
- ○ 10%
- ○ 20%
- ○ 30%
- ○ Savings are not a factor

Government incentives are an important factor for you to invest in greywater technologies? *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Treated Greywater is safe to use in my hotel *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree



Greywater Adoption in Hotels in Abu Dhabi

Send

Questions Responses 36

Treated Greywater is safe to use in my hotel *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Treated Greywater is clean to use in my hotel *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

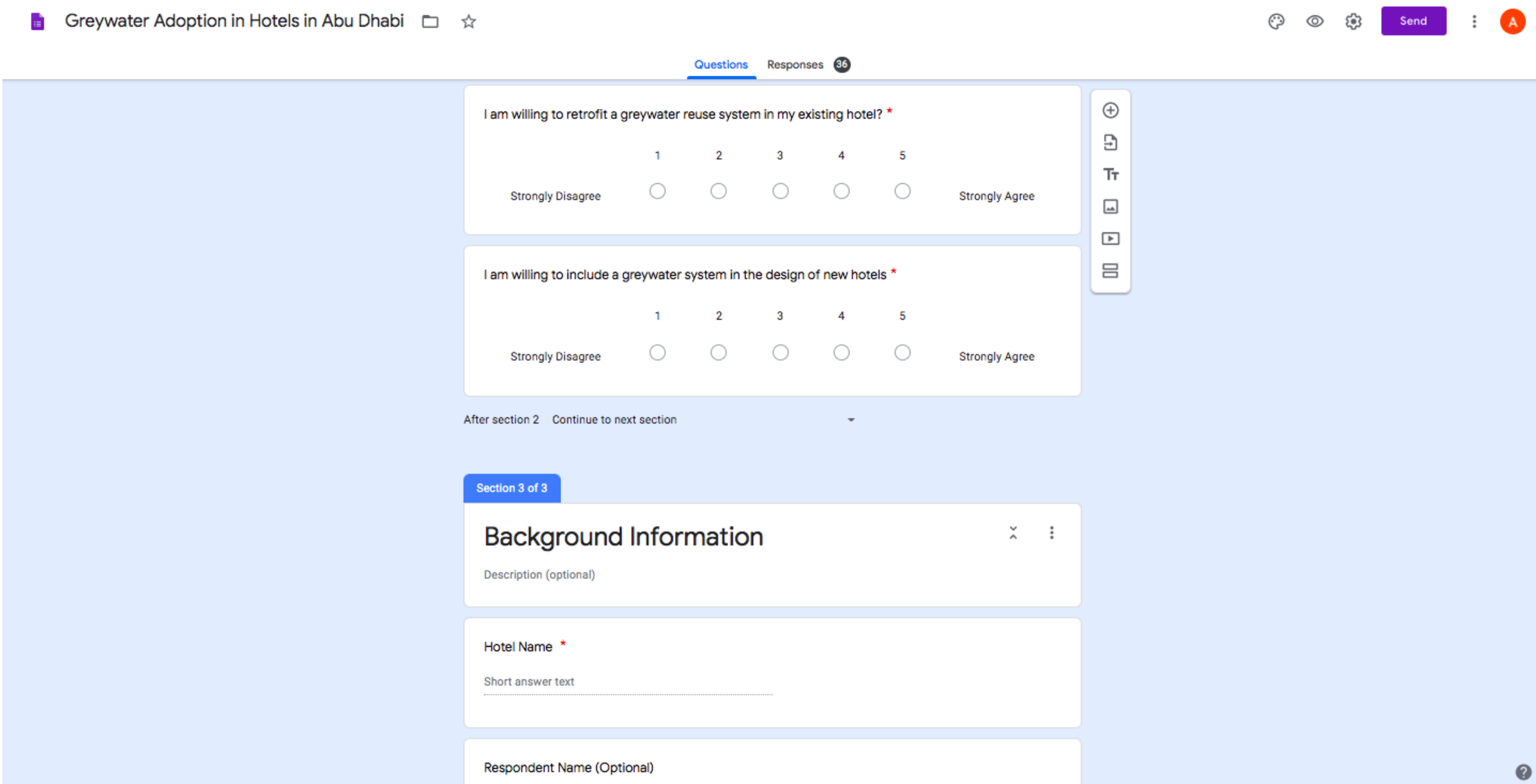
There is a risk to using greywater in your hotel *

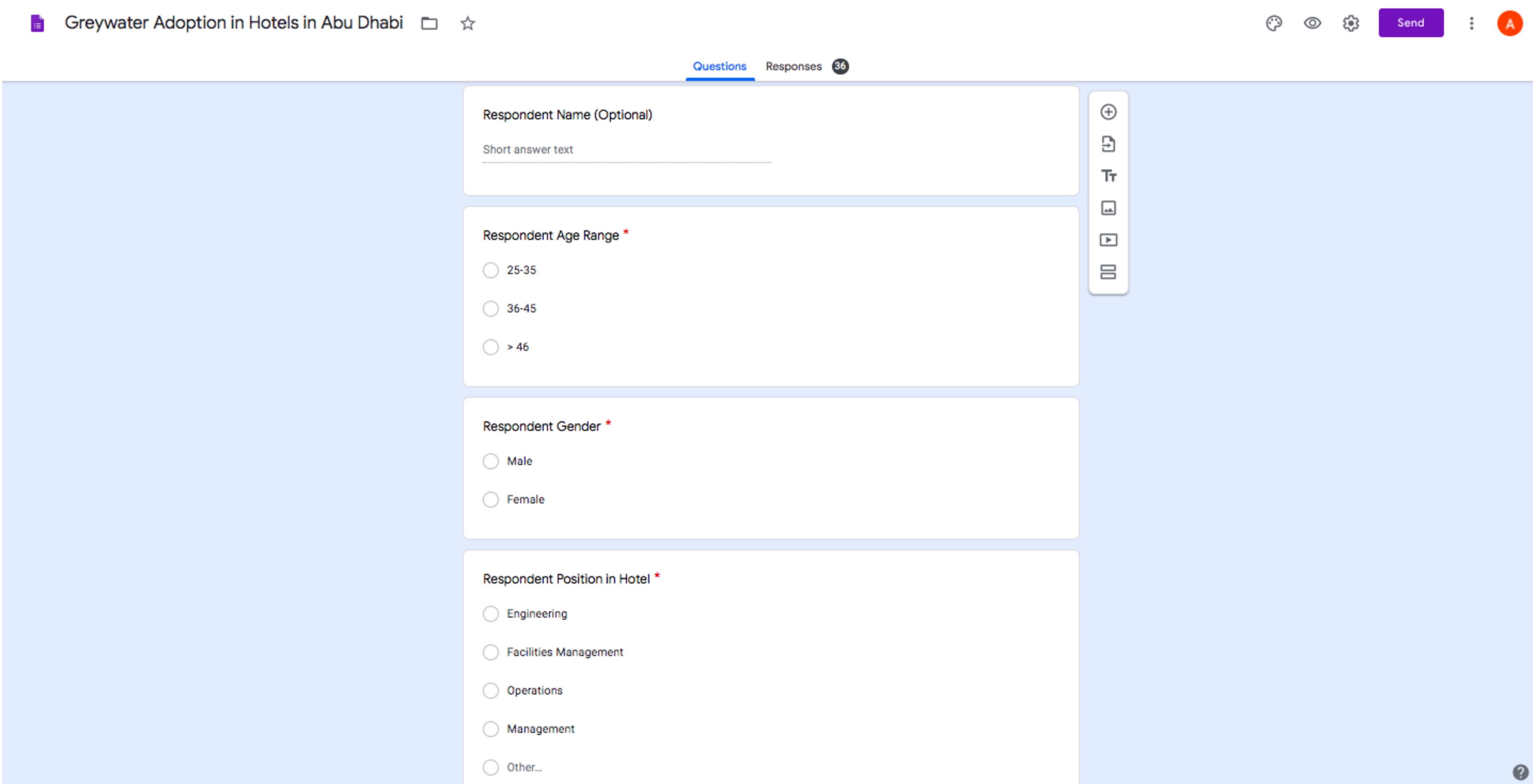
	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Using greywater for irrigation will damage the landscape *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am willing to retrofit a greywater reuse system in my existing hotel? *


Greywater Adoption in Hotels in Abu Dhabi
Send
Questions
Responses 36
I am willing to retrofit a greywater reuse system in my existing hotel? *
1 2 3 4 5
Strongly Disagree
Strongly Agree
I am willing to include a greywater system in the design of new hotels *
1 2 3 4 5
Strongly Disagree
Strongly Agree
After section 2 Continue to next section
Section 3 of 3
Background Information
Description (optional)
Hotel Name *
Short answer text
Respondent Name (Optional)



Greywater Adoption in Hotels in Abu Dhabi

Send

A

Questions

Responses 36

Respondent Name (Optional)

Short answer text

Respondent Age Range *

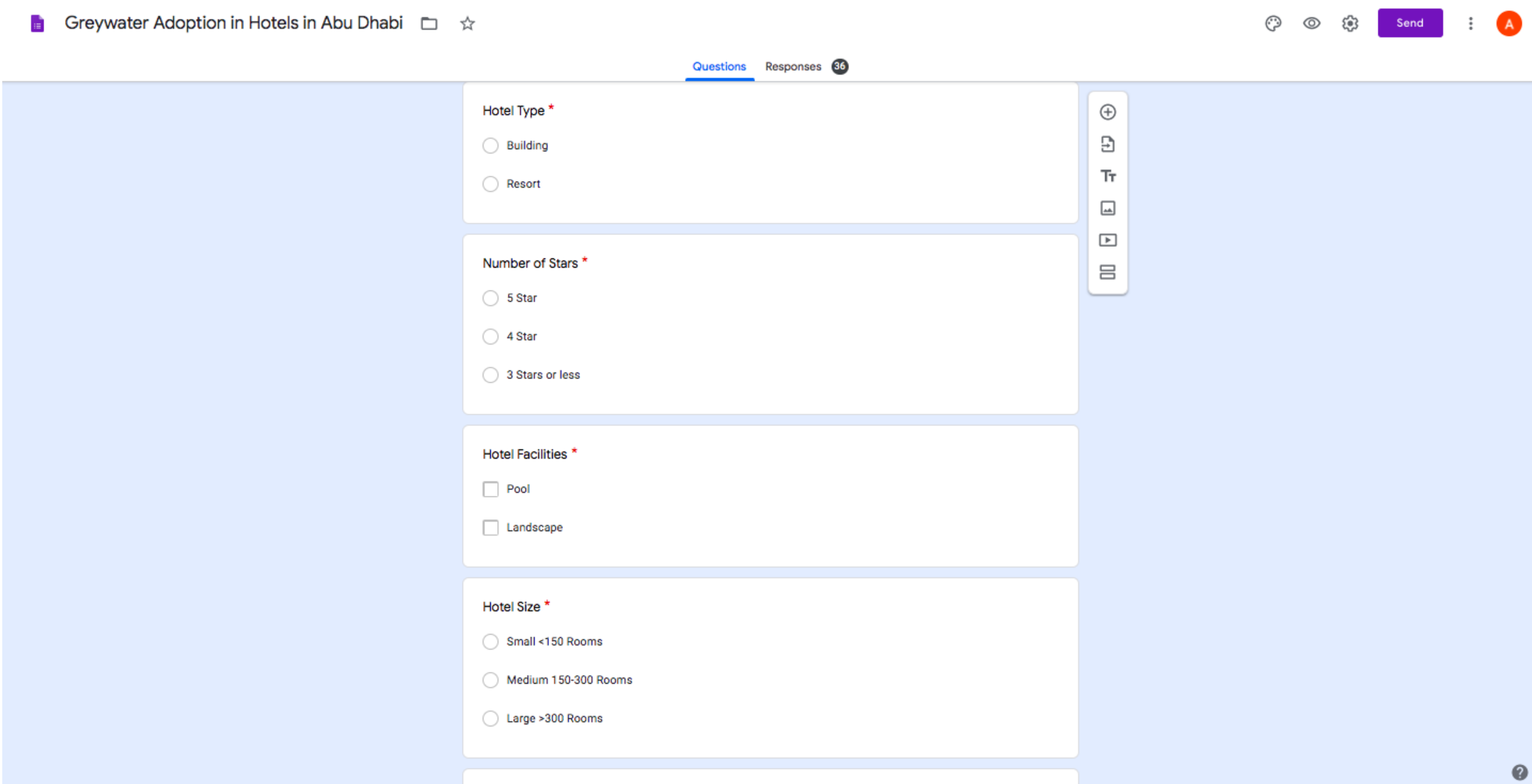
- 25-35
- 36-45
- > 46

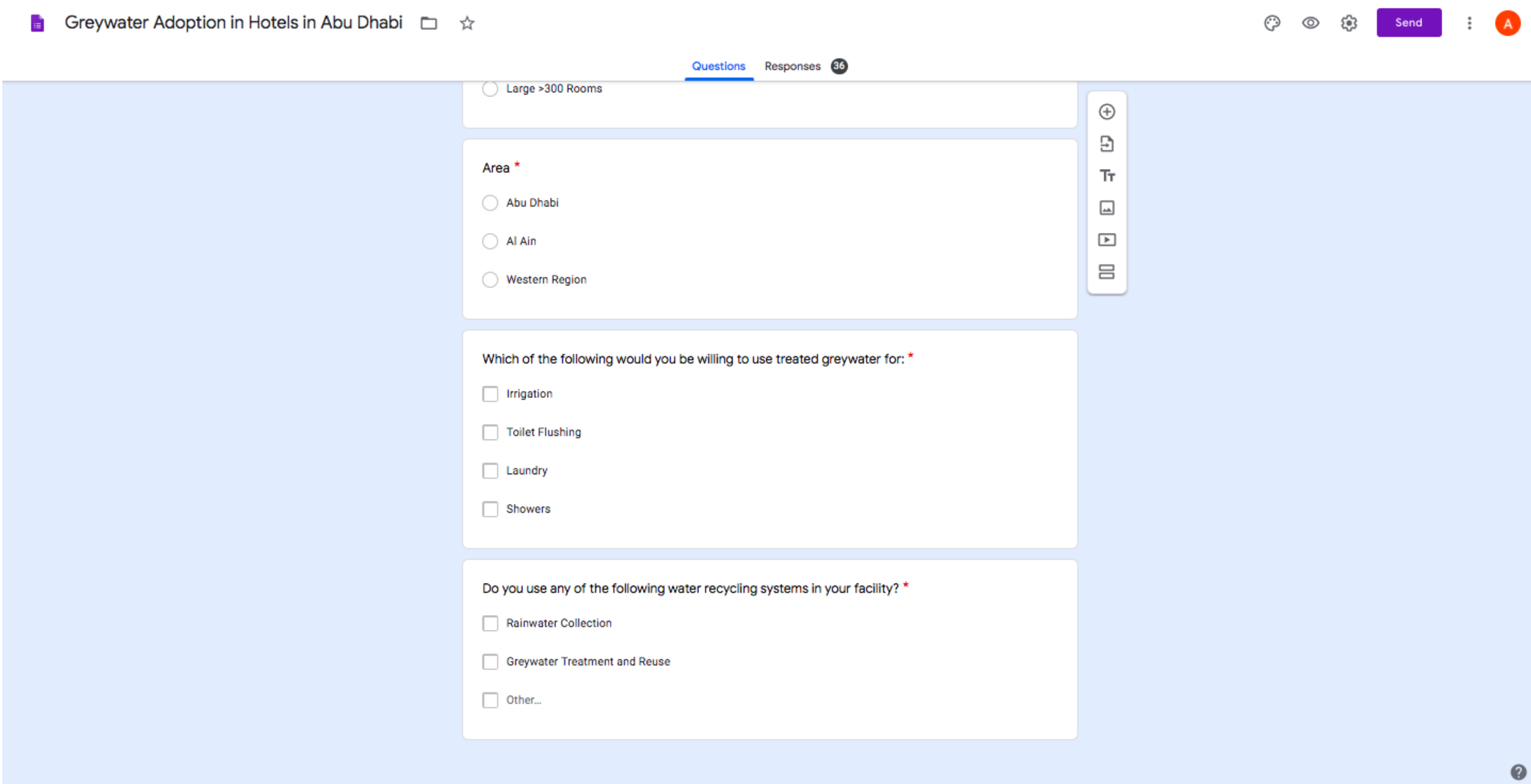
Respondent Gender *

- Male
- Female

Respondent Position in Hotel *

- Engineering
- Facilities Management
- Operations
- Management
- Other...


Greywater Adoption in Hotels in Abu Dhabi
Send
Questions
Responses 36
Hotel Type *
Building
Resort
Number of Stars *
5 Star
4 Star
3 Stars or less
Hotel Facilities *
Pool
Landscape
Hotel Size *
Small <150 Rooms
Medium 150-300 Rooms
Large >300 Rooms



Greywater Adoption in Hotels in Abu Dhabi

Send

Questions Responses 36

Large >300 Rooms

Area *

Abu Dhabi

Al Ain

Western Region

Which of the following would you be willing to use treated greywater for: *

Irrigation

Toilet Flushing

Laundry

Showers

Do you use any of the following water recycling systems in your facility? *

Rainwater Collection

Greywater Treatment and Reuse

Other...

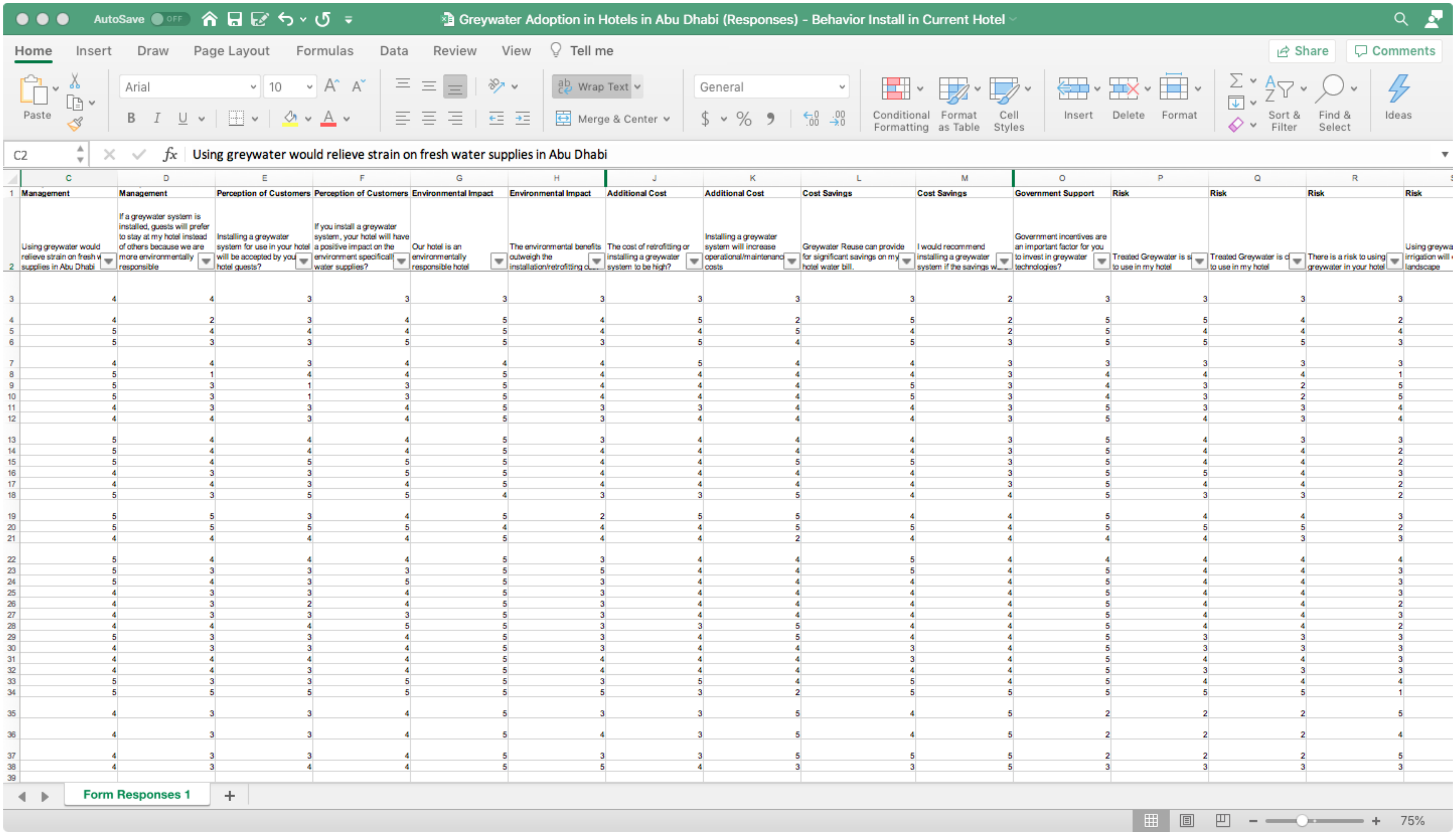
Appendix B – Sample Table

Table 1: Table for Determining Minimum Returned Sample Size for a Given Population Size for Continuous and Categorical Data

	Sample size					
	Continuous data (margin of error=.03)			Categorical data (margin of error=.05)		
Population size	alpha=.10 t=1.65	alpha=.05 t=1.96	alpha=.01 t=2.58	p=.50 t=1.65	p=.50 t=1.96	p=.50 t=2.58
100	46	55	68	74	80	87
200	59	75	102	116	132	154
300	65	85	123	143	169	207
400	69	92	137	162	196	250
500	72	96	147	176	218	286
600	73	100	155	187	235	316
700	75	102	161	196	249	341
800	76	104	166	203	260	363
900	76	105	170	209	270	382
1,000	77	106	173	213	278	399
1,500	79	110	183	230	306	461
2,000	83	112	189	239	323	499
4,000	83	119	198	254	351	570
6,000	83	119	209	259	362	598
8,000	83	119	209	262	367	613
10,000	83	119	209	264	370	623

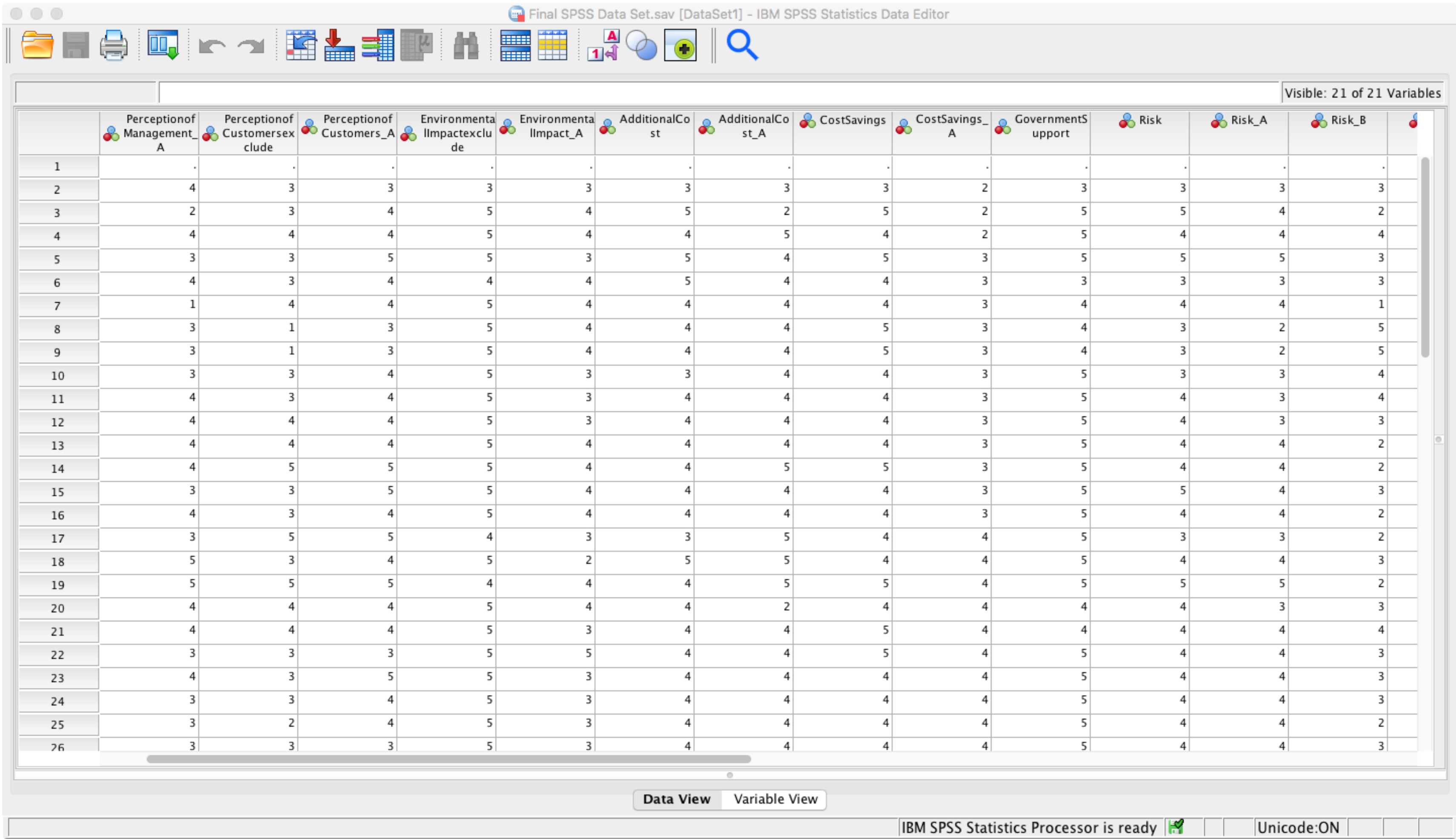
Appendix C – SPSS Results – Factor Analysis and Sample Set from Regression

Data in Organized in Excel



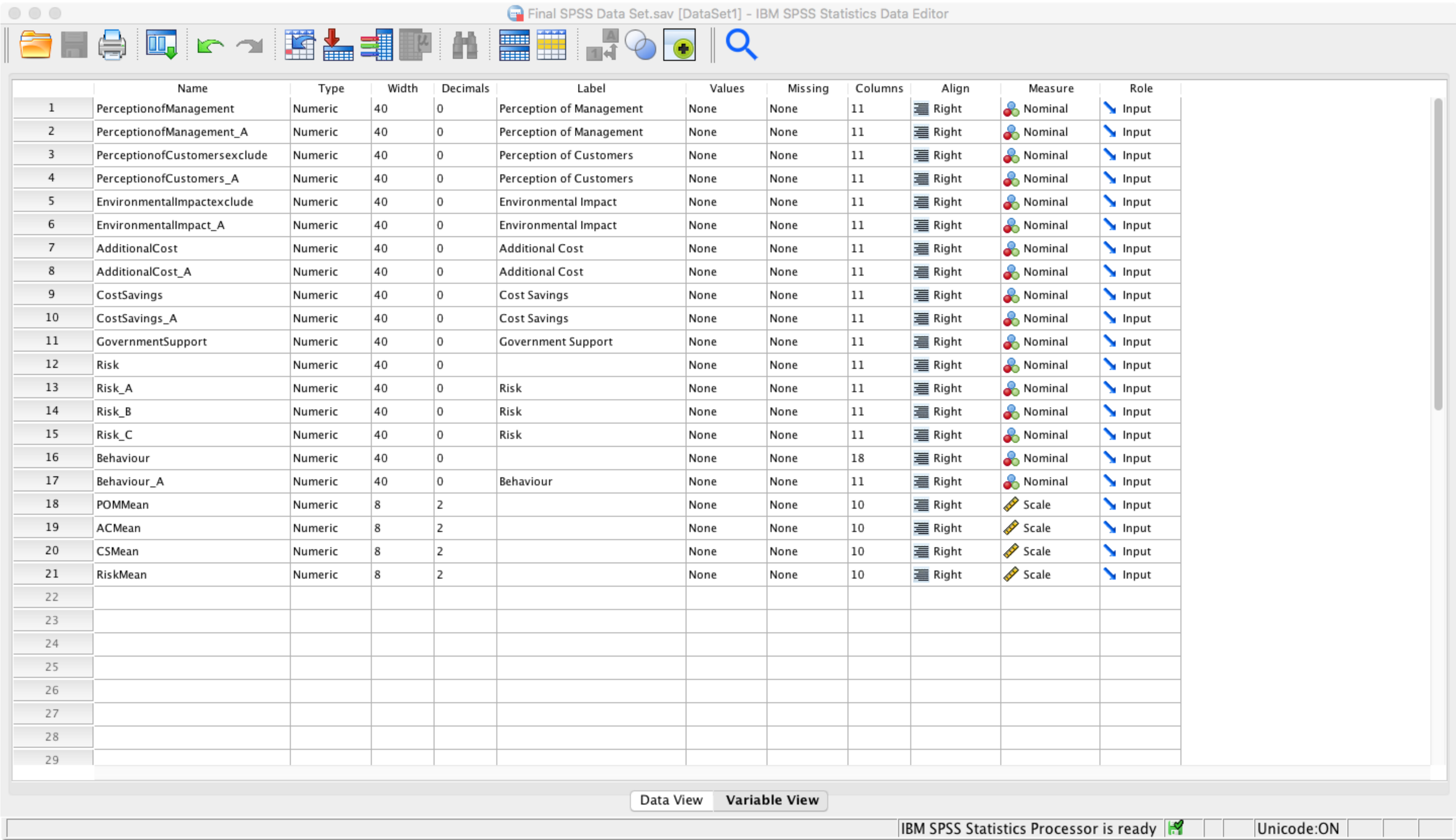
	C	D	E	F	G	H	J	K	L	M	O	P	Q	R	S
1	Management	Management	Perception of Customers	Perception of Customers	Environmental Impact	Environmental Impact	Additional Cost	Additional Cost	Cost Savings	Cost Savings	Government Support	Risk	Risk	Risk	Risk
2	Using greywater would relieve strain on fresh w supplies in Abu Dhabi	If a greywater system is installed, guests will prefer to stay at my hotel instead of others because we are more environmentally responsible	Installing a greywater system for use in your hotel will be accepted by you hotel guests?	If you install a greywater system, your hotel will have a positive impact on the environment specificall water supplies?	Our hotel is an environmentally responsible hotel	The environmental benefits outweigh the installation/retrofitting c	The cost of retrofitting or installing a greywater system to be high?	Installing a greywater system will increase operational/maintenanc costs	Greywater Reuse can provide for significant savings on my hotel water bill.	I would recommend installing a greywater system if the savings w	Government incentives are an important factor for you to invest in greywater technologies?	Treated Greywater is s to use in my hotel	Treated Greywater is c to use in my hotel	There is a risk to using greywater in your hotel	Using greywa irrigation will landscape
3	4	4	3	3	3	3	3	3	3	2	3	3	3	3	
4	4	2	3	4	5	4	5	2	5	2	5	5	4	2	
5	5	4	4	4	5	4	4	5	4	2	5	4	4	4	
6	5	3	3	5	5	3	5	4	5	3	5	5	5	3	
7	4	4	3	4	4	4	5	4	4	3	3	3	3	3	
8	5	1	4	4	5	4	4	4	4	3	4	4	4	1	
9	5	3	1	3	5	4	4	4	5	3	4	3	2	5	
10	5	3	1	3	5	4	4	4	5	3	4	3	2	5	
11	4	3	3	4	5	3	3	4	4	3	5	3	3	4	
12	4	4	3	4	5	3	4	4	4	3	5	4	3	4	
13	5	4	4	4	5	3	4	4	4	3	5	4	3	3	
14	5	4	4	4	5	4	4	4	4	3	5	4	4	2	
15	5	4	5	5	5	4	4	5	5	3	5	4	4	2	
16	4	3	3	5	5	4	4	4	4	3	5	5	3	3	
17	4	4	3	4	5	4	4	4	4	3	5	4	4	2	
18	5	3	5	5	4	3	3	5	4	4	5	3	3	2	
19	5	5	3	4	5	2	5	5	4	4	5	4	4	3	
20	5	5	5	5	4	4	4	5	5	4	5	5	5	2	
21	4	4	4	4	5	4	4	2	4	4	4	4	3	3	
22	5	4	4	4	5	3	4	4	5	4	4	4	4	4	
23	5	3	3	3	5	5	4	4	5	4	5	4	4	3	
24	5	4	3	5	5	3	4	4	4	4	5	4	4	3	
25	4	3	3	4	5	3	4	4	4	4	5	4	4	3	
26	4	3	2	4	5	3	4	4	4	4	5	4	4	2	
27	4	3	3	3	5	3	4	4	4	4	5	4	4	3	
28	4	4	4	5	5	3	3	5	4	4	5	4	4	2	
29	5	3	3	4	5	3	4	5	4	4	5	3	3	3	
30	4	3	3	4	5	3	4	4	3	4	5	3	3	3	
31	4	4	4	4	5	4	4	4	3	4	5	4	4	3	
32	4	4	3	4	5	4	4	4	4	4	5	3	3	3	
33	5	3	3	5	5	3	5	4	5	4	5	4	4	4	
34	5	5	5	5	5	5	3	2	5	5	5	5	5	1	
35	4	3	3	4	5	3	3	5	4	5	2	2	2	5	
36	4	3	3	4	5	4	3	5	4	5	2	2	2	4	
37	4	3	3	4	5	3	3	5	5	5	2	2	2	5	
38	4	3	4	4	5	5	4	3	3	5	3	3	3	3	
39															

Data Organized in SPSS



	PerceptionofManagement_A	PerceptionofCustomersexclude	PerceptionofCustomers_A	EnvironmentalImpactexclude	EnvironmentalImpact_A	AdditionalCost	AdditionalCost_A	CostSavings	CostSavings_A	GovernmentSupport	Risk	Risk_A	Risk_B
1	.	.	.	.	.	.	.	.	.	.	.	.	.
2	4	3	3	3	3	3	3	3	2	3	3	3	3
3	2	3	4	5	4	5	2	5	2	5	5	4	2
4	4	4	4	5	4	4	5	4	2	5	4	4	4
5	3	3	5	5	3	5	4	5	3	5	5	5	3
6	4	3	4	4	4	5	4	4	3	3	3	3	3
7	1	4	4	5	4	4	4	4	3	4	4	4	1
8	3	1	3	5	4	4	4	5	3	4	3	2	5
9	3	1	3	5	4	4	4	5	3	4	3	2	5
10	3	3	4	5	3	3	4	4	3	5	3	3	4
11	4	3	4	5	3	4	4	4	3	5	4	3	4
12	4	4	4	5	3	4	4	4	3	5	4	3	3
13	4	4	4	5	4	4	4	4	3	5	4	4	2
14	4	5	5	5	4	4	5	5	3	5	4	4	2
15	3	3	5	5	4	4	4	4	3	5	5	4	3
16	4	3	4	5	4	4	4	4	3	5	4	4	2
17	3	5	5	4	3	3	5	4	4	5	3	3	2
18	5	3	4	5	2	5	5	4	4	5	4	4	3
19	5	5	5	4	4	4	5	5	4	5	5	5	2
20	4	4	4	5	4	4	2	4	4	4	4	3	3
21	4	4	4	5	3	4	4	5	4	4	4	4	4
22	3	3	3	5	5	4	4	5	4	5	4	4	3
23	4	3	5	5	3	4	4	4	4	5	4	4	3
24	3	3	4	5	3	4	4	4	4	5	4	4	3
25	3	2	4	5	3	4	4	4	4	5	4	4	2
26	3	3	3	5	3	4	4	4	4	5	4	4	3

SPSS Variable View



	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	PerceptionofManagement	Numeric	40	0	Perception of Management	None	None	11	Right	Nominal	Input
2	PerceptionofManagement_A	Numeric	40	0	Perception of Management	None	None	11	Right	Nominal	Input
3	PerceptionofCustomersexclude	Numeric	40	0	Perception of Customers	None	None	11	Right	Nominal	Input
4	PerceptionofCustomers_A	Numeric	40	0	Perception of Customers	None	None	11	Right	Nominal	Input
5	EnvironmentalImpactexclude	Numeric	40	0	Environmental Impact	None	None	11	Right	Nominal	Input
6	EnvironmentalImpact_A	Numeric	40	0	Environmental Impact	None	None	11	Right	Nominal	Input
7	AdditionalCost	Numeric	40	0	Additional Cost	None	None	11	Right	Nominal	Input
8	AdditionalCost_A	Numeric	40	0	Additional Cost	None	None	11	Right	Nominal	Input
9	CostSavings	Numeric	40	0	Cost Savings	None	None	11	Right	Nominal	Input
10	CostSavings_A	Numeric	40	0	Cost Savings	None	None	11	Right	Nominal	Input
11	GovernmentSupport	Numeric	40	0	Government Support	None	None	11	Right	Nominal	Input
12	Risk	Numeric	40	0		None	None	11	Right	Nominal	Input
13	Risk_A	Numeric	40	0	Risk	None	None	11	Right	Nominal	Input
14	Risk_B	Numeric	40	0	Risk	None	None	11	Right	Nominal	Input
15	Risk_C	Numeric	40	0	Risk	None	None	11	Right	Nominal	Input
16	Behaviour	Numeric	40	0		None	None	18	Right	Nominal	Input
17	Behaviour_A	Numeric	40	0	Behaviour	None	None	11	Right	Nominal	Input
18	POMMean	Numeric	8	2		None	None	10	Right	Scale	Input
19	ACMean	Numeric	8	2		None	None	10	Right	Scale	Input
20	CSMean	Numeric	8	2		None	None	10	Right	Scale	Input
21	RiskMean	Numeric	8	2		None	None	10	Right	Scale	Input
22											
23											
24											
25											
26											
27											
28											
29											

Factor Analysis

Correlation Matrix

Correlation Matrix

		Perception of Management	Perception of Management	Perception of Customers	Perception of Customers	Environmental Impact	Additional Cost	Additional Cost	Cost Savings	Cost Savings	Government Support	Risk	Risk	Risk	Risk
Correlation	Perception of Management	1.000	.137	.203	.191	.045	.226	.209	.515	-.126	.317	.288	.300	-.105	.128
	Perception of Management	.137	1.000	.356	.233	-.023	-.034	.045	-.017	.091	.198	.223	.271	-.100	-.051
	Perception of Customers	.203	.356	1.000	.579	.193	-.205	.012	-.066	.160	.180	.325	.475	-.583	-.495
	Perception of Customers	.191	.233	.579	1.000	-.081	.025	.154	.163	.190	.295	.403	.489	-.407	-.500
	Environmental Impact	.045	-.023	.193	-.081	1.000	-.023	-.404	.139	.011	-.080	.156	.097	-.242	.042
	Additional Cost	.226	-.034	-.205	.025	-.023	1.000	-.162	.196	-.346	.358	.466	.364	-.083	.234
	Additional Cost	.209	.045	.012	.154	-.404	-.162	1.000	.034	.154	-.067	-.353	-.164	.262	.036
	Cost Savings	.515	-.017	-.066	.163	.139	.196	.034	1.000	-.026	.089	.286	.190	.115	-.132
	Cost Savings	-.126	.091	.160	.190	.011	-.346	.154	-.026	1.000	-.326	-.333	-.142	.090	-.293
	Government Support	.317	.198	.180	.295	-.080	.358	-.067	.089	-.326	1.000	.713	.663	-.478	.133
	Risk	.288	.223	.325	.403	.156	.466	-.353	.286	-.333	.713	1.000	.884	-.581	-.197
	Risk	.300	.271	.475	.489	.097	.364	-.164	.190	-.142	.663	.884	1.000	-.682	-.250
	Risk	-.105	-.100	-.583	-.407	-.242	-.083	.262	.115	.090	-.478	-.581	-.682	1.000	.308
	Risk	.128	-.051	-.495	-.500	.042	.234	.036	-.132	-.293	.133	-.197	-.250	.308	1.000

KMO & Bartlett Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.644
Bartlett's Test of Sphericity	Approx. Chi-Square	234.156
	df	91
	Sig.	.000

Anti-Image Matrices

Anti-image Matrices

		Perception of Management	Perception of Management	Perception of Customers	Perception of Customers	Environmental Impact	Additional Cost	Additional Cost	Cost Savings	Cost Savings	Government Support	Risk	Risk	Risk	Risk
Anti-image Covariance	Perception of Management	.477	.002	-.134	.028	.042	-.060	-.097	-.263	.013	-.026	.000	.001	.024	-.135
	Perception of Management	.002	.747	-.145	.002	.054	.058	-.003	.035	-.089	-.005	-.029	-.014	-.110	-.084
	Perception of Customers	-.134	-.145	.303	-.119	-.120	.097	-.012	.116	.028	.017	.013	-.029	.069	.109
	Perception of Customers	.028	.002	-.119	.444	.069	-.054	-.109	-.052	-.115	-.034	-.026	.014	.021	.079
	Environmental Impact	.042	.054	-.120	.069	.590	.046	.120	-.141	-.084	.119	-.040	.034	.103	-.168
	Additional Cost	-.060	.058	.097	-.054	.046	.568	.016	.023	.046	.057	-.046	-.024	-.021	-.093
	Additional Cost	-.097	-.003	-.012	-.109	.120	.016	.492	-.031	.075	-.077	.099	-.082	-.086	.015
	Cost Savings	-.263	.035	.116	-.052	-.141	.023	-.031	.448	-.030	.026	-.038	.003	-.101	.122
	Cost Savings	.013	-.089	.028	-.115	-.084	.046	.075	-.030	.600	-.017	.096	-.090	-.051	.099
	Government Support	-.026	-.005	.017	-.034	.119	.057	-.077	.026	-.017	.294	-.075	.017	.082	-.142
	Risk	.000	-.029	.013	-.026	-.040	-.046	.099	-.038	.096	-.075	.084	-.074	-.026	.053
	Risk	.001	-.014	-.029	.014	.034	-.024	-.082	.003	-.090	.017	-.074	.120	.075	-.025
	Risk	.024	-.110	.069	.021	.103	-.021	-.086	-.101	-.051	.082	-.026	.075	.309	-.065
	Risk	-.135	-.084	.109	.079	-.168	-.093	.015	.122	.099	-.142	.053	-.025	-.065	.368
Anti-image Correlation	Perception of Management	.554[a]	.004	-.351	.060	.078	-.115	-.200	-.569	.023	-.069	-.001	.006	.062	-.322
	Perception of Management	.004	.634[a]	-.305	.004	.082	.088	-.005	.061	-.133	-.012	-.115	-.047	-.230	-.161
	Perception of Customers	-.351	-.305	.675[a]	-.325	-.283	.233	-.031	.314	.066	.057	.081	-.153	.225	.327
	Perception of Customers	.060	.004	-.325	.813[a]	.134	-.107	-.233	-.116	-.222	-.093	-.137	.059	.057	.194
	Environmental Impact	.078	.082	-.283	.134	.362[a]	.079	.222	-.274	-.140	.286	-.179	.128	.242	-.361
	Additional Cost	-.115	.088	.233	-.107	.079	.790[a]	.031	.046	.078	.139	-.209	-.091	-.051	-.203
	Additional Cost	-.200	-.005	-.031	-.233	.222	.031	.455[a]	-.066	.139	-.202	.486	-.337	-.220	.035
	Cost Savings	-.569	.061	.314	-.116	-.274	.046	-.066	.412[a]	-.059	.071	-.195	.015	-.272	.300
	Cost Savings	.023	-.133	.066	-.222	-.140	.078	.139	-.059	.542[a]	-.041	.427	-.333	-.119	.211
	Government Support	-.069	-.012	.057	-.093	.286	.139	-.202	.071	-.041	.722[a]	-.474	.089	.272	-.431
	Risk	-.001	-.115	.081	-.137	-.179	-.209	.486	-.195	.427	-.474	.645[a]	-.732	-.164	.300
	Risk	.006	-.047	-.153	.059	.128	-.091	-.337	.015	-.333	.089	-.732	.725[a]	.390	-.118
	Risk	.062	-.230	.225	.057	.242	-.051	-.220	-.272	-.119	.272	-.164	.390	.752[a]	-.192
	Risk	-.322	-.161	.327	.194	-.361	-.203	.035	.300	.211	-.431	.300	-.118	-.192	.494[a]

a. Measures of Sampling Adequacy(MSA)

Communalities

Communalities

	Initial	Extraction
Perception of Management	1.000	.771
Perception of Management	1.000	.637
Perception of Customers	1.000	.795
Perception of Customers	1.000	.734
Environmental Impact	1.000	.836
Additional Cost	1.000	.610
Additional Cost	1.000	.732
Cost Savings	1.000	.864
Cost Savings	1.000	.524
Government Support	1.000	.766
Risk	1.000	.906
Risk	1.000	.862
Risk	1.000	.746
Risk	1.000	.824

Extraction Method: Principal Component Analysis.

Total Variance Explained Table

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.173	29.809	29.809	4.173	29.809	29.809	3.158	22.554	22.554
2	2.361	16.863	46.672	2.361	16.863	46.672	2.708	19.341	41.895
3	1.700	12.142	58.815	1.700	12.142	58.815	1.651	11.796	53.691
4	1.334	9.528	68.343	1.334	9.528	68.343	1.623	11.594	65.285
5	1.040	7.428	75.771	1.040	7.428	75.771	1.468	10.486	75.771
6	.819	5.852	81.623						
7	.640	4.570	86.193						
8	.519	3.706	89.899						
9	.416	2.970	92.869						
10	.359	2.565	95.434						
11	.223	1.592	97.026						
12	.192	1.369	98.395						
13	.174	1.240	99.636						
14	.051	.364	100.000						

Extraction Method: Principal Component Analysis.

Component Matrix

Component Matrix[a]

	Component				
	1	2	3	4	5
Perception of Management	.406		.595		
Perception of Management					.635
Perception of Customers	.608	−.609			
Perception of Customers	.620	−.479			
Environmental Impact			−.516	.633	
Additional Cost		.654			
Additional Cost			.757		
Cost Savings			.473	.713	
Cost Savings		−.661			
Government Support	.716				
Risk	.903				
Risk	.922				
Risk	−.753				
Risk		.685			.470

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

Rotated Component Matrix

Rotated Component Matrix[a]

	Component 1	2	3	4	5
Perception of Management			.772		
Perception of Management					.790
Perception of Customers		.690			.538
Perception of Customers		.768			
Environmental Impact				-.880	
Additional Cost	.682				
Additional Cost				.755	
Cost Savings			.895		
Cost Savings	-.603				
Government Support	.819				
Risk	.824				
Risk	.728	.490			
Risk	-.495	-.544			
Risk		-.876			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 8 iterations.

Component Transformation Matrix

Component Transformation Matrix

Component	1	2	3	4	5
1	.718	.555	.212	-.184	.311
2	.595	-.727	.204	-.078	-.262
3	-.059	-.013	.634	.751	.172
4	-.321	.082	.713	-.573	-.231
5	-.151	-.394	.050	-.259	.867

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Regression

Descriptive Statistics

	Mean	Std. Deviation	N
Behaviour	3.22	.898	36
POMMean	3.9722	.50631	36

Correlations

		Behaviour	POMMean
Pearson Correlation	Behaviour	1.000	.422
	POMMean	.422	1.000
Sig. (1-tailed)	Behaviour	.	.005
	POMMean	.005	.
N	Behaviour	36	36
	POMMean	36	36

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	POMMean[b]	.	Enter

a. Dependent Variable: Behaviour

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.422[a]	.178	.154	.826

a. Predictors: (Constant), POMMean

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.036	1	5.036	7.386	.010[b]
	Residual	23.186	34	.682		
	Total	28.222	35			

a. Dependent Variable: Behaviour

b. Predictors: (Constant), POMMean

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.246	1.104		.223	.825		
	POMMean	.749	.276	.422	2.718	.010	1.000	1.000

a. Dependent Variable: Behaviour

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions	
				(Constant)	POMMean
1	1	1.992	1.000	.00	.00
	2	.008	15.976	1.00	1.00

a. Dependent Variable: Behaviour