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Apartment Residents' Understanding of and Satisfaction with Water Savings Devices

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Apartment Residents' Understanding of and Satisfaction with Water Savings Devices

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by

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ABSTRACT

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by

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As the human population increases, the way we use and manage our shrinking supply of drinking water becomes even more important. Education in water management is key to sustaining this life essential resource. One approach to water conservation is through mechanical means using low flow devices. The purpose of this study was to determine residents' satisfaction level of and performance rating of new water savings devices installed in their apartments. Specifically the investigation focused on ratings of new low flow shower heads, kitchen faucet aerators, bath faucet aerators, and fill valve and flapper systems installed in existing toilets that reduce water use up to 50%.

This quantitative survey included residents at 4 apartment complexes in Tennessee using a paper questionnaire (N = 626). The participants were grouped by age, ethnicity, gender, and whether or not they had experienced both nonrestrictive devices or restrictive low flow devices within their apartment. An independent samples *t* test was conducted from the research questions for each of these 4 groups.

The testing variables for each group consisted of the overall performances of the low flow devices, and the satisfaction of the time to get hot water to shower heads and faucets. There was no significant difference between the 4 grouping variables; residents aged 62 and over compared to 61 and younger, males compared to females, whites compared to nonwhites, and those who had experienced both nonrestrictive and

restrictive devices while living in the same apartment when compared to these variables; performance rating of low flow shower heads, kitchen faucet aerators, bath faucet aerators, and low flow toilet devices. The variables also included the satisfaction rating of the time needed to get hot water to the new low flow shower heads and kitchen and bath faucet aerators.

These findings support the effort to save clean water and reduce water and sewer costs by installing low flow shower heads, bath and faucet aerators, and water saving toilets. Mean score suggest satisfactory ratings were encountered in every testing category and within every group. In particular, the satisfactory mean score of residents who experienced both nonrestrictive and low flow devices while in the same apartment led to the conclusion that the reduction of water can be achieved satisfactorily in all types of residences.

DEDICATION

This work is dedicated to my wife Kay. Thank you for your love, support, and patience.

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The researcher acknowledges his sincere thanks to: James Lampley, my committee chair, who kept me focused and encouraged, and Greg McGrath, CEO of Earth Water Company, who chose me as a partner to help the world save clean water, one community at a time.

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CHAPTER 1

INTRODUCTION

Two phenomena have occurred in the United States concerning water consumption, an increased demand for potable (drinking) water resources (Attari, 2014), and the aging and deterioration of urban water and sewer infrastructure (Halsey 2012). Jeong, Gulbinas, Jain, and Taylor (2014) predicted that by 2030 only 60% of the world's demand for water will be met. Halsey (2012) noted that just like aging roads and bridges, the sanitary sewer infrastructure in urban cities is in dire need of repair. The resources needed to engineer and modernize this infrastructure will come from future increases in water and sewer rates (Halsey, 2012).

In addition to increased water demand, cities have faced fiscal challenges with leaky sanitary sewers. For example the city of Akron Ohio paid $1.4 million in a 2009 federal lawsuit for violations of the Clean Water Act (Akron to Settle, 2009). Billions of gallons of water contaminated with sewage spilled into the Cuyahoga River and two other tributaries that flow into Cleveland and on into Lake Erie. As directed by the Clean Water Act, Akron must eliminate sewage overflows into the Cuyahoga by 2028.

One way to sustainably engage these upcoming increases will be to consume less water, not just voluntarily, but more consistently through low flow mechanical means such as low cost and low flow toilets, shower heads, and faucet aerators. Additionally, a more costly but complementary solution would be to include water conserving washing machines and dishwashers. Apartment owners and landlords who pay for water and sewer as part of resident's rent have now realized one way to reduce

their costs and be more sustainable would be to install these fixtures themselves or use a contractor that would provide a turnkey water reduction program with a pay back through savings.

Water conservation has become an issue of increasing importance as drinking water has exceeded supply (Attari 2014). Much of the literature focused on situations in dry states such as Arizona, Nevada, California, and other western states, but most states have been affected by drought conditions in recent years. For example, as recently as March 2018 Georgia made headlines as it continues to battle Tennessee for access to the Tennessee River near Chattanooga. Metro Atlanta has been growing so rapidly that it consumes 500,000 gallons of water per day, about half of what Georgia water rights attorneys believe the Tennessee River could deliver ("Georgia wants to take," 2018).

Because United States residents use more than three times the water than the average European citizen, water conservation and education policies in the U.S. continue to be important (Campbell, Johnson, & Larson, 2004). Campbell et al. examined several aspects of the City of Phoenix' water conservation programs, several aspects of resident behavior such as volunteer programs, the use of low flow shower heads and sink faucet restrictors, and how effective and continuous direct human communication was versus general and generic written communication. For example, this study found that the use low flow devices alone without instruction or good communication could cause off setting behavior, a negative effect where persons use more water because they resist a policy being forced on them. Low flow devices alone

have proven to reduce water consumption, but they are most efficient when combined with a well communicated and accepted conservation plan.

Campbell et al. (2004) also found in their Phoenix study that increasing water and sewer prices by 1% would reduce household water use by 0.27%. At a large aggregate rate such as 278,000 homes, the small price increase could save over 1 billion gallons in 1 year. The team also measured conservation information that was delivered to households, and separately to children and the general public. Educational brochures distributed directly to households on how to perform a home water audit proved noneffective but providing the same information to residents with children was. For every 1% increase in the number of children in the household there was a decrease in water use by 0.31%. Their findings concluded that one time printed information sent to homes was ineffective, but the most effective happened with repeated communication such as billboards, radio announcements, and in combination with children's education directed at water conservation.

Corral Verdugo, Bechtel, and Fraijo Sing (2003) addressed environmental beliefs on water consumption from 510 persons in Hermosillo and Ciudad Obregon, two northern Mexican cities. The researchers used the term conservation competency to describe a factor that directly influences conservation behavior. Corrol Verdugo et al. asserted that water beliefs are directly related to water consumption and that it is imperative water education include convincing evidence that water is not an unlimited resource. They added that more global environmental efforts might guide the public to increase their conservation efforts.

Statement of the Problem

The purpose of this qualitative study was to determine the satisfaction level of low flow water savings devices installed in subsidized apartments in Nashville and Knoxville Tennessee. The intent of the study was to identify the opinions of those who were present both before and after the devices were installed versus the population who experienced only the new low flow devices. This approach was taken because there were residents in both age groups (62 and over and 61 and under) who experienced the old higher flow and the new low flow devices and residents in both age groups who experienced only the new low flow devices.

Research Questions

The following research questions guided this research. Most focused on the mechanical means and devices used in residential units for saving water.

Research Question 1: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their shower head?

Research Question 2: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the satisfaction of time to get hot water to their shower head?

Research Question 3: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their kitchen faucet aerator?

Research Question 4: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their kitchen faucet?

Research Question 5: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding performance of their bath faucet aerator?

Research Question 6: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their bath faucet?

Research Question 7: Is there a significant difference in the mean score of residents 62 and over as compared to 61 and under regarding performance of their toilet after installation of water savings devices?

Research Question 8: Is there a significant difference in the mean score of males compared to females regarding performance of their shower head?

Research Question 9: Is there a significant difference in the mean score of males compared to females regarding satisfaction of time to get hot water to their shower head?

Research Question 10: Is there a significant difference in the mean score of males compared to females regarding performance of their kitchen faucet aerator?

Research Question 11: Is there a significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their kitchen faucet?

Research Question 12: Is there a significant difference in the mean score of males as compared to females regarding performance of bath faucet aerators?

Research Question 13: Is there a significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their bath faucet?

Research Question 14: Is there a significant difference in the mean score of males as compared to females regarding performance of their toilet after installation of water savings devices?

Research Question 15: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their shower heads?

Research Question 16: Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their shower head?

Research Question 17: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their kitchen faucet aerators?

Research Question 18: Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their kitchen faucet?

Research Question 19: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their bath faucets?

Research Question 20: Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their

bath faucets?

Research Question 21: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their toilets after installation of water savings devices?

Research Question 22: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their shower heads?

Research Question 23: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their shower heads?

Research Question 24: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their kitchen faucet aerators?

Research Question 25: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their kitchen faucets?

Research Question 26: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their bath faucet aerators?

Research Question 27: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their bath faucets?

Research Question 28: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their toilets after installation of water savings devices?

Significance of the Study

Apartment owners across the country who pay for their residents' water and sewer as part of their rent may be interested in saving water for the purposes of reducing consumption and saving money. Saving water may also be beneficial to public housing and other public budgets funded by taxpayers. Renters opinions and perspectives will matter most to leasing agents and property managers as their job is to lease the apartments, collect rent, and keep occupancy numbers high.

If the opinions of the residents (both age groups, genders, and ethnicities) who experienced only the low flow devices rank satisfactory to very satisfactory; then, it may be hypothesized these low flow devices are of sufficient flow and provide hot water to the fixture at an effective rate that they may be used in any apartment and be classified as a new standard.

If both age groups, genders, and ethnicities rate the devices as unsatisfactory then the study would be significant to apartment leasing agents and owners who may

consider their amenities as substandard. There is not a minimum mechanical standard of sufficient water flow as part of this study, but if the lack of adequate water pressure affected the ability to market and lease the apartments, owners may consider changing their water reduction methods.

Limitations and Delimitations

Adequate water pressure was provided in each apartment. A lack of adequate water pressure would directly affect respondents' answers toward unsatisfactory. Representatives of the two age groups (62 and older and 61 and under) were no different in Nashville or Knoxville. Those areas were chosen because almost identical water savings devices had been installed in both areas.

Managers or apartment staff did not influence resident's answers and the residents had no idea how much water these devices collectively were saving. It is assumed that saving money was a primary motive in using the low flow devices; however, saving natural resources could be equally important to apartment owners.

Water reduction within apartments in each of the four property areas was mandatory and the residents did not receive the benefits of money savings. Similar research regarding the satisfaction of low flow water devices has been conducted on private homeowners who received a direct monetary benefit through lower water bills. This benefit could affect how people perceive water savings initiatives.

Water pressure was not documented at any of the apartment sites but could be a factor in how residents answer the questions regarding how quickly hot water reaches the faucet. Disability status was not considered within the scope of this study.

Definitions of Terms

The following terms were used throughout this study. All are common terms in water conservation and the efficient use of water.

Aerator – A threaded device on the end of a faucet that water passes through and is filtered. Aerators come in different gallons per minute (gpm) flow rates. (US EPA Combined retrofit report, 2005)

Hundred Cubic Feet (CCF). The typical unit of measure for water consumption used in water billing. (Mayer et al., 2004)

Flow Rate – The rate of flow of water through a fixture typically measured in gallons per minute (GPM) or gallons per flush (GPF). (Mayer et al., 2004)

High efficiency toilets – Toilets that have a flow rate of less than 1.6 gallons per flush. Ultra high efficiency toilets have a flow rate of less than 1.0 gallons per flush. (Mayer et al., 2003)

Low flow devices – A general term describing shower heads that have a flow rate of less than 2.0 gallons per minute and faucet aerators that have a flow rate of less than 1.5 gallons per minute. (Mayer et al., 2003)

WaterSense – A water conservation program using low flow fixtures that was developed by the Environmental Protection Agency in 2006. Many financial lenders require plumbing fixtures to meet minimum WaterSense standards. (GMP Research, 2015)

Overview of Study

Chapter 1 includes a brief introduction as part of the problem statement, 28

research questions in a null hypothesis format, the assumptions presented by the researcher, the limitations of the study, the significance of the research, definitions, and the organization of the study. Chapter 2 presents a review of literature and research relevant to the problem statement. Chapter 3 presents the procedures and methodology used in the study to obtain survey and other research data. It will include the description of the study and a detailed description of the apartment residents studied. Chapter 4 presents the data collected in the study, a discussion of the findings, and the analysis of data. Chapter 5 concludes the study with a summary of findings, conclusions, and recommendations for future studies.

CHAPTER 2

REVIEW OF LITERATURE

Drinking water has always been essential for life but there are so many other uses we take for granted. As the world's population increases so does the need to manage critical resource of water (Russell & Fielding, 2010). The EPA stated that although the population has doubled in the last 50 years, the need for water has tripled ("Water conservation at EPA" website). Halsey 2012 described water in our homes as "magic" as we turn a knob and water comes out and what we don't use mysteriously disappears down a hole in the bottom of a sink, tub, or toilet. Just as importantly, but not a primary focus of this research is waste water, also known as sanitary sewage or simply "sewer." Waste water is directly proportional in quantity and cost and both water and waste water have elaborate underground infrastructure systems.

Infrastructure is being taxed in two ways, age and use. Halsey (2012) also described a pizza size hole in a downtown Washington D.C. street that developed after a metro bus passed by. A worker shined his flashlight into the hole expecting something minor, but it turned out to be a large cavern created from a leaking sewer line built in 1889. The repair took 3 weeks and cost over $1 million. The ultimate cost for replacing infrastructure will be paid by the end user and much of the cost will be based proportionally to the amount of water and sewer used. (Halsey, 2012)

As a result of an EPA fine for significant sewer leakage into a tributary that feeds into Lake Erie, Akron Ohio was fined $28 million in 2009. ("Akron to settle,"

2009). In order for the city of Akron to pay the fines and implement a plan to modernize its sanitary sewer system, sewer rates were raised to at least four times water consumption costs.

Lee, Tansel, and Balbin (2011) declared that an important factor in saving water will be to keep saving it for years to come. If not managed properly, leaks will continue and go unrepaired. Efficient water management should include making the issue a priority and recording water consumption each month. Lee et al. noted that a properly managed conservation program with water savings devices would actually show increased savings after the first 2 years, mainly for the reason that people had gotten used to the program and agreed with the benefit of saving water over time.

For owners of apartments who include water and sewer in their rent, water conservation has become a way of saving money and generating revenue. In the real estate investment world where bottom lines matter, saving 30%-50% in water and sewer costs with little or no investment should be a welcoming proposition, with the environmental impact a collateral benefit that truly makes this a win win result. Secondarily, this overall environment presents a low cost way to do the right thing and conserve water. The facts of lowering water consumption and costs have been made evident, but this research will be focused on the perceptions of residents who receive these devices, more specifically if there a difference in perception between two distinct affordable populations, those who are age 62 or older and those 61 and under. The reason this age was chosen was because HUD describes residents over age 62 as elderly and many times they are qualified to live in a high rise apartment building in

apartment flats served by elevators instead of the traditional townhouse or garden style that usually have stairs and require walking several yards from parking areas.

The full use of or life cycle of water from beginning to end also included the waste water categories of grey water and black water. Advanced technologies now allow for advances in water conservation, including the catchment and treatment of grey water and rain water that can be stored, recycled, and plumbed into a separate system for the purpose of flushing the toilet or be used in landscaping irrigation. Because much of the water released into drains from showers, tubs, sinks, and washing machines will be heated to some degree, new research has been finding ways to capture the heat and use it to preheat water before it enters a water heater, resulting in the water heater being much more efficient (Mooney, 2015).

History of Water Use and Regulations

Indoor water use had no real government regulation or standards until 1969. As seen in this chronological history, the Environmental Policy Act of 1992 was a significant first step by the federal government in regulating water use.

- 1880s – First high tank, gravity activated toilet which used 10 gallons per flush
- 1920s Typical tank toilet that used water pressure to fill tank. Used 5 to 7 gallons per flush
- 1969 – ANSI produced first standards on plumbing fixtures
- 1974 – First 3.5 gallons per flush tank toilets introduced
- 1978 – California issued new law that no tank toilets be manufactured that are more than 3.5 gallons per flush (gpf)

- 1989 – Connecticut was first state to pass and enforce water efficiency standards.
- 1992 – The Environmental Policy Act of 1992 was signed by George H.W. Bush. Tank toilets to have maximum flush of 1.6gpf, and that faucets and shower heads produce no more than 2.5gpm. The Act did not go into effect until 1994.
- 2005 – Environmental Policy Act was revised to lower faucet rates to 2.2 gallons per minute (gpm)
- 2006 – Environmental Protection Agency launched WaterSense, a voluntary program with advanced water efficiency goals.
- 2012 – Georgia begins the Water Stewardship Act that required increased efficiency for toilets and faucets, as well as required sub metering for multi-unit residential buildings.
- 2014 – Colorado was the first state to require WaterSense fixtures at new construction or major renovation.
- 2015 – Several states have enacted programs for minimum water efficiency

("History of Plumbing," 2014, p. 1).

A positive effect that has occurred as a result of water conservation is less hot water is needed to accomplish the same tasks as showering and sink use. Mayer et al. (2003) found in their study of the East Bay district that after new low flow shower heads and faucet aerators were installed, residents reduced their hot water use an average of 4.6 gallons per day. That is about $10 to $15 per month electricity savings, depending on the rate of electricity. Typically in apartments where residents received some form of financial subsidy, landlords paid for water, sewer, and trash removal, while the resident paid for electric and the nonessential utilities such as cable, internet, and phone service.

Water Conservation and Efficiency

Domestic water can be conserved in two ways: 1) Consciously reducing the amount of water used such as taking shorter showers, not running water while brushing teeth or shaving, flushing only when necessary, using shorter cycles on dishwashers and washing machines, and 2) mechanically reducing water usage through devices that restrict flow and water pressure such as low flow shower heads, sink aerators, and toilets. Modern dishwashers and washing machines now use much less water through more efficient cycles and improved detergent cleaning. This research involved the mechanical reduction (Russell & Fielding, 2010).

Much of the literature regarding attitudes of water conservation predominately comes from Australia, Brazil, Mexico, and regional areas in the United States, including Florida and California. For example, Coelho et al. (2010) focused on conservation and wastage in Brazil, while Russel and Fielding (2010) documented water demand management in Australia. There seems to be much information on water conservation in general but finding specific information regarding opinions of residents in a residential was more of a challenge.

A second theme from the literature has been certain areas that are under constant threat of not having enough drinking water because of drought. Australia experienced a great drought for 2 years beginning in 2005 that forced the country to institute immediate water conservation, but it also brought that country to the forefront of cutting edge technology and social acceptance of using less water (Randolph & Troy 2008).

Randolph and Troy (2008) studied Sydney Australia's struggle with sustaining a stable water supply during their 2005/2006 drought. They concluded that water demand was very complex from different residential sources and needed to be better understood. They randomly called 2,179 households with a telephone survey. In addition to dwelling type, they found that behavioral, cultural, and institutional aspects of consumption all need to be considered if public policy is to be successful.

Attitudes Toward Conservation

Seyranian, Sinatra, and Polikoff (2014) examined the effectiveness of four different communications that were sent to affluent households in Los Angeles County about how much water would be saved. They suggested one limitation was that this was only behavioral research and recommended a survey with age and education would be helpful, and that socially oriented interventions appear to be a promising area of future research for promoting water stewardship and reducing water waste. They concluded that more socially oriented communications instead of just knowledge based communications would help in limiting resident's resistances to conservation methods.

In addition to motivating factors, Coelho, Gouveia, de Souza, Milfont, and Barros (2015) asserted there are emotional issues within environmental engagement that promote water conservation. These researchers created a 12 step Rating Scale of Emotions towards Water Wastage (RSEWW) that can be used in future research to further its development. Coelho et al. suggested that future studies can develop both cognitive and emotional approaches to predict water conservation.

Dean, Fielding, and Smith (2016) drew on an existing Australian national survey of 5,194 citizens to identify five key groups and their community profiles of engagement in saving water. They concluded that initiatives are best focused on younger urban renters without gardens and who not have experienced water restrictions. The researchers admitted that respondents' behaviors were self reported, and they suggested that further research assess the stability of their profiles over time.

Similar to family and senior housing, student housing is another population where in most cases residents' water bills are included in rent. Jeong, Gulbinas, Jain, and Taylor (2014) examined the link between water consumption and the associated energy savings in 18 dormitories (4,700 residents) over a 6-week period. Student communications and feedback that included language that both water and energy would be saved when participating in water consumption methods produced significant water savings over just the communication that water consumption only would be accomplished. The researchers suggested a longer study that would allow the possibility to tracking diminishing returns over time.

Lee, Tansel, and Balbin's (2011) 4 year study of the effects of the city of Miami and Dade County's three incentive programs to replace shower heads, install efficient toilets and washing machines, and water conservation practices. They concluded that the savings declined in years 3 and 4 as most savings were achieved in the first 2 years. No suggestions for further research were discussed.

Corral Verdugo and Frias Armenta (2006) received responses from 177 residents to assess personal beliefs about water savings and water conservation laws, antisocial

behavior, and private water conservation behavior in two Mexican cities. The researchers noted that their sample size was small, and that future research should have more participants, and that new alternative methods, along with some self-reporting methods should be used when studying these relationships.

In comparing the water conservation possibilities Cahill and Lund (2013) noted that Australia's efforts provided a realistic target for residential conservation. They revealed that California and Australia share the same climate, culture, and economy. Their research included a comparison of per capita usage and claims California could have saved significant water if efforts had been instituted earlier. No recommendations for additional research were noted.

A telephone survey of Miami residents conducted by Lee and Tansel (2013) determined that attitudes and opinions of those receiving water efficiency measures such as high efficiency toilets, low flow shower heads, and aerators, were closely correlated to the actual amount of water reduced by participating households. In their similar research, participants were able to keep the cost of water savings. Their report showed an 80%+ positive attitudes for a successful water incentive program.

Water conservation behaviors can be presented as either efficiency or curtailment behavior as explained by Russell and Fielding (2010). Efficiency behavior can be described as one who would use low flow shower heads and or faucets, whereas curtailment described behaviors such as using washing machines only when they were full, turning off the faucet while brushing teeth, and taking shorter showers. They also recommended that the field of environmental psychology needed to be

used in establishing water demand policy. They specifically studied attitudes, beliefs, habits, personal capabilities, and contextual factors and recommended how these could be used to promote further water conservation. They advised that more intervention literature needed to be established.

Before 1992, toilets used approximately three gallons per flush (gpf), sinks used three gallons per minute. Massachusetts became the first state in 1988 to begin requiring low flow toilets. In 1992, President George HW Bush signed the Energy Policy Act required that all toilets manufactured thereafter must be 1.6 gpm or less (History of Plumbing, 2014). Reference the report from 1984 regarding HUD study on water use in over 200 homes in several states. In 1996, researchers at Aquacraft performed a study using the flow trace analysis technique to measure the impacts of a conservation retrofit program. Specifically, it measured shower heads and faucets and clothes washers. Their *Trace Wizard* software automatically disaggregated flow traces into specific end water uses such as toilets and showers (Mayer et al., 2004).

Satisfaction with Low Flow Devices

The US EPA retrofit report (2005) showed that in almost every category, including low flow shower heads, sink aerators, and toilets, residents who received these were better satisfied with the results than they were with their previous non low flow fixtures. In a rating of 0 to 5 with 5 being the most satisfactory these residents ranked their new shower heads at 4.51, new sink aerators at 4.36, and new toilets at a 4.5 versus a 3.5 rating before.

Mayer et al. (2004) noted similar results in their study in the Tampa Florida area.

Fifty percent of the respondents stated they had a noticeable reduction in their water bill, while 19% said they did not believe their water bill was lower. Eighty-four percent said they would keep the water savings devices and 12% said they may make some changes, while 4% were unsure. Four months post installation over 92% liked their new low flow toilets better than the old ones (Mayer et al.)

Unrealized Potential

Johnson (2010) predicted that Florida's projected water demand would go from 7.2 billion gallons per day to 9.1 billion gallons per day by 2020, a substantial rise. GMP Research (2015) shows there are currently over 30 million apartments and condominiums in the United States. GMP also shows just how much of a penetration low flow fixtures have made as yet and how much potential remains for shower heads, toilets, and aerators.

Many large metropolitan areas and municipalities now offer rebate programs for low flow devices such as showerheads and aerators, but are now focusing on appliances such as dishwashers and washing machines and irrigation management. Price and Felardo (2014) found that although toilets by far used the most residential water, their Albuquerque study on water demand found that showerheads were the most cost effective device in the city's rebate program.

By a similar comparison, Willis et al. (2013) showed that the Australian rebate program helped make payback for new low flow showerheads at less than 6 months, but water efficient washing machines had a marginal 6.5 year payback. They conclude that the side effects of a lower demand of water use such as lower water heating

demand and less taxing of the wastewater system is substantial.

Water Conservation Education

A comprehensive water conservation involves several strategies. For example, Rice (2009) referenced a study introducing a water education program on the top 1% high end residential users in San Antonio Texas who received a free water audit from the local water authority during drought conditions. Although it would not be cost effective to provide water audits to every resident, the project did prove this program could produce at least 9% saving. The San Antonio program included commercial and industrial conservation efforts also, but in addition to low flow devices, the residential strategies focused on school education, rebate programs, and changing landscaping to drought tolerant species.

Low flow shower heads save energy by saving hot water, specifically saving the electricity or gas needed to produce hot water. Mooney (2015) reported that low flow shower heads save up to 370 kilowatts in energy to produce hot water over conventional shower heads. That was enough energy to supply a house for 13 days.

Mooney (2015) also described a new water heating recapture system at the forefront of technology and complementary to saving energy through low flow shower heads called a drain water heat recovery system. Using copper as a super heat conductor, copper pipe wraps the plastic drain under a sink or tub. The heated water being lost down the drain heats the cold water in the domestic water system, essentially preheating the water before it enters the water heater.

In addition to water conservation and the side effects of saving electricity or gas for water heating, a major area of consideration is the rising cost of water and sewer. In a water reduction program, amounts saved must be compared to the future cost to get the true picture of money being saved. The University Neighborhood Housing Program (2015) indicated that part of New York City's affordable housing crisis was the ever increasing cost of water and sewer. The cost of both in 2000 was $3.37/CCF but has almost tripled to $9.57 by 2015.

CHAPTER 3

RESEARCH METHOD

The purpose of this research was to determine the satisfaction of and the performance ratings of low flow water savings showerheads, kitchen faucet aerators, bath faucet aerators, and toilets with water saving retrofit devices among four different groups, including age, gender, ethnic background, and between residents who lived in their apartments before March 1, 2016 compared to residents who moved in after that date. Specifically, the two age groups consisted of residents age 62 and over and residents 61 and under. The two gender groups were male and female, whereas the two ethnic groups were whites and nonwhites. Residents who had lived in their apartments prior to and after March 1, 2016 experienced both non low flow and low flow devices, while residents who moved in after March 1, 2016 experienced only the low flow devices. The devices had been installed in an effort to save water and reduce water and sewer costs.

In all four properties surveyed for this research, residents under age 62 typically lived in family units, which broadly meant either townhouses with indoor stairs, one story flats, or garden style apartments. Generally these units have between two and four bedrooms and were accessible from both front and back entrances. Other family members may have lived in the unit but it is the leaseholder who would be under age 61 and younger. Conversely, most residents age 62 and over lived in senior units. These properties normally consisted of a one bedroom unit with one single resident. The apartments housing seniors were located within a multi story high rise building

accessible by an elevator. Residents frequently had access to a pubic laundry room, community room with kitchen, and fitness room.

Research Questions

The following 28 research questions were introduced into the survey in order to meet the objectives of the study. The term water savings fixtures collectively referred to new shower heads, kitchen and bath sink faucet aerators, and new toilet tank devices that lowered the amount of water needed for flushing. Residents who moved in after March 17, 2016 did not experience both the less restrictive water devices and the more restrictive devices. They experienced only the more restrictive devices.

Research Question 1: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their shower head?

Ho1: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of the shower head.

Research Question 2: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the satisfaction of time to get hot water to their shower head?

Ho2: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the satisfaction of time to get hot water to their shower head.

Research Question 3: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their kitchen faucet aerator?

Ho3: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their kitchen faucet aerator.

Research Question 4: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their kitchen faucet?

Ho4: There is no significant difference in the mean score on of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their kitchen faucet.

Research Question 5: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding performance of their bath faucet aerator?

Ho5: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding performance of their bath faucet aerator.

Research Question 6: Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their bath faucet?

Ho6: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their bath faucet.

Research Question 7: Is there a significant difference in the mean score of residents 62 and over as compared to 61 and under regarding performance of their toilet after installation of water savings devices?

Ho7: There is no significant difference in the mean score of residents 62 and over as compared to 61 and under regarding performance of their toilet after installation of water savings devices.

Research Question 8: Is there a significant difference in the mean score of males compared to females regarding performance of their shower head?

Ho8: There is no significant difference in the mean score of males compared to females regarding performance of their shower head.

Research Question 9: Is there a significant difference in the mean score of males compared to females regarding satisfaction of time to get hot water to their shower head?

Ho9: There is no significant difference in the mean score of males compared to females regarding satisfaction of time to get hot water to their shower head.

Research Question 10: Is there a significant difference in the mean score of males compared to females regarding performance of their kitchen faucet aerator?

Ho10: There is no significant difference in the mean score of males compared to females regarding performance of their kitchen faucet aerator.

Research Question 11: Is there a significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their kitchen faucet?

Ho11: There is no significant difference in the mean score of males as compared

to females regarding satisfaction of time to get hot water to their kitchen faucet.

Research Question 12: Is there a significant difference in the mean score of males as compared to females regarding performance of bath faucet aerators?

Ho12: There is no significant difference in the mean score of males as compared to females regarding performance of bath faucet aerators.

Research Question 13: Is there a significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their bath faucet?

Ho13: There is no significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their bath faucet.

Research Question 14: Is there a significant difference in the mean score of males as compared to females regarding performance of their toilet after installation of water savings devices?

Ho14: There is no significant difference in the mean score of males as compared to females regarding performance of their toilet after installation of water savings devices.

Research Question 15: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their shower heads?

Ho15: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their shower heads.

Research Question 16: Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their shower head?

Ho16: There is no significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their shower head.

Research Question 17: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their kitchen faucet aerators?

Ho17: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their kitchen faucet aerators.

Research Question 18: Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their kitchen faucet?

Ho18: There is no significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their kitchen faucet.

Research Question 19: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their bath faucets?

Ho19: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their bath faucets.

Research Question 20: Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their bath faucets?

Ho20: There is no significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their

bath faucets.

Research Question 21: Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their toilets after installation of water savings devices?

Ho2: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their toilets after installation of water savings devices.

Research Question 22: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their shower heads?

Ho22: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their shower heads.

Research Question 23: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their shower heads?

Ho23: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their shower heads.

Research Question 24L Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents

who moved in after March 1, 2016 regarding performance of their kitchen faucet aerators?

Ho24: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their kitchen faucet aerators.

Research Question 25: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their kitchen faucets?

Ho25: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their kitchen faucets.

Research Question 26: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their bath faucet aerators?

Ho26: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their bath faucet aerators.

Research Question 27: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their

bath faucets?

Ho27: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their bath faucets.

Research Question 28: Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their toilets after installation of water savings devices?

Ho28: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their toilets after installation of water savings devices?

Instrumentation

A survey in the form of a questionnaire (see Appendix) was distributed to obtain and provide a measurement of research data. Most items in the survey were formulated into a Likert-type format to gauge residents' satisfaction of and performance ratings of their water savings devices.

The survey was developed to examine two areas of mechanical means of saving water, overall performance of low flow devices including shower heads, faucet aerators, and toilet devices that save water per flush. In addition, as a result of lower flow, hot water takes longer to reach the shower head and faucets. Residents were asked their satisfaction rating of the time it takes to get hot water to the fixture. This area will be

critical in finding the right gallons per minute low flow device that can satisfactorily be installed and give hot water within a reasonable amount of time.

Survey questions (1 to 6) related to basic resident information such as, were the residents heads of household, were they adults, were they under or over age 61, ethnicity, gender, and finally did they live in their apartment on or before March 1, 2016. Their date of move in was relevant to the timing of the installation of water savings devices in their apartment.

Survey questions (7 to 14) were focused on the satisfaction and performance of showerheads, faucet aerators, and water saving toilets with five answer choices ranging from Not Satisfied (1), Somewhat Unsatisfied (2), Satisfied (3), Somewhat Satisfied (4), or Completely Satisfied (5). The performance rating meant the overall experience of the product such as spray quality or adequate water pressure. Satisfaction of the time to get hot water to the shower and faucets was developed as a separate question and was directly related, as low flow devices require more time to get hot water from the water heater to the shower and faucet.

Survey questions (14 to 18) were not relevant to the research but were important to identify residents' perception to other general sustainability issues such as overall energy and water conservation, and recycling. Question 15 related to a resident's inclination to request maintenance to repair a leaking faucet. This area of the survey also provided residents with an area for written comments.

Participants

Two properties in Nashville and two properties in Knoxville were chosen because they presented a sample of all the different grouping variables including various ages, both genders, a variety of ethnic groups, and water savings devices were installed on these sites on or near March 1, 2016.

One building in Nashville and one in Knoxville was a high rise, predominately senior (age 62 and over) occupied, with all apartments being one level, with indoor entrances from a corridor and each floor reached by an elevator, much like a hotel or dormitory. One complex in Nashville and one in Knoxville was a scattered site complex with four to eight apartments per building. Some units were townhouse type, with living room and kitchen on the ground level and steps leading to a second floor that housed two or more bedrooms. Other units were known as flats, with the interior of the apartment being on one level.

The two scattered site complexes typically consisted of family units, which describe persons mostly 61 years of age or younger, and many with children and / or grandchildren. Ethnicities consisted of a large majority of whites, but populations at all surveyed locations included African-Americans, Asians, and Hispanics,

Data Collection

Paper surveys containing return envelopes were distributed at four apartment buildings, two in Nashville and two in Knoxville. Because the owner had a strict *no solicitation* policy, surveys were distributed by the building managers. The researcher received written permission from the owner and each apartment manager who read and

approved the specific questions. Each survey packet included instructions to place the completed document in a sealed collection box at the manager's office within 1 week of distribution.

The researcher received permission from the IRB Manager to proceed with the study on September 7, 2018. A total of 626 surveys were distributed on September 21, 2018 and 215 were collected by the deadline. Data were entered into SPSS in January 2019 and appropriate box plots created.

Data Analysis

A quantitative approach was used for this analysis for specific survey questions. Using a paper questionnaire, the researcher examined potential relationships between residents 62 and over and residents 61 and under, gender, ethnicity, and those who experienced both restricted and nonrestricted water pressure on a nonvoluntary water reduction program that used water restrictive shower heads, faucet aerators, and water saving retrofit parts for toilets. The researcher used a series of independent samples *t* test to compare the means between groups to determine if these means are significantly different. All data were analyzed at the .05 level of significance.

CHAPTER 4

RESULTS

The purpose of this quantitative research was to compare the satisfaction of and performance of water saving showerheads, faucet aerators, and water saving toilet devices to the group variables of age, gender, ethnicity, and whether or not apartment residents experienced both low flow and nonrestrictive devices. From a survey conducted at four apartment complexes, two in Knoxville and two in Nashville Tennessee, 215 residents out of a potential 626 responded to a paper questionnaire in September 2018. Four independent group variables were compared to seven dependent variables, which produced 28 results. The comparisons of those mean scores are evaluated and described below.

Research Questions

Research Question 1

Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their shower head?

Ho1: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of the shower head.

An independent samples *t* test was conducted to evaluate whether the mean score of persons aged 62 and over were significantly different from the mean score of persons aged 61 and under regarding the general level of performance of water savings shower heads. The performance ranking was the test variable and the grouping

variable was the two age groups. The test was not significant, $t(188) = .40$, $p = .693$. Therefore, Ho1 was retained. The Cohen's *d* value of .17 indicated a small effect size. Apartment residents who were 62 years of age and older (M = 3.47, SD = 1.26) tended to rate the performance of new high efficiency low flow shower heads about the same as residents who were 61 years and under (M = 3.39, SD = 1.12). The 95% confidence interval for the difference in means was -.32 to .48. Figure 1 displays the distribution of scores for the for the two groups.

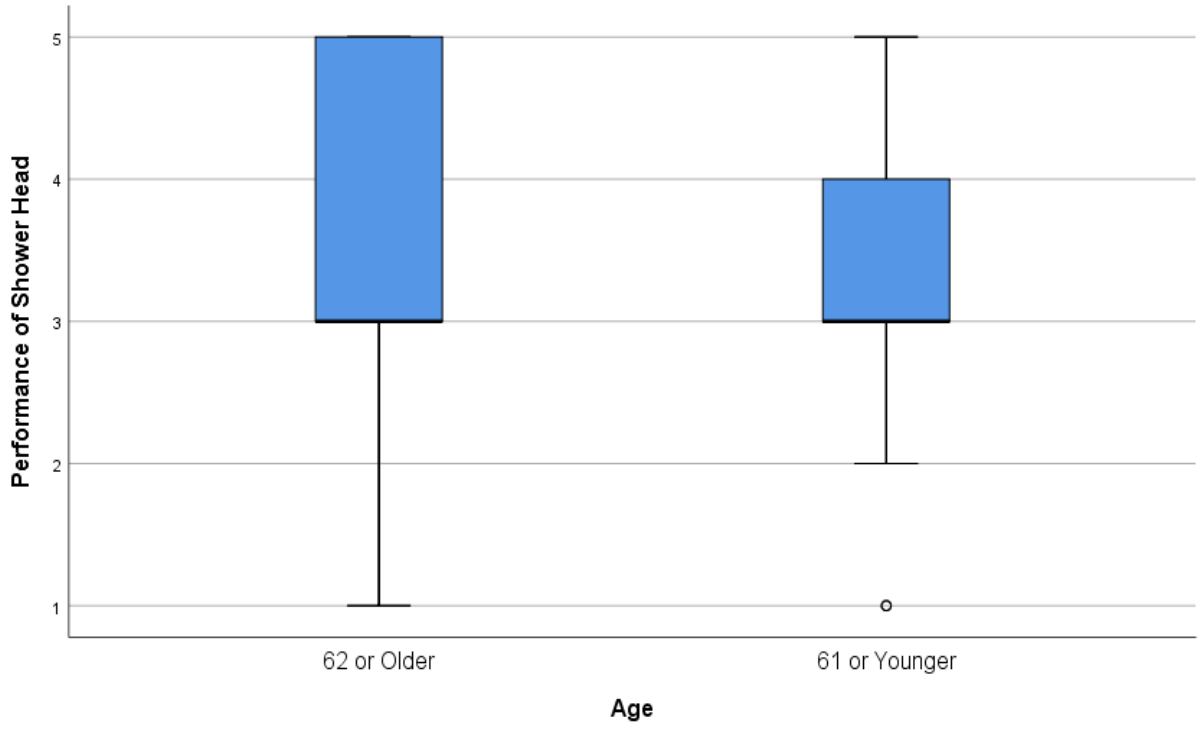

Figure 1. Distribution of scores of groups aged 62 and over compared to 61 and under regarding performance of their shower head.

Research Question 2

Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the satisfaction of time to get hot water to their shower head?

Ho2: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the satisfaction of time to get hot water to their shower head.

An independent samples *t* test was conducted to evaluate whether the mean score of persons aged 62 and over were significantly different from the mean score of persons aged 61 and under regarding their satisfaction of the amount of time it takes hot water to reach their low flow shower heads. The satisfaction ranking was the test variable and the grouping variable was the two age groups. The test was not significant, $t(187) = .93$, $p = .356$. Therefore, Ho2 was retained. The Cohen's *d* value of .17 indicated a small effect size. Apartment residents who were 62 years of age and older (M = 3.56, SD = 1.18) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow shower heads about the same as residents who were 61 years and under (M = 3.73, SD = 1.10). The 95% confidence interval for the difference in means was -.56 to .20. Figure 2 displays the distribution of scores for the for the two groups.

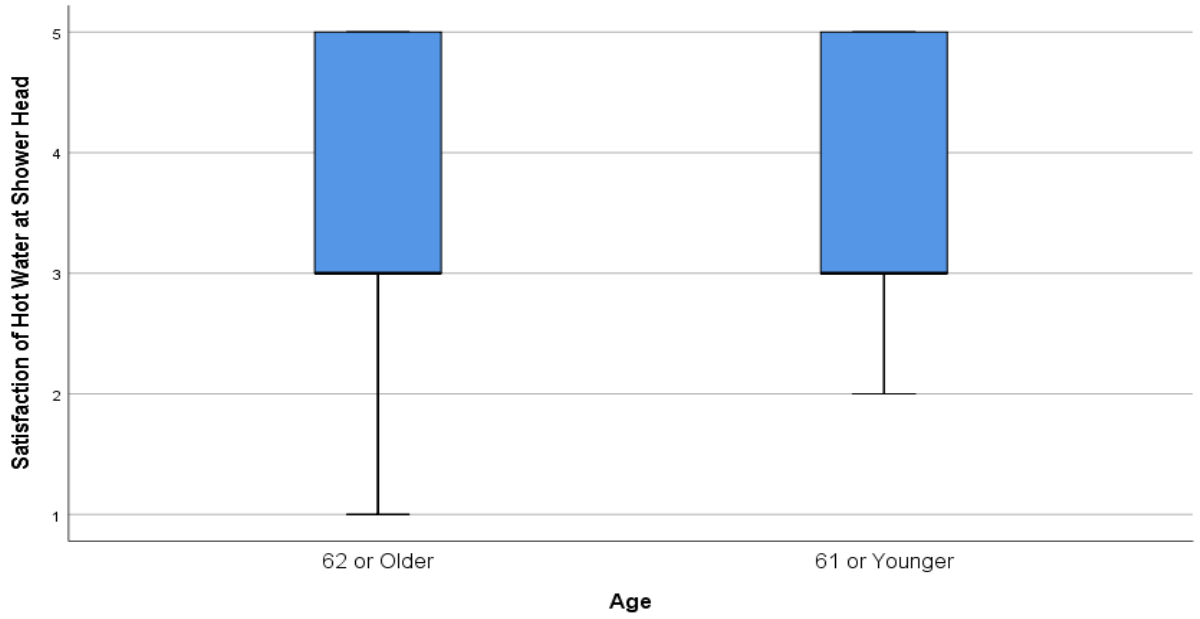

Figure 2. Distribution of scores of groups aged 62 and over compared to 61 and under regarding satisfaction of time to get hot water to their shower head.

Research Question 3

Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their kitchen faucet aerator?

Ho3: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding the performance of their kitchen faucet aerator.

An independent samples *t* test was conducted to evaluate whether the mean score of persons aged 62 and over were significantly different from the mean score of persons aged 61 and under regarding the general level of performance of water saving kitchen faucet aerators. The performance ranking was the test variable and the grouping variable was the two age groups. The test was not significant, $t(192) = .13$,

p = .900. Therefore, Ho3 was retained. The Cohen's *d* value of .17 indicated a small effect size. Apartment residents who were 62 years of age and older (M = 3.35, SD = 1.19) tended to rate the performance of new high efficiency low flow kitchen faucet aerators about the same as residents who were 61 years and under (M = 3.33, SD = 1.25). The 95% confidence interval for the difference in means was -.37 to .42. Figure 3 displays the distribution of scores for the for the two groups.

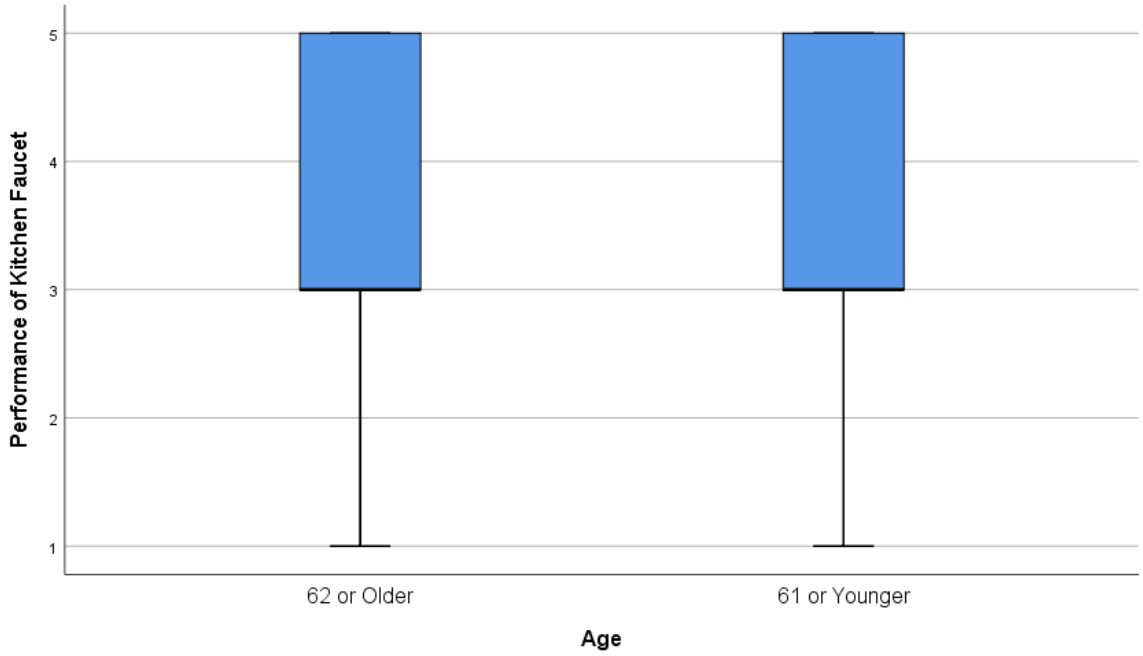

Figure 3. Distribution of scores of groups aged 62 and over compared to 61 and under regarding performance of their kitchen faucet aerator.

Research Question 4

Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their kitchen faucet?

Ho4: There is no significant difference in the mean score on of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their kitchen faucet.

An independent samples *t* test was conducted to evaluate whether the mean score of persons aged 62 and over were significantly different from the mean score of persons aged 61 and under regarding their satisfaction of the amount of time it takes hot water to reach their kitchen faucets. The satisfaction ranking was the test variable and the grouping variable was the two age groups. The test was not significant, $t(192) = 1.18$, $p = .239$. Therefore, Ho4 was retained. The Cohen's *d* value .17 indicated a small effect size. Apartment residents who were 62 years of age and older (M = 3.37, SD = 1.30) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow kitchen faucets about the same as residents who were 61 years and under (M = 3.61, SD = 1.17). The 95% confidence interval for the difference in means was -.66 to .17. Figure 4 displays the distribution of scores for the for the two groups.

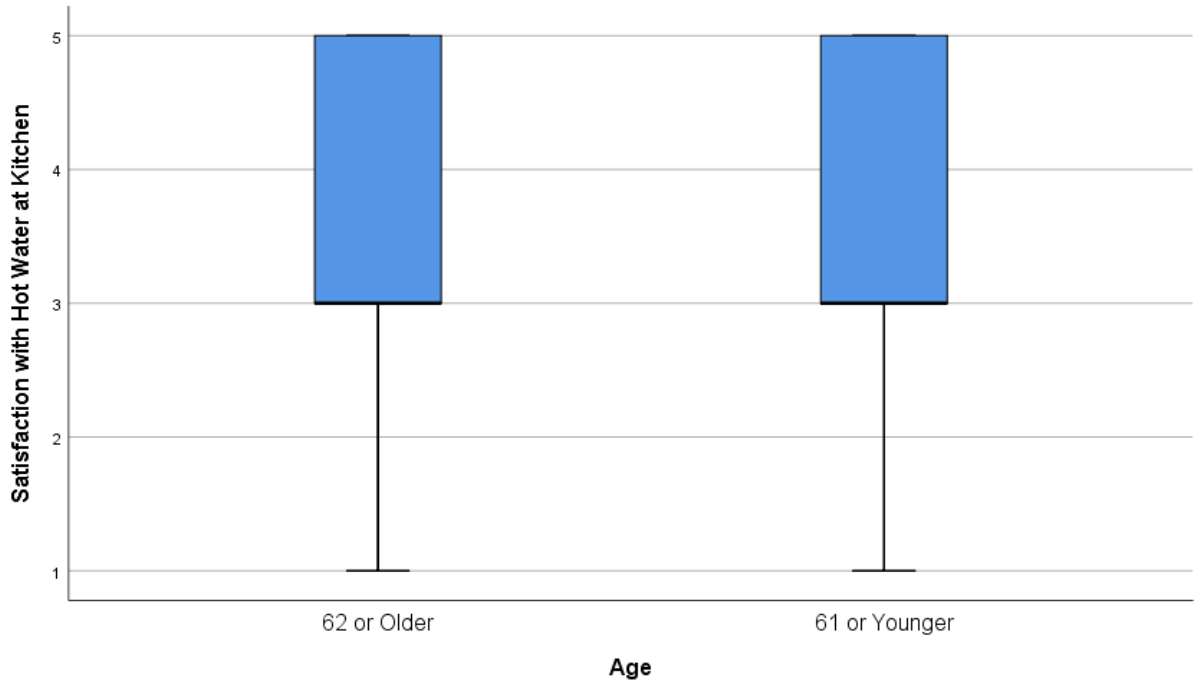

Figure 4. Distribution of scores of groups aged 62 and over compared to 61 and under regarding satisfaction of time to get hot water to their kitchen faucet.

Research Question 5

Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding performance of their bath faucet aerator?

Ho5: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding performance of their bath faucet aerator.

An independent samples *t* test was conducted to evaluate whether the mean score of persons aged 62 and over were significantly different from the mean score of persons aged 61 and under regarding the general level of performance of water savings bath faucet aerators. The performance ranking was the test variable and the grouping variable was the two age groups. The test was not significant, $t(189) = .51$, $p = .611$.

Therefore, Ho5 was retained. The Cohen's *d* value of .17 indicated a small effect size. Apartment residents who were 62 years of age and older (M = 3.30, SD = 1.24) tended to rate the performance of new high efficiency low flow bath faucets about the same as residents who were 61 years and under (M = 3.41, SD = 1.27). The 95% confidence interval for the difference in means was -.51 to .30. Figure 5 displays the distribution of scores for the for the two groups.

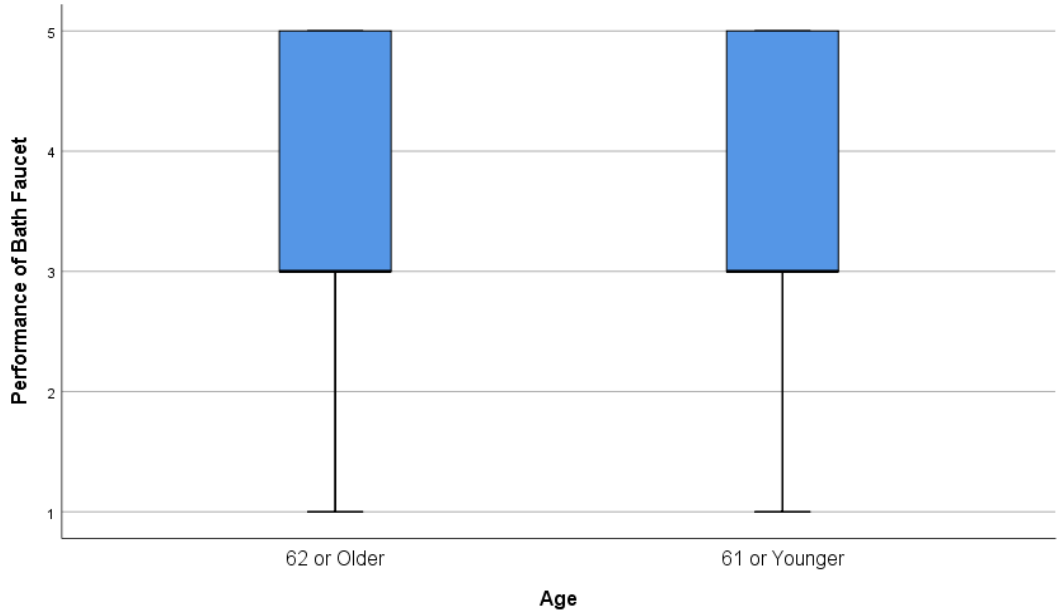

Figure 5. Distribution of scores of groups aged 62 and over compared to 61 and under regarding performance of their bath faucet aerator.

Research Question 6

Is there a significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their bath faucet?

Ho6: There is no significant difference in the mean score of residents aged 62 and over as compared to 61 and under regarding satisfaction of time to get hot water to their bath faucet.

An independent samples *t* test was conducted to evaluate whether the mean score of persons aged 62 and over were significantly different from the mean score of persons aged 61 and under regarding their satisfaction of the amount of time it takes hot water to reach their low flow bath faucets. The satisfaction ranking was the test variable and the grouping variable was the two age groups. The test was not significant, $t(190) = .06$, $p = .960$. Therefore, Ho6 was retained. The Cohen's *d* value of .17 indicated a small effect size. Apartment residents who were 62 years of age and older (M = 3.42, SD = 1.18) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow bath faucet aerators about the same as residents who were 61 years and under (M = 3.41, SD = 1.31). The 95% confidence interval for the difference in means was -.38 to .41. Figure 6 displays the distribution of scores for the for the two groups.

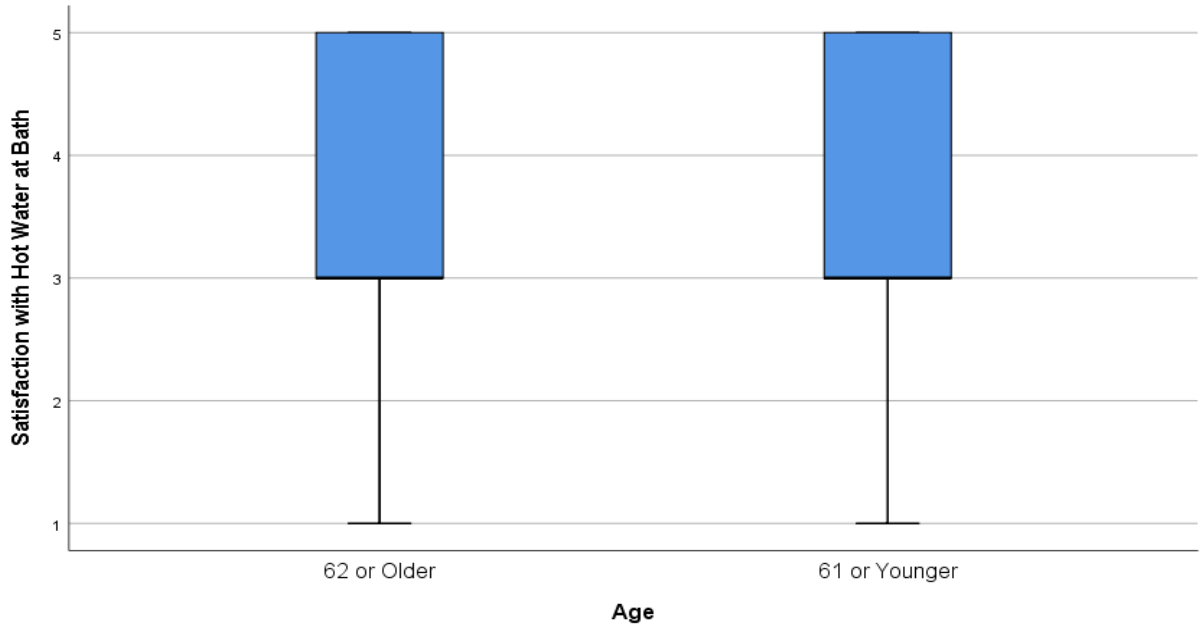

Figure 6. Distribution of scores of groups aged 62 and over compared to 61 and under regarding satisfaction of time to get hot water to their bath faucet.

Research Question 7

Is there a significant difference in the mean score of residents 62 and over as compared to 61 and under regarding performance of their toilet after installation of water savings devices?

Ho7: There is no significant difference in the mean score of residents 62 and over as compared to 61 and under regarding performance of their toilet after installation of water savings devices.

An independent samples *t* test was conducted to evaluate whether the mean score of persons aged 62 and over were significantly different from the mean score of persons aged 61 and under regarding the general level of satisfaction with their toilet after installation of a new toilet water savings system. The satisfaction ranking was the test variable and the grouping variable was the two age groups. The test was not

significant, $t(192) = .15$, $p = .884$. Therefore, Ho7 was retained. The Cohen's *d* value of .17 indicated a small effect size. Apartment residents who were 62 years of age and older (M = 3.15, SD = 1.37) tended to rate the satisfaction of their water saving toilet system about the same as residents who were 61 years and under (M = 3.18, SD = 1.20). The 95% confidence interval for the difference in means was -.46 to .40. Figure 7 displays the distribution of scores for the for the two groups.

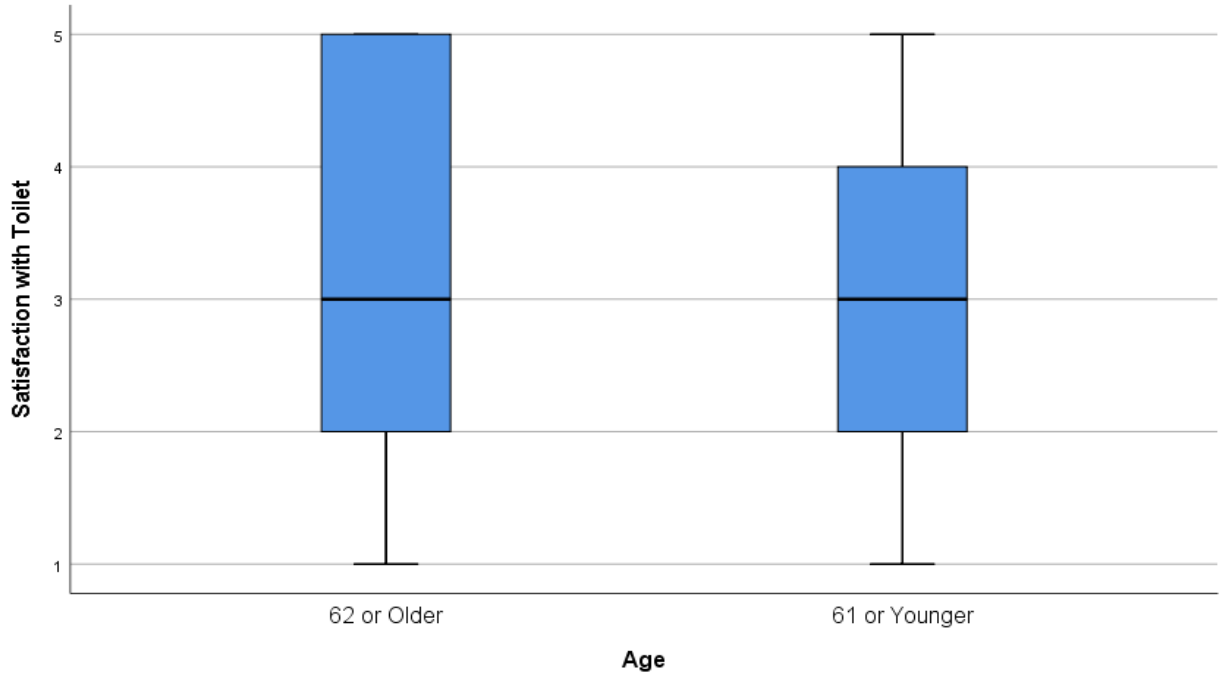

Figure 7. Distribution of scores of groups aged 62 and over compared to 61 and under regarding performance of their toilet after installation of water savings device.

Research Question 8

Is there a significant difference in the mean score of males compared to females regarding performance of their shower head?

Ho8: There is no significant difference in the mean score of males compared to females regarding performance of their shower head.

An independent samples *t* test was conducted to evaluate whether the mean score of male residents were significantly different from the mean score of female residents regarding the general level of performance of water savings shower heads. The performance ranking was the test variable and the grouping variable was the two gender groups. The test was not significant, $t(188) = .54$, $p = .591$. Therefore, Ho8 was retained. The Cohen's *d* value of .17 indicated a small effect size. Male apartment residents (M = 3.53, SD = 1.24) tended to rate the performance of new high efficiency low flow shower heads about the same as female residents (M = 3.42, SD = 1.22). The 95% confidence interval for the difference in means was -.30 to .53. Figure 8 displays the distribution of scores for the for the two groups.

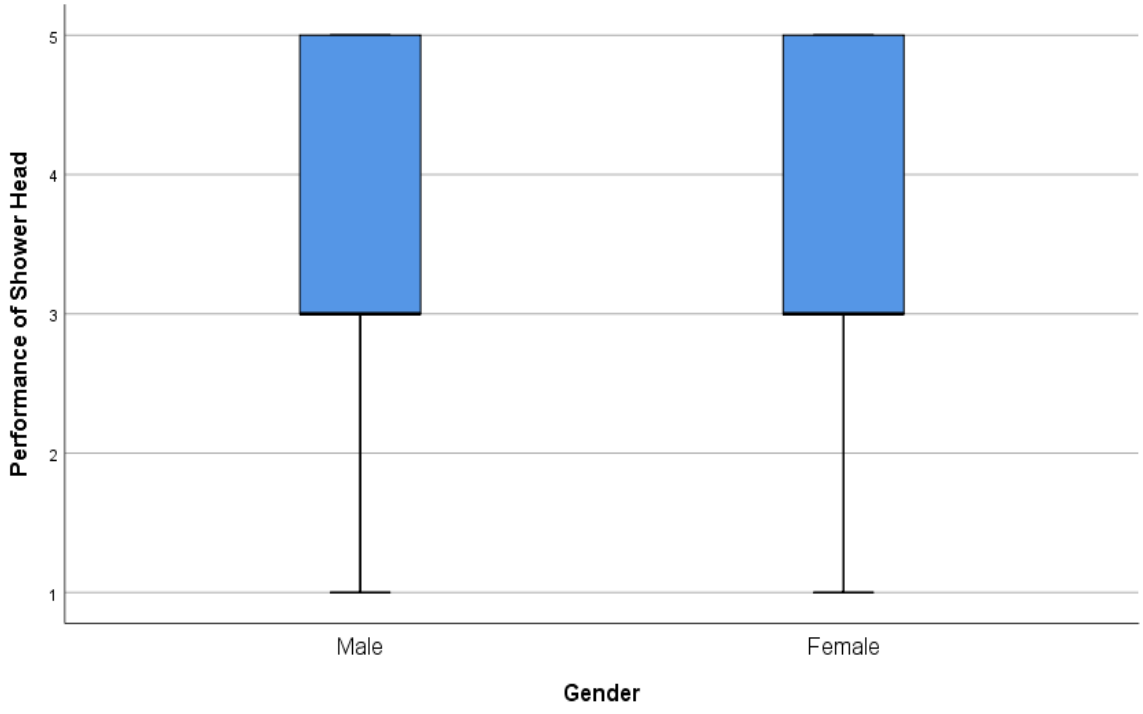

Figure 8. Distribution of scores of males compared to females regarding performance of their shower head.

Research Question 9

Is there a significant difference in the mean score of males compared to females regarding satisfaction of time to get hot water to their shower head?

Ho9: There is no significant difference in the mean score of males compared to females regarding satisfaction of time to get hot water to their shower head.

An independent samples *t* test was conducted to evaluate whether the mean score of male residents were significantly different from the mean score of female residents regarding their satisfaction of the amount of time it takes hot water to reach their low flow shower heads. The satisfaction ranking was the test variable and the grouping variable was the two gender groups. The test was not significant, $t(187) = .57$, $p = .570$. Therefore, Ho9 was retained. The Cohen's *d* value of .17 indicated a small effect size. Male apartment residents (M = 3.69, SD = 1.10) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow shower heads about the same as female residents (M = 3.58, SD = 1.17). The 95% confidence interval for the difference in means was -.28 to .50. Figure 9 displays the distribution of scores for the for the two groups.

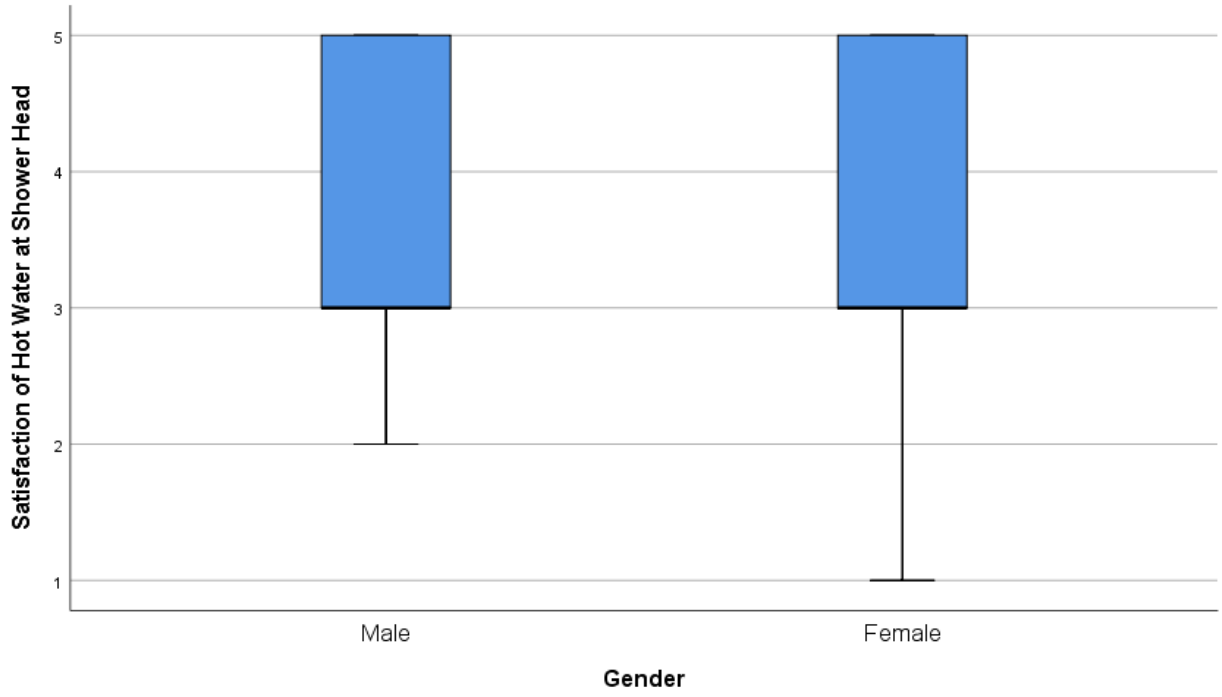

Figure 9. Distribution of scores of males compared to females regarding satisfaction of time to get hot water to their shower head.

Research Question 10

Is there a significant difference in the mean score of males compared to females regarding performance of their kitchen faucet aerator?

Ho10: There is no significant difference in the mean score of males compared to females regarding performance of their kitchen faucet aerator.

An independent samples *t* test was conducted to evaluate whether the mean score of male residents were significantly different from the mean score of female residents regarding the general level of performance of water saving kitchen faucet aerators. The performance ranking was the test variable and the grouping variable was the two gender groups. The test was not significant, t(192) = .36, *p* = .721. Therefore, Ho10 was retained. The Cohen's *d* value of .17 indicated a small effect size. Male

apartment residents (M = 3.29, SD = 1.24) tended to rate the performance of new water saving kitchen faucet aerators about the same as female residents (M = 3.36, SD = 1.20). The 95% confidence interval for the difference in means was -.48 to .33. Figure 10 displays the distribution of scores for the for the two groups.

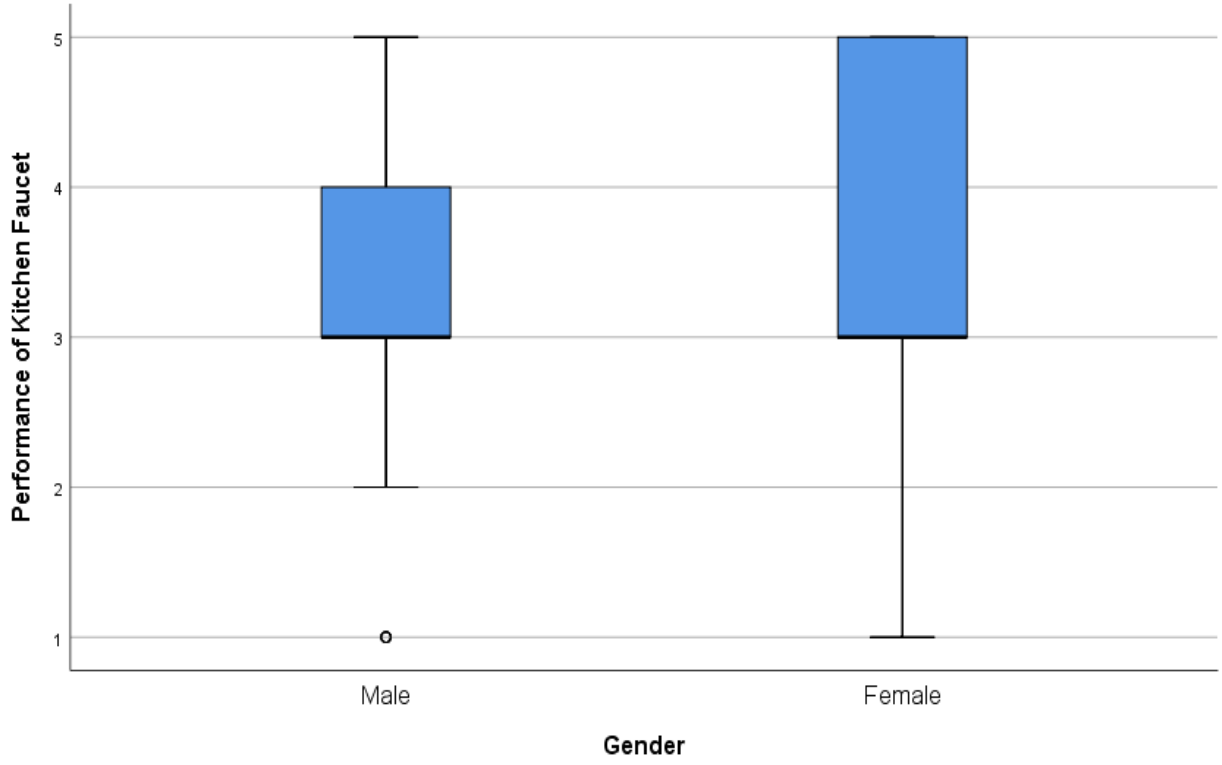

Figure 10. Distribution of scores of males compared to females regarding performance of their kitchen faucet aerator.

Research Question 11

Is there a significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their kitchen faucet?

Ho11: There is no significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their kitchen faucet.

An independent samples *t* test was conducted to evaluate whether the mean score of male residents were significantly different from the mean score of female residents regarding their satisfaction of the amount of time it takes hot water to reach their kitchen faucets. The satisfaction ranking was the test variable and the grouping variable was the two gender groups. The test was not significant, t(192) = .37, *p* = .713. Therefore, Ho11 was retained. The Cohen's *d* value of .17 indicated a small effect size. Male apartment residents (M = 3.49, SD = 1.22) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow kitchen faucets about the same as female residents (M = 3.41, SD = 1.28). The 95% confidence interval for the difference in means was -.35 to .51. Figure 11 displays the distribution of scores for the for the two groups.

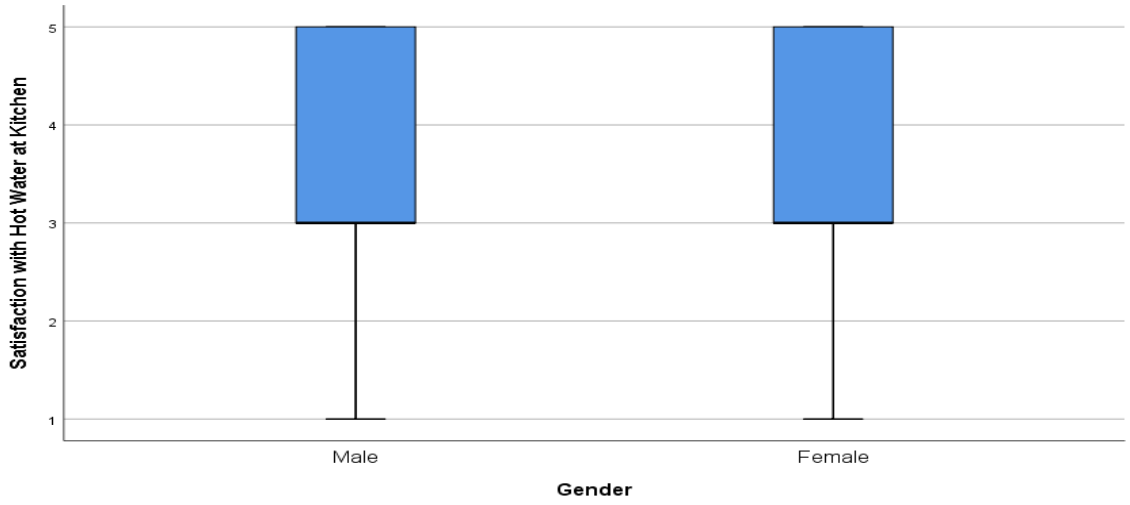

Figure 11. Distribution of scores of males compared to females regarding satisfaction of time to get hot water to their kitchen faucet

Research Question 12

Is there a significant difference in the mean score of males as compared to females regarding performance of bath faucet aerators?

Ho12: There is no significant difference in the mean score of males as compared to females regarding performance of bath faucet aerators.

An independent samples *t* test was conducted to evaluate whether the mean score of male residents were significantly different from the mean score of female residents regarding the general level of performance of water saving bath faucet aerators. The performance ranking was the test variable and the grouping variable was the two gender groups. The test was not significant, t(189) = .90, *p* = .370. Therefore, Ho12 was retained. The Cohen's *d* value of .17 indicated a small effect size. Male apartment residents (M = 3.18, SD = 1.23) tended to rate the performance of new high efficiency low flow bath faucet aerators about the same as female residents (M = 3.37, SD = 1.25). The 95% confidence interval for the difference in means was -.61 to .23. Figure 12 displays the distribution of scores for the for the two groups.

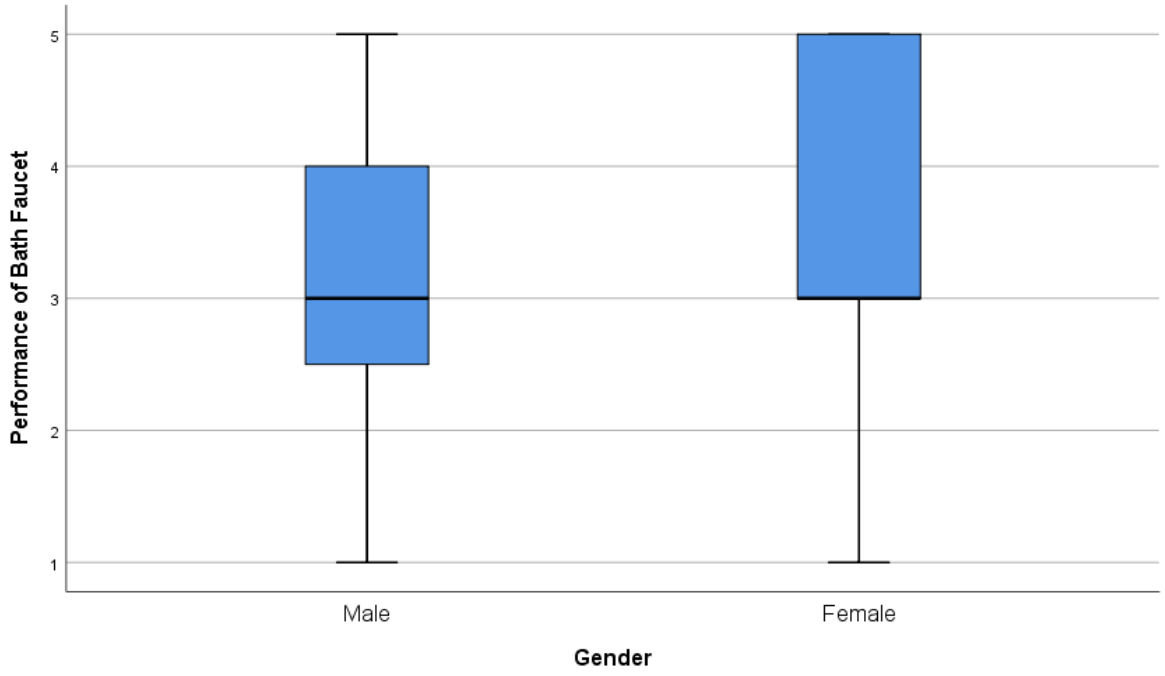

Figure 12. Distribution of scores of males compared to females regarding performance of bath faucet aerators.

Research Question 13

Is there a significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their bath faucet?

Ho13: There is no significant difference in the mean score of males as compared to females regarding satisfaction of time to get hot water to their bath faucet.

An independent samples *t* test was conducted to evaluate whether the mean score of male residents were significantly different from the mean score of female residents regarding their satisfaction of the amount of time it takes hot water to reach their low flow bath faucets. The satisfaction ranking was the test variable and the grouping variable was the two gender groups. The test was not significant, $t(190) = .32$, $p = .752$. Therefore, Ho13 was retained. The Cohen's *d* value of .17 indicated a small effect size. Male apartment residents (M = 3.47, SD = 1.24) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow kitchen faucets about the same as female residents (M = 3.40, SD = 1.20). The 95% confidence interval for the difference in means was -.34 to .47. Figure 13 displays the distribution of scores for the for the two groups.

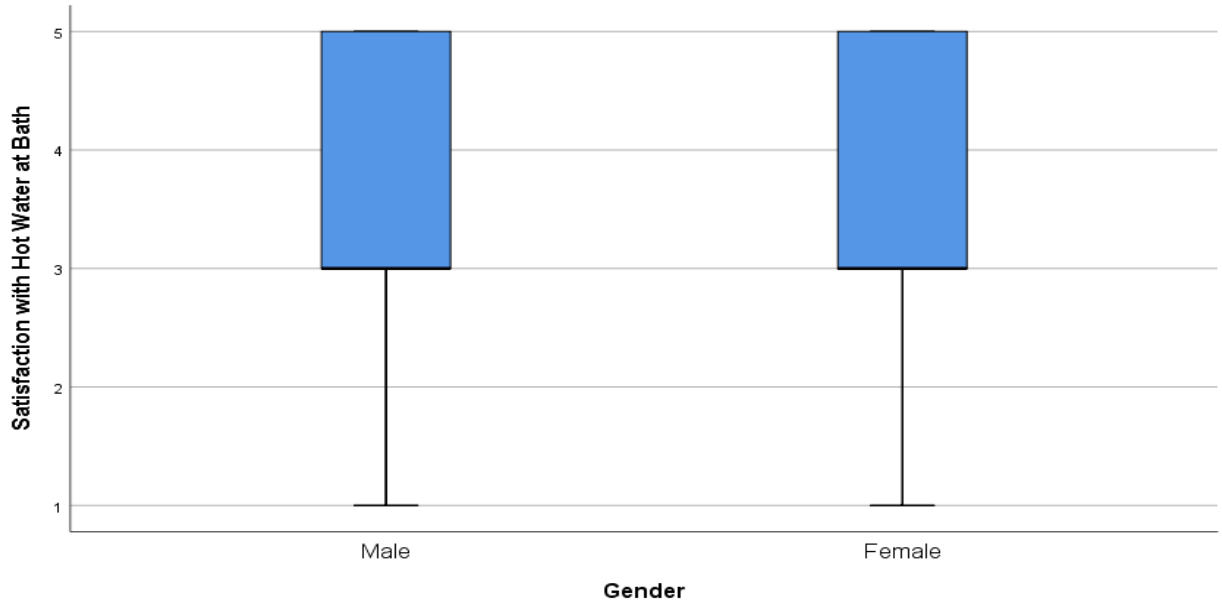

Figure 13. Distribution of scores of males compared to females regarding satisfaction of time to get hot water to their bath faucet.

Research Question 14

Is there a significant difference in the mean score of males as compared to females regarding performance of their toilet after installation of water savings devices?

Ho14: There is no significant difference in the mean score of males as compared to females regarding performance of their toilet after installation of water savings devices.

An independent samples *t* test was conducted to evaluate whether the mean score of male residents were significantly different from the mean score of female residents regarding the general level of performance of their toilet after installation of a new toilet water savings system. The performance ranking was the test variable and the grouping variable was the two gender groups. The test was not significant, t(192) = .28, *p* = .779. Therefore, Ho14 was retained. The Cohen's *d* value of .17 indicated a

small effect size. Male apartment residents (M = 3.11, SD = 1.42) tended to rate the performance of their water saving toilet system about the same as female residents (M = 3.17, SD = 1.30). The 95% confidence interval for the difference in means was -.51 to .38. Figure 14 displays the distribution of scores for the for the two groups.

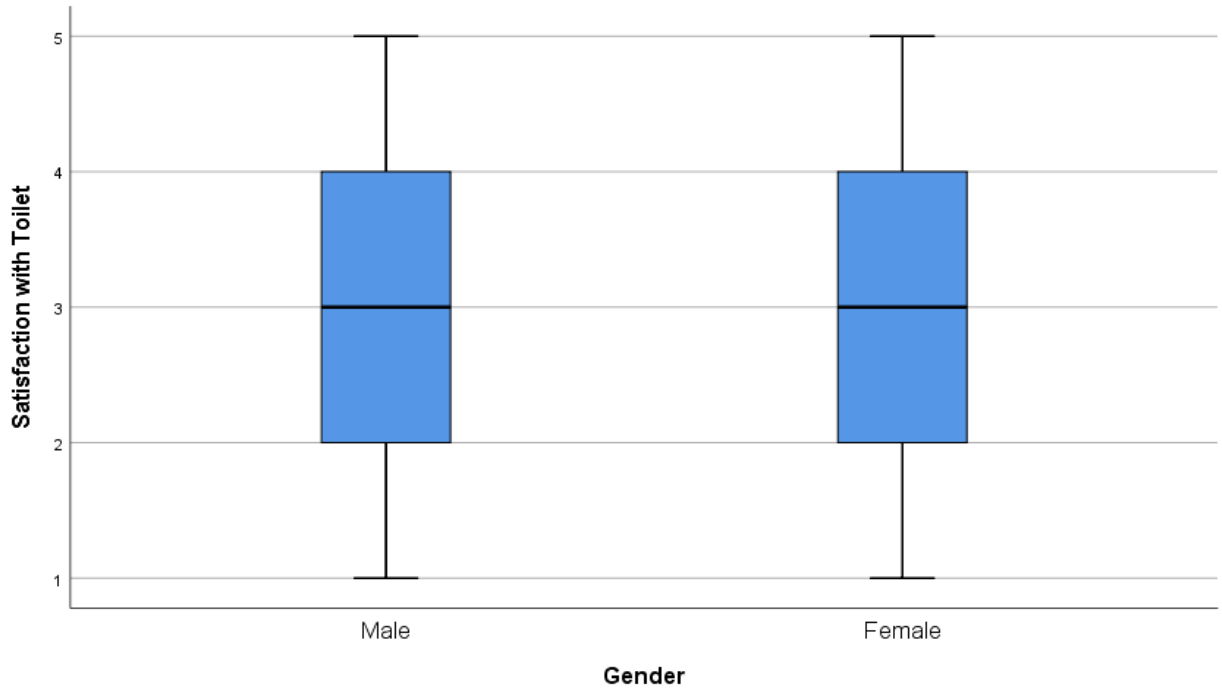

Figure 14. Distribution of scores of males compared to females regarding performance of their toilet after installation of water savings devices.

Research Question 15

Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their shower heads?

Ho15: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their shower heads.

An independent samples *t* test was conducted to evaluate whether the mean score of whites were significantly different from the mean score of nonwhites regarding the general level of performance of water savings shower heads. The performance ranking was the test variable and the grouping variable was the two groups. The test was not significant, t(188) = 1.28, *p* = .204. Therefore, Ho15 was retained. The Cohen's *d* value of .17 indicated a small effect size. White residents (M = 3.52, SD = 1.26) tended to rate the performance of new high efficiency low flow shower heads about the same as nonwhite residents (M = 3.24, SD = 1.07). The 95% confidence interval for the difference in means was -.145 to .68. Figure 15 displays the distribution of scores for the for the two groups.

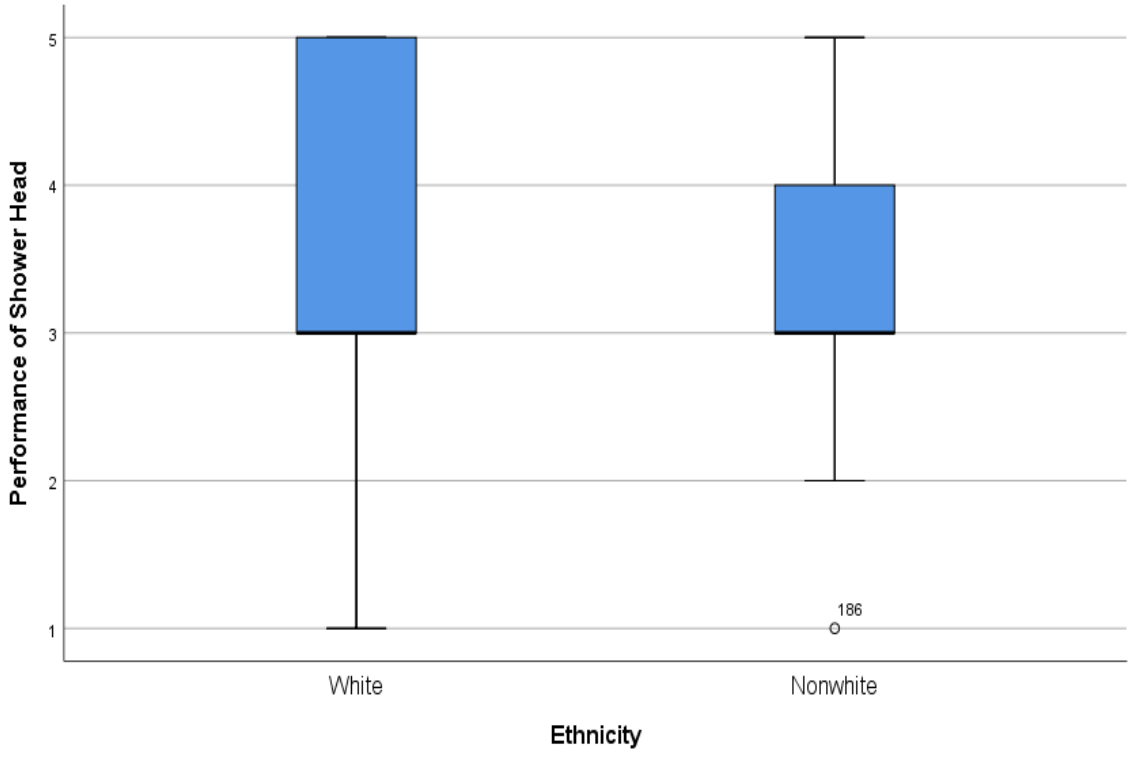

Figure 15. Distribution of scores of whites compared to nonwhites regarding performance of their shower heads.

Research Question 16

Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their shower head?

Ho16: There is no significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their shower head.

An independent samples *t* test was conducted to evaluate whether the mean score of whites were significantly different from the mean score of nonwhites regarding their satisfaction of the amount of time it takes hot water to reach their low flow shower heads. The satisfaction ranking was the test variable and the grouping variable was the two groups. The test was not significant, t(187) = 1.58, *p* = .115. Therefore, Ho16 was retained. The Cohen's *d* value of .17 indicated a small effect size. White apartment residents (M = 3.68, SD = 1.17) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow shower heads about the same as nonwhite (M = 3.37, SD = 1.10). The 95% confidence interval for the difference in means was -.08 to .69. Figure 16 displays the distribution of scores for the for the two groups.

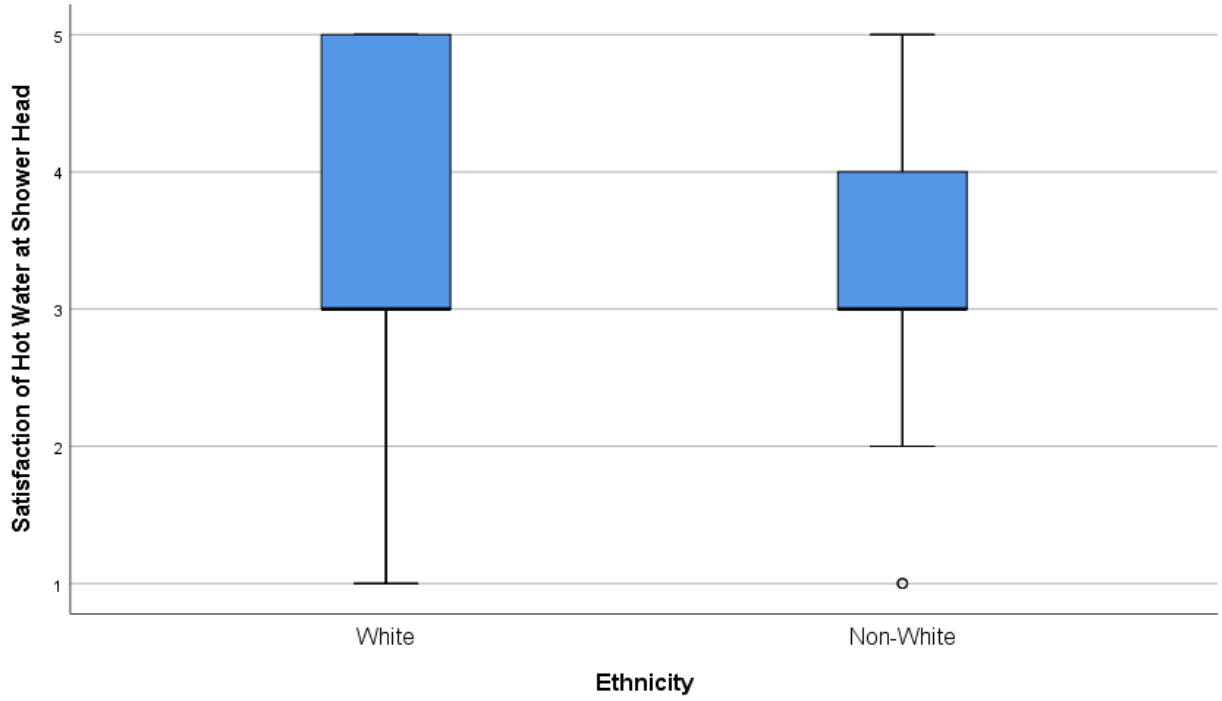

Figure 16. Distribution of scores of whites compared to nonwhites regarding satisfaction of time to get hot water to their shower head.

Research Question 17

Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their kitchen faucet aerators?

Ho17: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their kitchen faucet aerators.

An independent samples *t* test was conducted to evaluate whether the mean score of whites were significantly different from nonwhites regarding the general level of performance of water saving kitchen faucet aerators. The performance ranking was the test variable and the grouping variable was the two groups. The test was not significant, t(192) = 1.43, *p* = .155. Therefore, Ho17 was retained. The Cohen's *d* value of .17 indicated a small effect size. White apartment residents (M = 3.41, SD = 1.25)

tended to rate the performance of new water saving kitchen faucet aerators about the same as nonwhite residents (M = 3.13, SD = 1.04). The 95% confidence interval for the difference in means was -.11 to .68. Figure 17 displays the distribution of scores for the for the two groups.

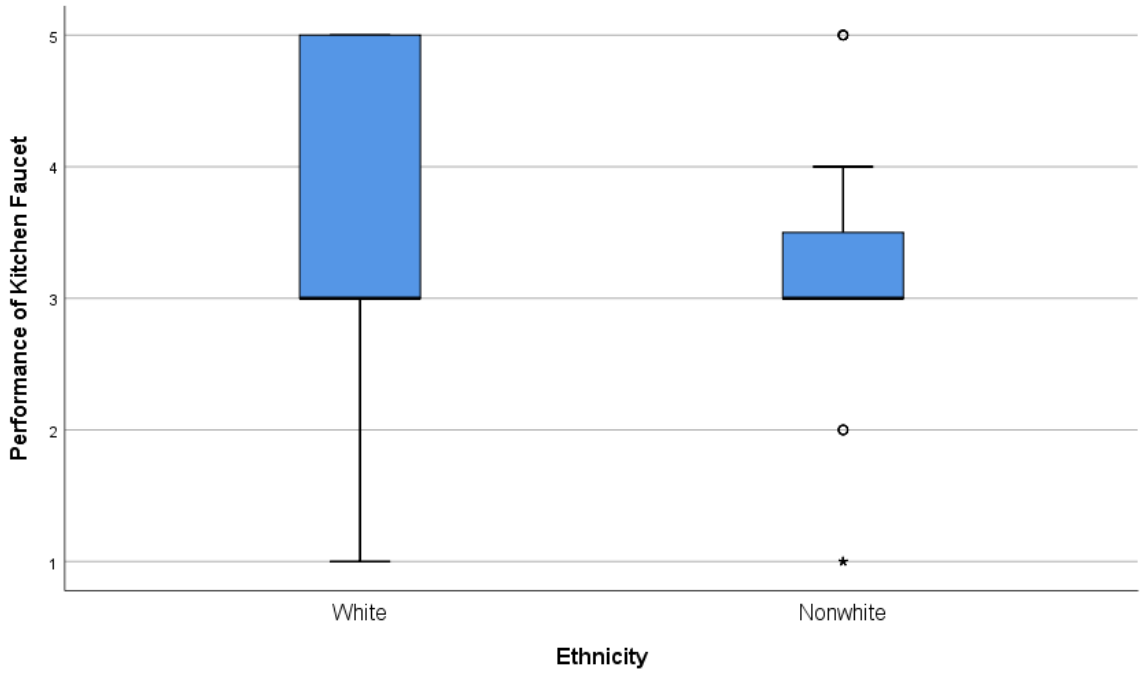

Figure 17. Distribution of scores of whites compared to nonwhites regarding performance of their kitchen faucet aerators.

Research Question 18

Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their kitchen faucet?

Ho18: There is no significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their kitchen faucet.

An independent samples *t* test was conducted to evaluate whether the mean score of whites were significantly different from the mean score of nonwhites regarding their satisfaction of the amount of time it takes hot water to reach their kitchen faucets. The satisfaction ranking was the test variable and the grouping variable was the two groups. The test was not significant, t(192) = 1.34, *p* = .182. Therefore, Ho18 was retained. The Cohen's *d* value of .17 vindicated a small effect size. White apartment residents (M = 3.50, SD = 1.29) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow kitchen faucets about the same as nonwhite residents (M = 3.21, SD = 1.18). The 95% confidence interval for the difference in means was -.13 to .70. Figure 18 displays the distribution of scores for the for the two groups.

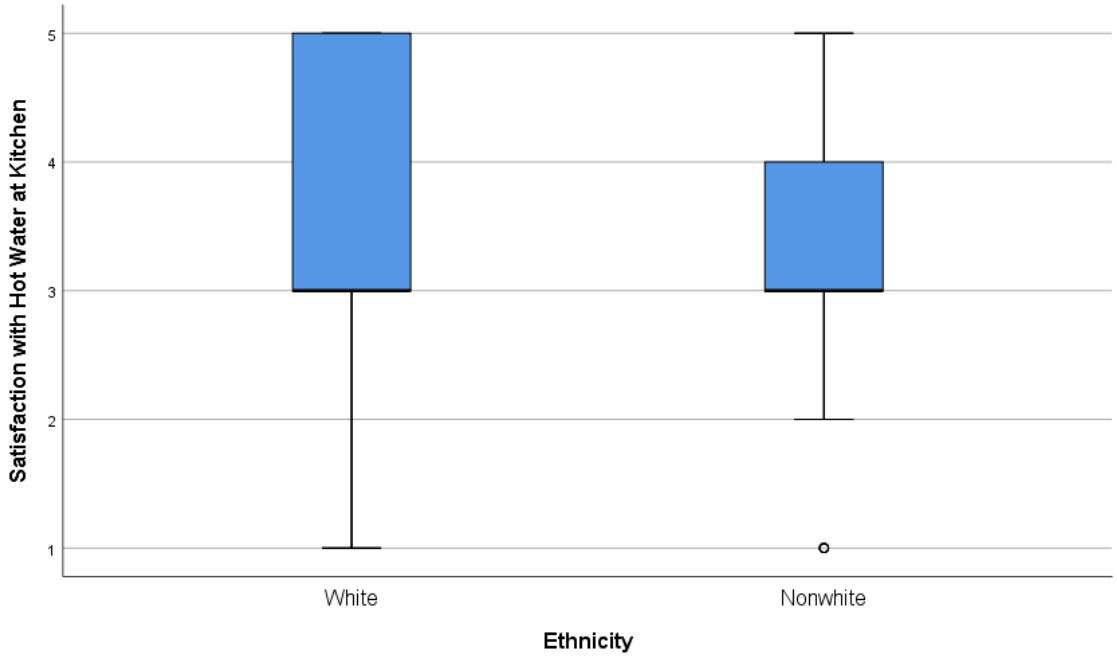

Figure 18. Distribution of scores of whites compared to nonwhites regarding satisfaction of time to get hot water to their kitchen faucet.

Research Question 19

Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their bath faucets?

Ho19: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their bath faucets.

An independent samples *t* test was conducted to evaluate whether the mean score of whites compared to nonwhites regarding the general level of performance of their bath faucet aerators. The performance ranking was the test variable and the grouping variable was the two ethnic groups. The test was not significant, t(189) = 1.80, *p* = .073. Therefore, Ho19 was retained. The Cohen's *d* value of .17 indicated a small effect size. White apartment residents (M = 3.42, SD = 1.23) tended to rate the performance of new high efficiency low flow shower heads about the same as nonwhite (M = 3.04, SD = 1.25). The 95% confidence interval for the difference in means was -.04 to .79. Figure 19 displays the distribution of scores for the for the two groups.

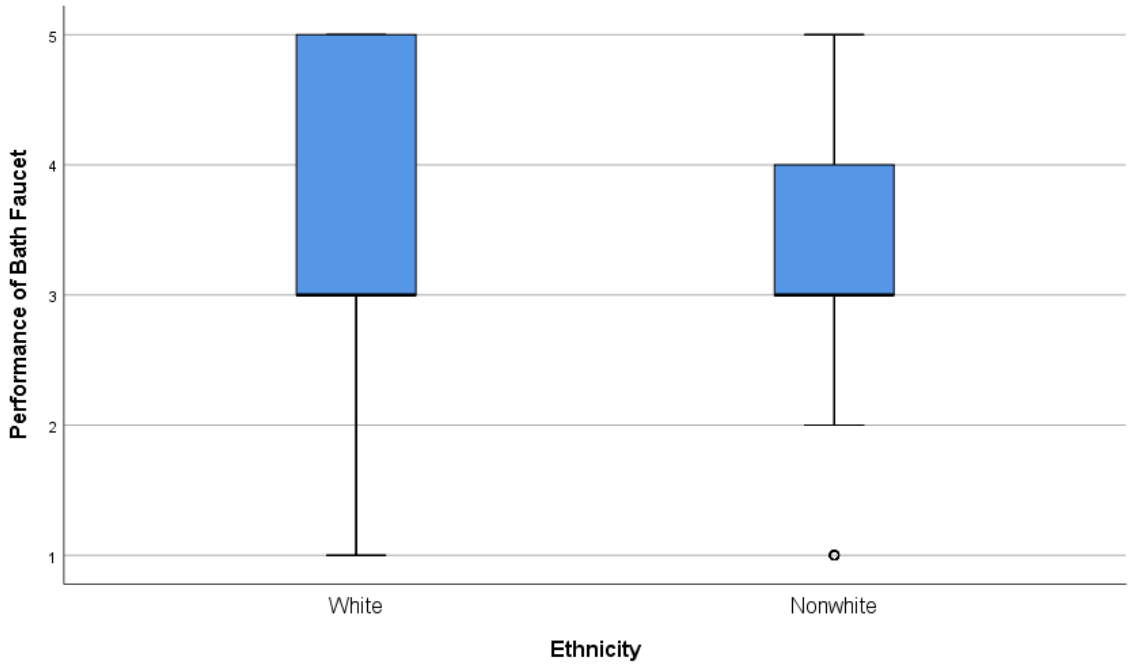

Figure 19. Distribution of scores of whites compared to nonwhites regarding performance of their bath faucet aerators.

Research Question 20

Is there a significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their bath faucets?

Ho20: There is no significant difference in the mean score of whites as compared to nonwhites regarding satisfaction of time to get hot water to their bath faucets.

An independent samples *t* test was conducted to evaluate whether the mean score of white was significantly different from the mean score of nonwhites regarding their satisfaction of the amount of time it takes hot water to reach their bath faucets. The satisfaction ranking was the test variable and the grouping variable was the two ethnic groups. The test was not significant, $t(190) = 1.71$, $p = .089$. Therefore, Ho20

was retained. The Cohen's *d* value of .17 indicated a small effect size. White apartment residents (M = 3.50, SD = 1.22) tended to rate the satisfaction of the amount of time it takes hot water to reach their bath faucets about the same as nonwhite residents (M = 3.15, SD = 1.14). The 95% confidence interval for the difference in means was -.05 to .75. Figure 20 displays the distribution of scores for the for the two groups.

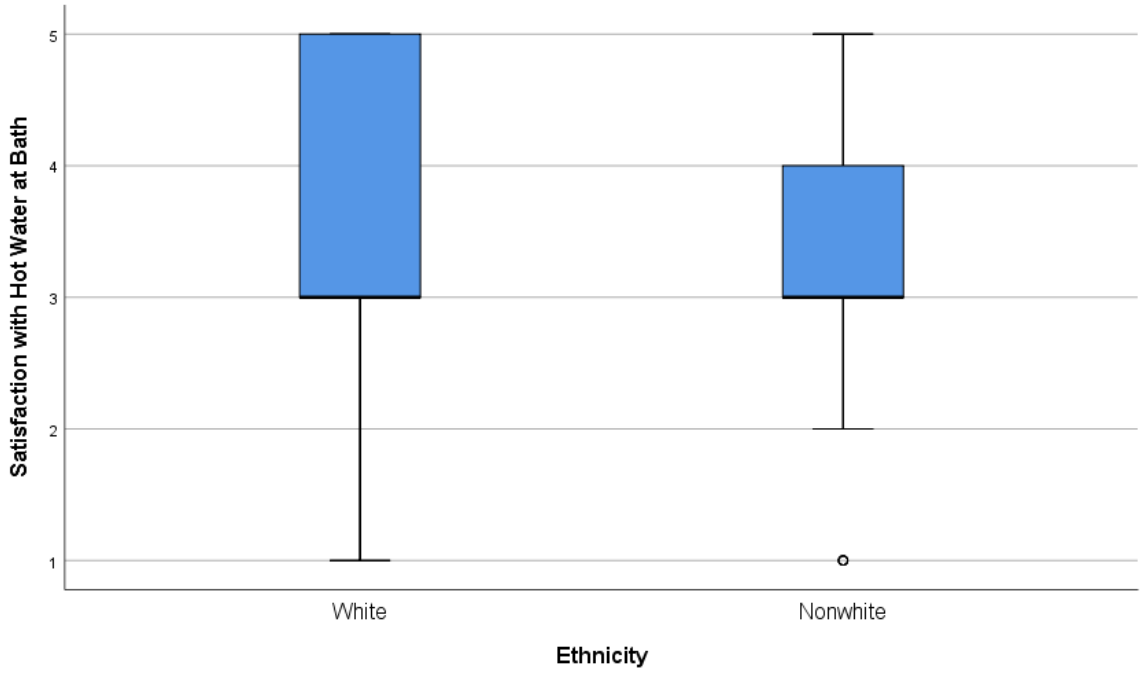

Figure 20. Distribution of scores of whites compared to nonwhites regarding satisfaction of time to get hot water to their bath faucets.

Research Question 21

Is there a significant difference in the mean score of whites as compared to nonwhites regarding performance of their toilets after installation of water savings devices?

Ho2: There is no significant difference in the mean score of whites as compared to nonwhites regarding performance of their toilets after installation of water savings devices.

An independent samples *t* test was conducted to evaluate whether the mean score of whites as compared to nonwhites male residents regarding the general level of performance of their toilet after installation of a new toilet water savings system. The performance ranking was the test variable and the grouping variable was the two ethnic groups. The test was not significant, t(192) = .95, *p* = .343. Therefore, Ho21 was retained. The Cohen's *d* value of .17 indicated a small effect size. White apartment residents (M = 3.21, SD = 1.40) tended to rate the performance of their water saving toilet system about the same as nonwhite (M = 3.00, SD = 1.23). The 95% confidence interval for the difference in means was -.23 to .65. Figure 21 displays the distribution of scores for the for the two groups.

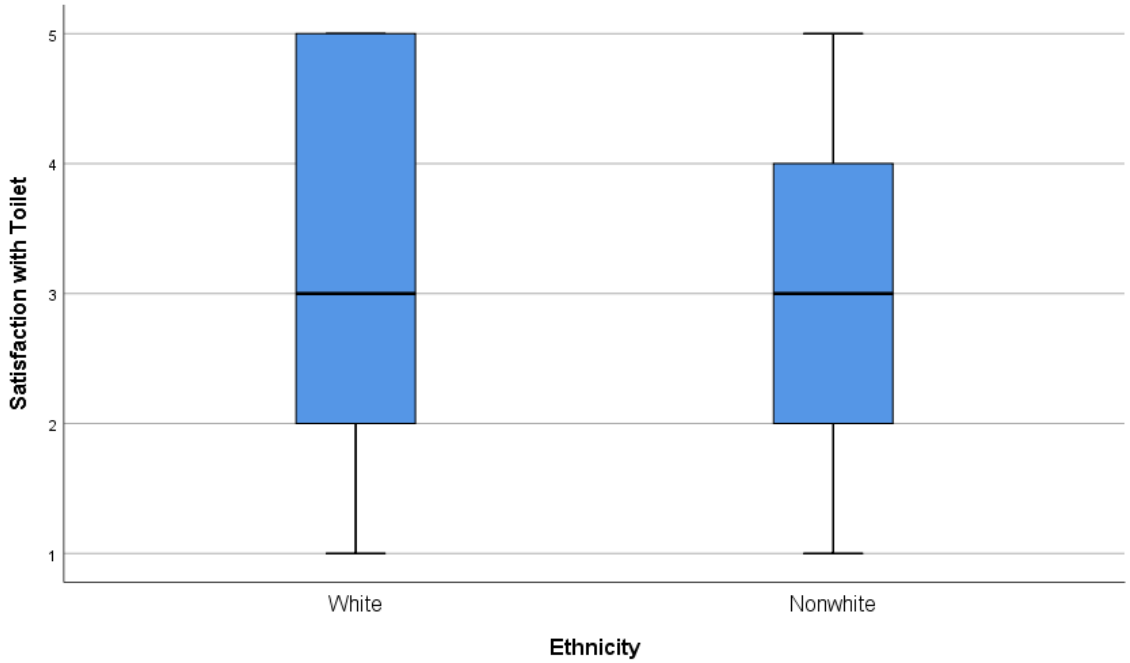

Figure 21. Distribution of scores of whites compared to nonwhites regarding performance of their toilets after installation of water savings devices.

Research Question 22

Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their shower heads?

Ho22: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their shower heads.

An independent samples *t* test was conducted to evaluate whether the mean score of residents living in their apartments before March 1, 2016 was significantly different from the mean score of residents moving in after March 1, 2016 regarding the general level of performance of water savings shower heads. The performance ranking was the test variable and the grouping variable was the two move in dates. The test was not significant, t(188) = .29, p = .771. Therefore, Ho22 was retained. The Cohen's *d* value of.16 indicated a small effect size. Apartment residents who lived in their apartments before March 1, 2016 (M = 3.43, SD = 1.22) tended to rate the performance of new high efficiency low flow shower heads about the same as residents who moved in after March 1, 2016 (M = 3.49, SD = 1.26). The 95% confidence interval for the difference in means was -.46 to .34. Figure 22 displays the distribution of scores for the for the two groups.

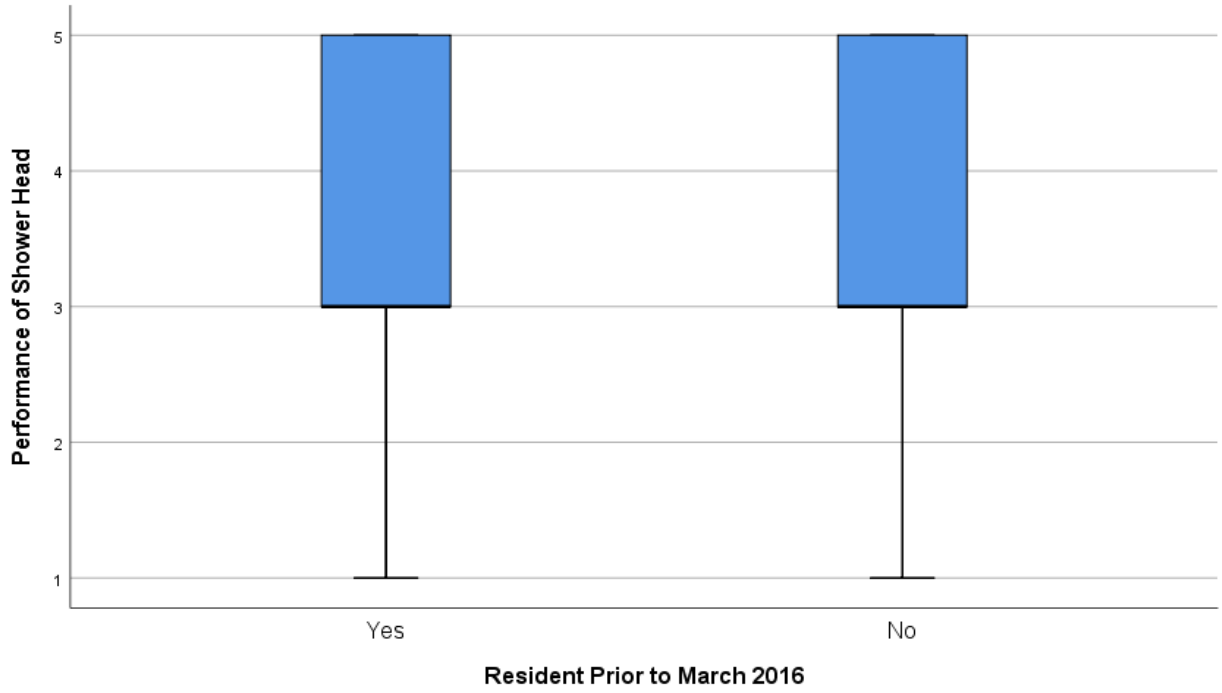

Figure 22. Distribution of scores of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their showerheads.

Research Question 23

Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their shower heads?

Ho23: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their shower heads.

An independent samples *t* test was conducted to evaluate whether the mean score of residents living in their apartments before March 1, 2016 was significantly

different from the mean score of residents who moved in after March 1, 2016 regarding their satisfaction of the amount of time it takes hot water to reach their shower heads. The satisfaction ranking was the test variable and the grouping variable was the move in dates. The test was not significant, t(187) = 1.56, *p* = .122. Therefore, Ho23 was retained. The Cohen's *d* value of .16 indicated a small effect size. Residents who lived in their apartments before March 1, 2016 (M = 3.53, SD = 1.18) tended to rate the satisfaction of the amount of time it takes hot water to reach their low flow shower heads about the same as residents who moved in after March 1, 2016 (M = 3.82, SD = 1.06). The 95% confidence interval for the difference in means was -.67 to .08. Figure 23 displays the distribution of scores for the for the two groups.

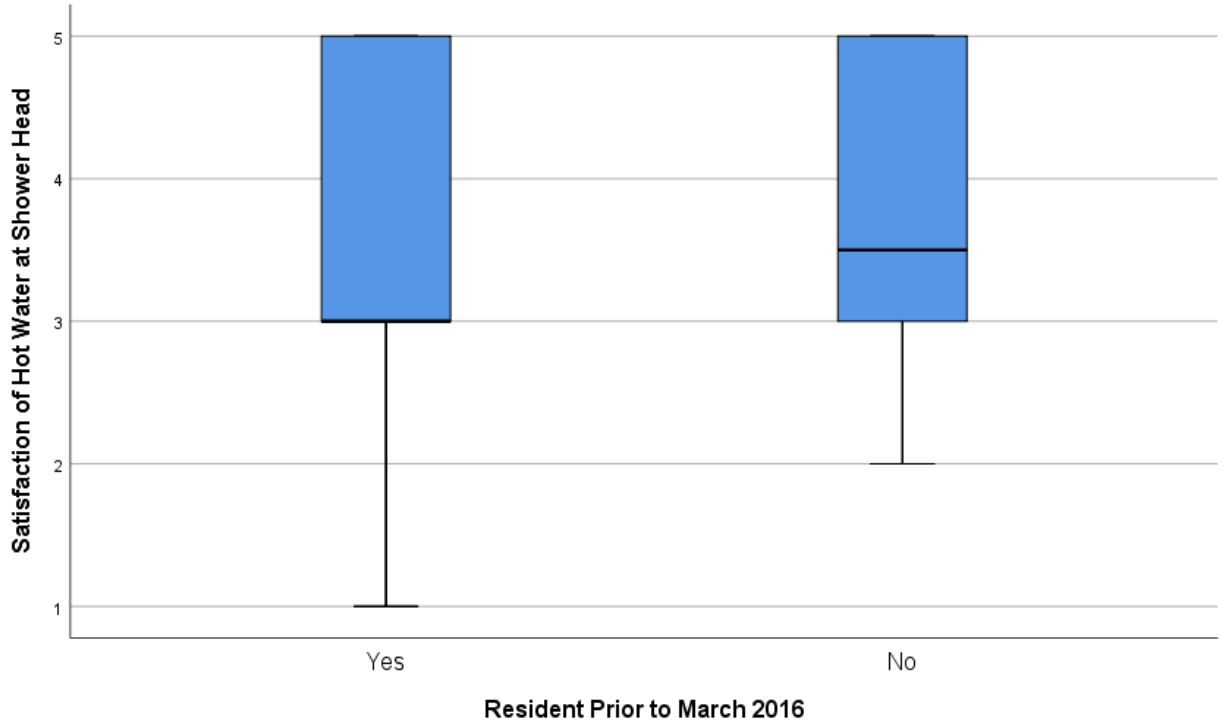

Figure 23. Distribution of scores of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their showerheads.

Research Question 24

Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their kitchen faucet aerators?

Ho24: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their kitchen faucet aerators.

An independent samples *t* test was conducted to evaluate whether the mean score of residents living in their apartments before March 1, 2016 were significantly different from the mean score of residents who moved in after March 1, 2016 regarding the performance of their kitchen faucet aerators. The performance ranking was the test variable and the grouping variable was the two move in dates. The test was not significant, t(192) = 1.00, p = .318. Therefore, Ho24 was retained. The Cohen's d value of .16 indicated a small effect size. Residents living in their apartments before March 1, 2016 (M = 3.29, SD = 1.23) tended to rate the performance of their kitchen faucet aerators about the same as residents who moved in after March 1, 2016 (M = 3.49, SD = 1.14). The 95% confidence interval for the difference in means was -.58 to .19. Figure 24 displays the distribution of scores for the for the two groups.

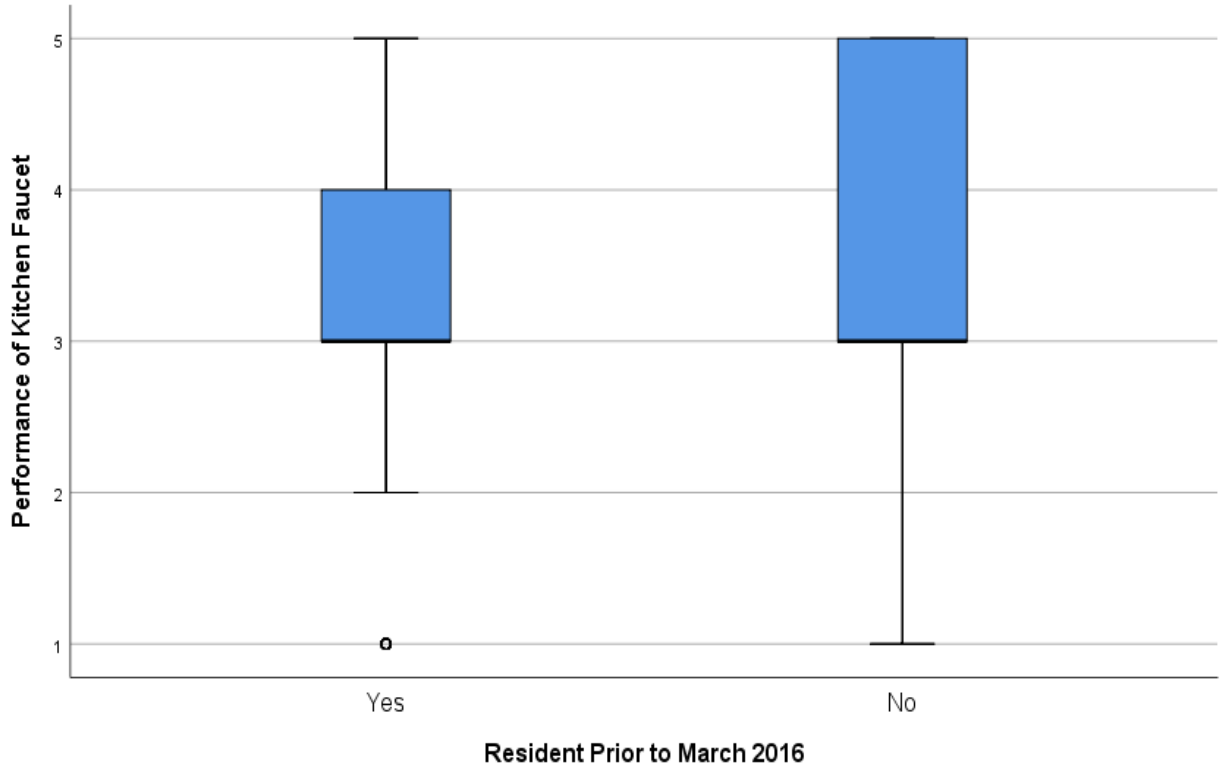

Figure 24. Distribution of scores of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their kitchen faucet aerators.

Research Question 25

Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their kitchen faucets?

Ho25: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their kitchen faucets.

An independent samples *t* test was conducted to evaluate whether the mean

score of residents who were living in their apartments before March 1, 2016 were significantly different from the mean score of residents who moved in after March 1, 2016 regarding their satisfaction of the amount of time it takes hot water to reach their kitchen faucets. The satisfaction ranking was the test variable and the grouping variable was the two move in dates. The test was not significant, t(192) = 1.05, *p* = .293. Therefore, Ho25 was retained. The Cohen's *d* value of .16 indicated a small effect size. Residents who were living in their apartments before March 1, 2016 (M = 3.37, SD = 1.29) tended to rate the satisfaction of the amount of time it takes hot water to reach kitchen faucets about the same as residents who were living in their apartment after March 1, 2016 (M = 3.59, SD = 1.19). The 95% confidence interval for the difference in means was -.63 to .19. Figure 25 displays the distribution of scores for the for the two groups.

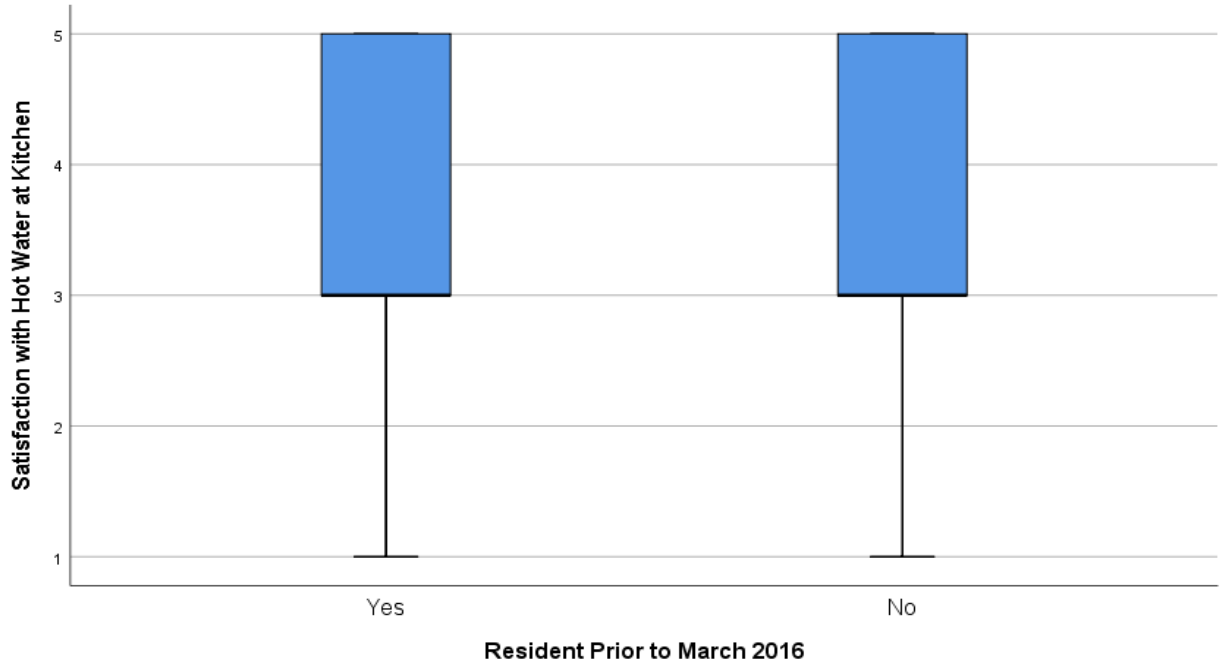

Figure 25. Distribution of scores of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their kitchen faucets.

Research Question 26

Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their bath faucet aerators?

Ho26: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their bath faucet aerators.

An independent samples *t* test was conducted to evaluate whether the mean score of residents living in their apartment before March 1, 2016 were significantly different from the mean score of residents moving in to their apartment after March 1, 2016 regarding the level of performance of their bath faucet aerators. The performance ranking was the test variable and the grouping variable was the two move in dates. The test was not significant, t(189) = .73, p = .486. Therefore, Ho26 was retained. The Cohen's d value of .16 indicated a small effect size. Residents who lived in their apartments before March 1, 2016 (M = 3.29, SD = 1.22) tended to rate the performance of their bath faucet aerators about the same as residents who moved in after March 1, 2016 (M = 3.44, SD = 1.33). The 95% confidence interval for the difference in means was -.55 to .26. Figure 26 displays the distribution of scores for the for the two groups.

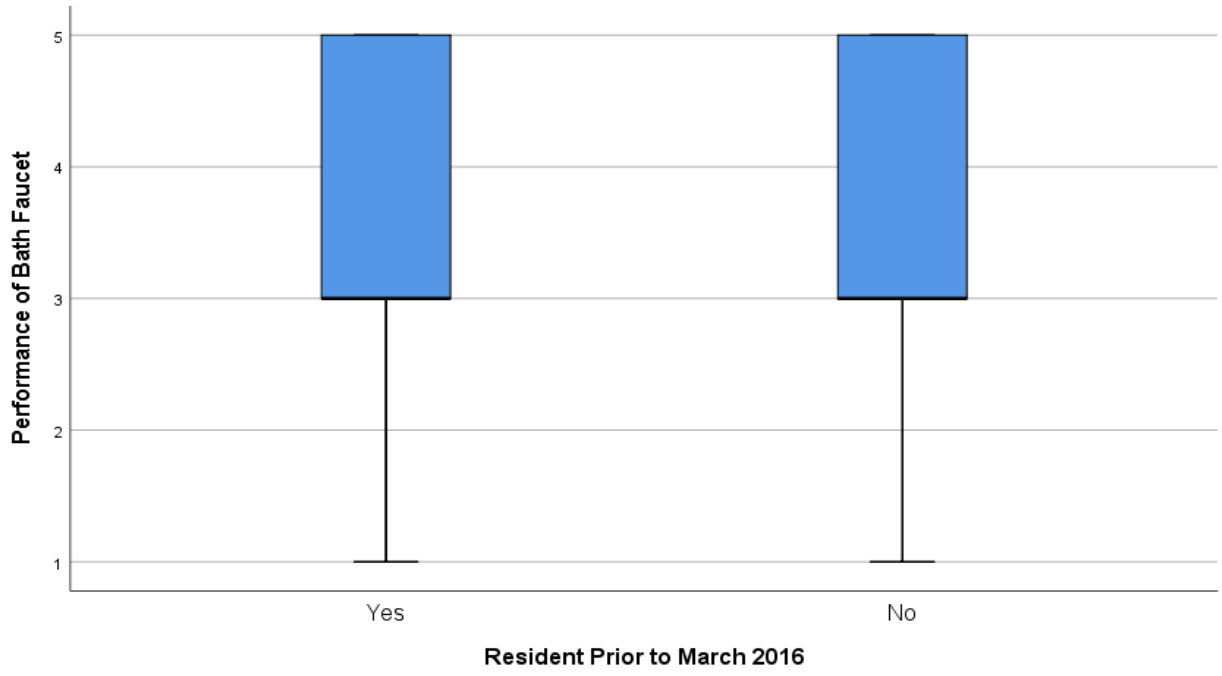

Figure 26. Distribution of scores of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their bath faucet aerators.

Research Question 27

Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their bath faucets?

Ho27: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their bath faucets.

An independent samples *t* test was conducted to evaluate whether the mean score of residents living in their apartments before March 1, 2016 were significantly different from the mean score of residents who moved in after March 1, 2016 regarding

their satisfaction of the amount of time it takes hot water to reach their bath faucets. The satisfaction ranking was the test variable and the grouping variable was the two move in dates. The test was not significant, t(190) = 1.32, *p* = .188. Therefore, Ho27 was retained. The Cohen's *d* value of.16 indicated a small effect size. Residents who were living in their apartment before March 1, 2016 (M = 3.35, SD = 1.19) tended to rate the satisfaction of the amount of time it takes hot water to reach their bath faucets about the same as residents who moved in after March 1, 2016 (M = 3.61, SD = 1.25). The 95% confidence interval for the difference in means was -.65 to .13. Figure 27 displays the distribution of scores for the for the two groups.

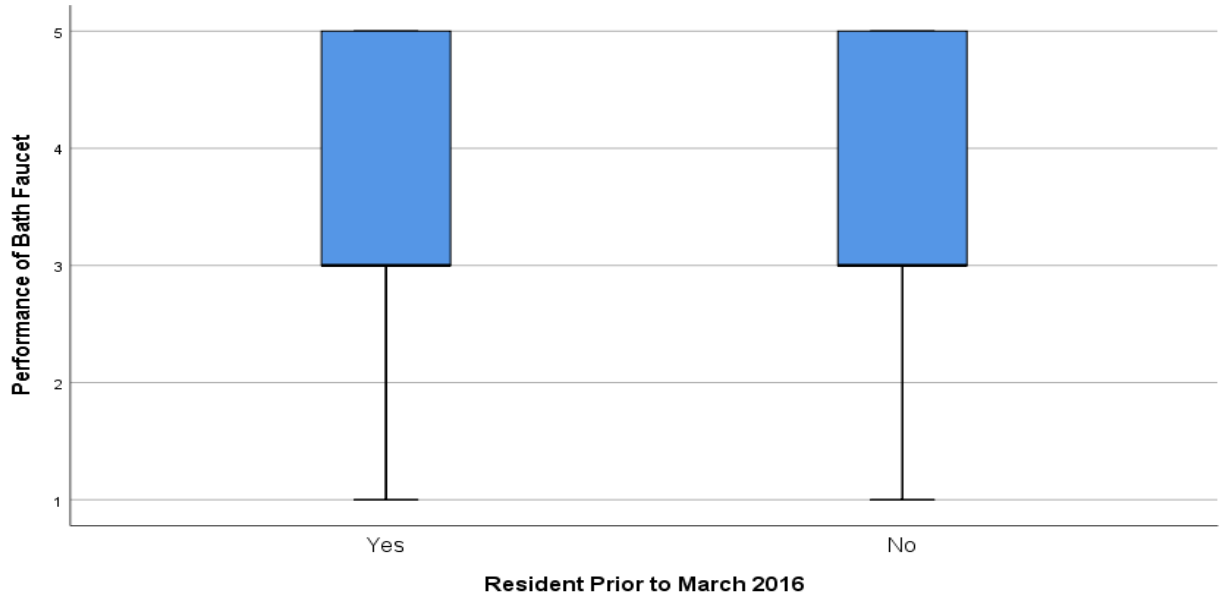

Figure 27. Distribution of scores of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding satisfaction of time to get hot water to their bath faucets.

Research Question 28

Is there a significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1,

2016 regarding performance of their toilets after installation of water savings devices?

Ho28: There is no significant difference in the mean score of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their toilets after installation of water savings devices?

An independent samples *t* test was conducted to evaluate whether the mean score of residents who were living in their apartments before March 1, 2016 were significantly different from the mean score of residents who moved in after March 1, 2016 regarding the performance of their toilets after installation of water savings devices. The performance ranking was the test variable and the grouping variable was the two move in dates. The test was not significant, t(192) = .84, *p* = .400. Therefore, Ho28 was retained. The Cohen's *d* value of .16 indicated a small effect size. Residents who were living in their apartments before March 1, 2016 (M = 3.11, SD = 1.32) tended to rate the performance of their toilets after installation of water savings devices about the same as residents who moved in after March 1, 2016 (M = 3.29, SD = 1.35). The 95% confidence interval for the difference in means was -.61 to .24. Figure 28 displays the distribution of scores for the for the two groups.

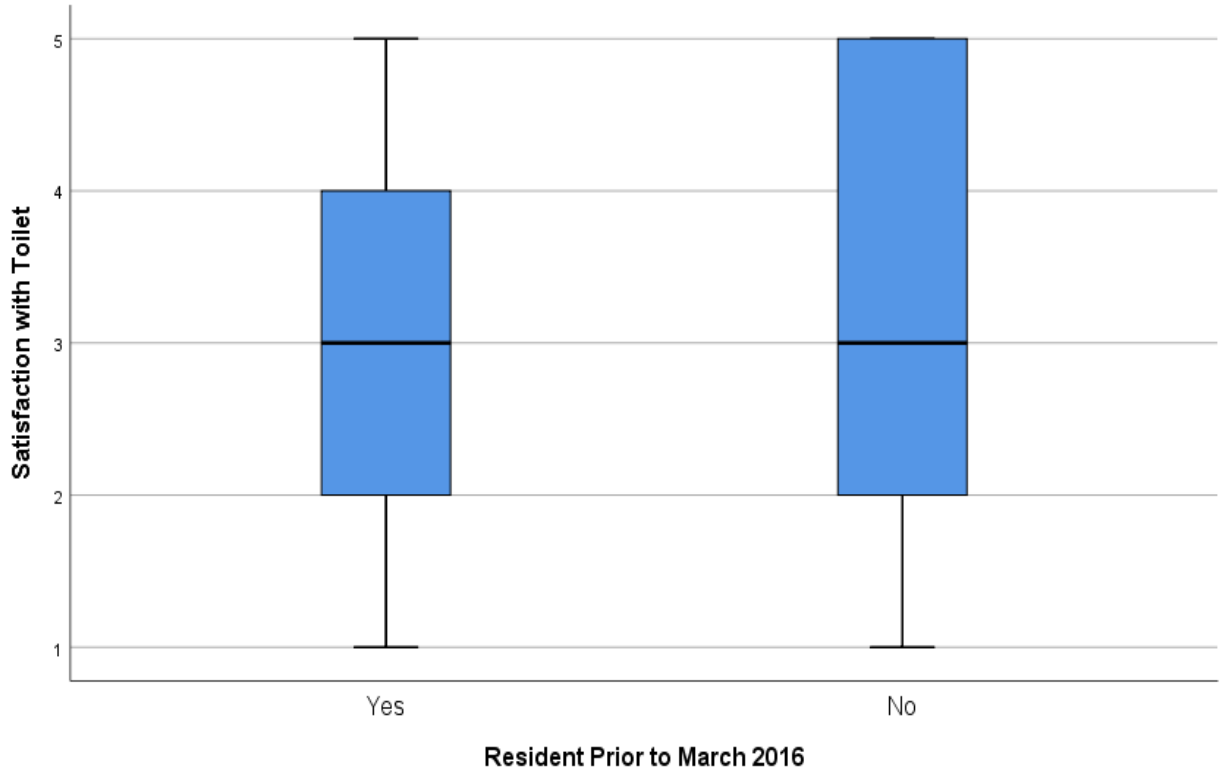

Figure 28. Distribution of scores of residents who lived in their apartments before March 1, 2016 compared to residents who moved in after March 1, 2016 regarding performance of their toilets after installation of water savings devices.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this quantitative study was to determine apartment residents' satisfaction of and performance rankings of new water saving showerheads, faucet aerators, and toilets. The researcher sought to find and identify areas of concern and get feedback from residents who had received these products involuntarily.

Data gathered from 215 surveys out of a potential 626 apartments at four complexes resulted in a 34% response rate. Testing of 28 research questions resulted in no significant differences in the mean score in all dimensions. Thus, regardless of age, gender, ethnicity, and whether or not residents had experienced both nonrestrictive and restrictive water savings devices, there was no significant difference in their means score. In addition, all mean score were in the satisfactory range (greater or equal to a score of 3).

These results indicated that mechanical means of water reduction through low flow showerheads, faucet aerators, and toilets can be achieved satisfactorily without significant negative feedback from residents.

Summary

Research Questions 1 to 7 focused specifically on residents aged 62 and over compared to those 61 and under. Age 62 has been commonly used in the subsided housing population as the dividing age between housing for families or housing for elderly (24 CFR891.205). For the purposes of this research residents were grouped as 62 or 61 and under. One age group was compared to the other age group regarding

their satisfaction of and performance ratings of showerheads, kitchen faucet aerators, bath faucet aerators, and water saving toilets. The results indicated there was no significant differences in the mean score of the two age groups of residents.

Research Questions 8 to 14 were comparisons of mean score on the seven dimensions of the survey by gender regarding the dependent variables of satisfaction of and performance ratings of showerheads, kitchen faucet aerators, bath faucet aerators, and water saving toilets. The results indicated no significant difference in the mean score of males as compared to females regarding the seven test variables.

Research Questions 15 to 21 were comparisons of mean score on the seven dimensions of the survey between whites and nonwhites regarding the dependent variables of satisfaction of and performance ratings of showerheads, kitchen faucet aerators, bath faucet aerators, and water saving toilets. The results indicated no significant difference in any mean score between whites and nonwhites regarding the seven dependent variables.

Research Questions 22 to 28 were comparisons of mean score on the seven dimensions of the survey between residents who had experienced both nonrestrictive and restrictive low flow water devices and residents who had only experienced the restrictive water savings devices regarding the dependent variables of satisfaction of and performance ratings of showerheads, kitchen faucet aerators, bath faucet aerators, and water saving toilets. The results indicated no significant difference in any mean score of whites as compared to nonwhites regarding the seven dependent variables.

Conclusions

Educating the public on the practice of water conservation can have significant impact on reducing consumption with little cost. San Antonio, Texas has set a leading example by incorporating resident education, school educational programs in all grades, free water home audits, low flow mechanical devices with appliances with the use of rebates, and a water cost rate structure that rewards conservation at the individual homeowner level (Rice 2009). As a result of increased population density, apartment complexes present tremendous opportunity to establish and implement such programs.

The present study was an indication that water conservation can be achieved through mechanical means of low flow showerheads, faucet aerators, and toilets without loss of satisfaction of residents. As a general comparison to the findings in the discussion section above, the Tampa (Florida) Water Department Survey (Mayer et al. 2004) produced similar results using the same 1 to 5 performance rating with 1 being not satisfactory and 5 being completely satisfied. Water savings showerheads, kitchen faucet aerators, bath faucet aerators, and water saving toilets were installed in 26 households. The survey was just a single question of satisfaction of each device. Residents rated toilets flushing performance at a mean score of 4.52 (n = 26), shower head water flow satisfaction mean score of 4.27 (n=26), kitchen faucet water flow satisfaction mean score of 3.76 (n = 21), and bath faucet aerators water flow mean score of 4.33 (n = 18). The findings in this study were consistent with the findings in the Tampa study.

One major difference between this research and similar studies reported in the

literature review was that the residents had no choice in whether to receive the water savings devices, and they did not share in any money saved; yet residents responses still proved the devices were viewed as satisfactory or better (mean score greater than or equal to 3), making this investigation unique. In the 2004 Tampa Water Department study, homeowners and apartment residents paid the water bill directly themselves, so when water was saved, residents had the benefit of reduced bills and even further incentive to save water.

Education at all levels will be key to future water conservation. As the demand for fresh water continues to grow, not only will the use of mechanical means be needed to save water, but a new conservation mindset needs to become the normal, particularly with water. Middle and High School are great places to begin understanding this resource and the importance of saving. In higher education, on campus dormitories and apartments can be fitted with the most efficient water conserving devices and appliances available to set an example of exemplary conservation.

A byproduct of apartment competition is the use of and upkeep of seasonal flowers, plants, and shrubbery. Companies that are hired to maintain and warranty such aesthetically pleasing landscapes will require much watering. It is recommended that landscaping in arid states and communities be consistent with local natural plantings and not plants and flowers that need constant water just to get the effect. Establishing rain catch basins and cisterns and other water collection, if cost effective, is one way to divert the use of municipal drinking water.

Recommendations for Practice

Residents of affordable housing, student housing, public housing, and other federal and state subsidized programs typically have their water and sewer included in their rent. By using low flow products, not only is saving water the right thing to do environmentally, but the apartment owners save money and in the process provide increased property value.

The present research indicated that regardless of age, gender, ethnicity, or whether or not residents have experienced both nonrestrictive and restrictive showerheads, faucets, and toilets, the mean score suggested water savings devices were satisfactory for residents. Owners and developers of new housing are now required by state and federal regulations to meet certain water restrictive requirements, and this research revealed that water savings programs can be successfully implemented within existing housing.

Therefore, the researcher recommends that all apartment owners perform a water use audit of their monthly bills at least once per year to be assured that use is within industry guidelines. This is a simple no cost assessment that may lead to consideration of low flow devices. As water and sewer rates rise, these best practices in management make even more sense.

Recommendations for Further Research

Although this research focused on residential consumption and the satisfaction of showerheads, faucet aerators, and toilets, there are other opportunities for resident education and research such as the use of washing machines and dishwashers.

Landscaping irrigation at apartment complexes present a unique opportunity for study of water use and water conservation. Studies of regionally appropriate plantings that require less water, to appropriate metering that removes sewage charges, to assuring that landscaping contractors use appropriate amounts of water is recommended. Collectively hundreds of millions of additional gallons of water can still be saved.

Additional qualitative studies of residents' opinions and attitudes about water conservation is recommended. It is the researcher's opinion that on and off campus student housing has much potential for the addition of low flow devices. More specifically, qualitative studies of millennials and trends in water conservation would be encouraged and supported.

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APPENDIX

Instrument

Dear Resident:

My name is David Farmer, and I am a graduate student at East Tennessee State University. I am working on a doctorate of education degree in water management. In order to finish my studies, I need to complete a research project. The name of my research study is Understanding and Satisfaction of Water Savings Devices, and I very much appreciate your assistance in completing this 5-minute voluntary survey. Please complete and return sealed in the blank envelope provided to the manager's office within one week.

The purpose of this study is to determine the level of satisfaction of certain water savings devices that would save millions of gallons of water in apartments throughout the United States. The office staff is aware of the survey and your confidentiality will be protected. No one knows your answers but you. By submitting the survey you agree (consent) that the answers will be a part of the research.

If you have any research related questions or problems, you may contact me, David Farmer, at 423-791-4544. I am working on this project together with my teacher Dr. James Lampley. You may reach him at 423-439-4430. Also, you may call the chairperson of the IRB at ETSU at (423) 439-6054 or 423-439-6055. Thank you for your participation.

Questionnaire (front and back)

1. Are you the lease holder, also known as the head of household? Yes___ No___
2. Are you 18 years or older? Yes___ No___
3. Are you age 62 or over? Yes___ No ___
4. Gender: Male ___ Female ____
5. Ethnicity origin (or Race): Please check.

   White ___

   Hispanic or Latino ___

   African American ___

   Native American or American Indian ___

Asian / Pacific Islander ___

Other _____

6. Were you a resident in your current apartment before March 1, 2016?
   Yes ___ No___

For questions 7-13, on a scale of 1 – 5, how satisfied are you with your plumbing fixtures in the following areas?

7. The overall performance of your shower head.

1___	2___	3___	4___	5___
Not Satisfied	Somewhat Unsatisfied	Satisfied	Somewhat Satisfied	Completely Satisfied

8. The amount of time it takes to get hot water to your shower.

1___	2___	3___	4___	5___
Not Satisfied	Somewhat Unsatisfied	Satisfied	Somewhat Satisfied	Completely Satisfied

9. The overall performance of your kitchen faucet (aerator).

1___	2___	3___	4___	5___
Not Satisfied	Somewhat Unsatisfied	Satisfied	Somewhat Satisfied	Completely Satisfied

10. The amount of time it takes to get hot water to your kitchen faucet.

1___	2___	3___	4___	5___
Not Satisfied	Somewhat Unsatisfied	Satisfied	Somewhat Satisfied	Completely Satisfied

11. The overall performance of your bath faucet (aerator).

1___	2___	3___	4___	5___
Not Satisfied	Somewhat Unsatisfied	Satisfied	Somewhat Satisfied	Completely Satisfied

12. The amount of time it takes to get hot water to your bath faucet.

1___	2___	3___	4___	5___
Not Satisfied	Somewhat Unsatisfied	Satisfied	Somewhat Satisfied	Completely Satisfied

13. Rate your satisfaction with the performance of your toilet.

1___	2___	3___	4___	5___
Not Satisfied	Somewhat Unsatisfied	Satisfied	Somewhat Satisfied	Completely Satisfied

14. If you rated any of the previous questions as Not Satisfied or Somewhat Unsatisfied, please explain.

_____

Which answer below best describes your reaction in this situation.

15. Would you request maintenance if your tub, bath, or kitchen faucet is dripping?

1___ No, I don't want to bother anyone

2___ No, dripping water is not important

3___ Yes, I don't want to waste water

4___ Yes, I want everything in my apartment working properly

What is your level of agreement with the following statements.

16. I support the idea of conserving water.

1___	2___	3___	4___	5___	6___
Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree

17. I participate in conserving energy such as turning my lights and TV off when I'm not at home.

1___	2___	3___	4___	5___	6___
Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree

18. I would participate in recycling, if a program was offered.

1___	2___	3___	4___	5___	6___
Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree

19. Additional comments:

_____

_____

_____

*Note – By completing and submitting this questionnaire, you are giving consent to agree to participate in this research.

VITA

DAVID A. FARMER

Education:

Ed.D. Educational Leadership, East Tennessee State University, Johnson City, Tennessee 2019

M.A. Organizational Management, Tusculum University, Greeneville, Tennessee 2004

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President, Farmer Construction Inc., Wytheville, Virginia, 1988 – 1995

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40 Under Forty Award. *Tri-Cities Business Journal*, Johnson City, Tennessee, 2002

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