Spring 2018

Cleaning The World One SmartLink At A Time

Ryan Zwahlen
rwz1@zips.uakron.edu

Sarah Lucas
sal102@zips.uakron.edu

Sara Woika
srw88@zips.uakron.edu

Faith Goforth
fcg5@zips.uakron.edu

Logan Hanreck
ljh54@zips.uakron.edu

See next page for additional authors

Author
Ryan Zwahlen, Sarah Lucas, Sara Woika, Faith Goforth, Logan Hanreck, and Rachel Schirripa

Cleaning The World One SmartLink At A Time

Killin' It (99.9% of the time)

The University of Akron

Faith Goforth, Logan Hanreck, Sarah Lucas, Rachel Schirripa, Sara Woika, Ryan Zwahlen

Introduction

The primary task for our project with GOJO was to improve the SmartLink business model to make it the most useful and attractive to commercial buildings as possible. Right now, GOJO is in the testing phase for SmartLink with the assumption that most companies will move to adopt this technology once it hits the market. GOJO wants to have a solid business model in place before launching the whole system - one that will ensure the greatest positive experience for commercial buildings.

"Commercial buildings" is a very broad category (one that includes hospitals, sports stadiums, and even airports), so we conducted secondary research in order to narrow our scope to one specific type of commercial building. After looking into technology in relation to commercial buildings, we found that a lot of airports have already implemented a lot of smart technology into their systems, which goes hand-in-hand with the SmartLink service. We figured that airports would be a good target market for the product due to their current drive for technology, and that they would have useful input on how the product could best suit their needs.

In order to start determining what within the SmartLink model would have to be added or changed, we conducted secondary research on a variety of topics. We began by researching current hand washing behavior to uncover more information on the users of commercial buildings. We then followed by learning more about smart buildings and smart technology in order to get a better understanding of what exactly smart buildings are and what they are currently doing successfully. Since GOJO mentioned that SmartLink uses the company's WiFi, additional research was conducted to develop a better understanding of security within IT and how that may affect the SmartLink technology. GOJO also stated that they are not against

partnering with competitors to create an improved product, so we researched GOJO's current competitors and how their processes relate to GOJO's offerings.

GOJO is in the industry of hand sanitizer manufacturing, with its biggest competitor being Vi-Jon Industries. This industry is very dependent on the current health expenditure within countries and the price of crude oil, as these factors drive the supply and demand for hand sanitizer manufacturing. If the price of crude oil goes up, it makes it more costly for manufacturers to produce hand sanitizer. In contrast, if the current health expenditure increases, this means that countries are most likely demanding more hand sanitizer products from the manufacturers. The biggest purchasers of hand sanitizer and other related products are hospitals, pharmacies, and grocery stores. Demand in this industry relies on environmental factors as well, as shown when the Ebola outbreak caused a lot of individuals and business to purchase hand sanitizer. GOJO is a major player within the industry, along with Vi-Jon, and is expected to remain a major player moving forward.

Handwashing Behavior

When looking at hand washing behavior, many people do not seem to be educated or simply do not care much about hand hygiene. There are many factors that determine whether people wash their hands, how often, and how well they do it. It has been found that most people wash their hands after using the restroom; however, around 95% of those people fail to wash their hands long enough to kill harmful bacteria. The U.S. Centers for Disease Control and Prevention recommend that people wash their hands vigorously using soap and water for 15 to 20 seconds. It turns out that, on average, bathroom users only wash their hands for six seconds with only five percent of people washing their hands for 15 seconds or longer. Researchers have also found that only two in three people even use soap, while one in ten don't wash their hands at

all after using the bathroom. In general, men have much worse hand hygiene than women (Livescience, 2013).

In 2011, a survey was taken from around 3,000 U.S and Canadian adults, and it revealed some bad habits. Around 53% of the people surveyed said they sometimes skip using soap when washing their hands. Around 25% do not wash their hands after coughing or sneezing and over 80% do not wash their hands after using their computers at work. Other research has shown that paper towels are more effective, and that individuals prefer to use them. Damp hands spread up to 500 more germs than dry hands, and only 65% of individuals dry their hands all the way when using a hot air dryer. As far as the preference, 70% prefer paper towels for hand drying in food service, offices, and healthcare facilities. More than 50% of people even claim to avoid using hot air dryers while in a public restroom because they either take too long to dry hands or they don't dry them completely. Hand washing also has potential to be more openly encouraged, as around 25% of people feel that their place of employment does not provide adequate encouragement for employees to wash their hands ("Research Reveals," 2011).

There are many reasons why proper hand washing hygiene is important. Some of them are pointed out in an article from the Indian Journal of Public Health. This article focuses a lot on children, which is important because children develop habits at their impressionable age that develop as they continue into their adulthood. It was found that contaminated hands play a major role in fecal-oral transmission of diseases. There is a proven link between infection and unclean hands, and it was shown that washing hands could reduce transmission of puerperal fever (childbirth fever). The way in which washing hands is believed to reduce infection transmission is by washing off potential microorganisms and by removing dirt, which can also harbor microorganisms and allow their survival for longer periods of time (Ray, 2011). There is also a

big focus on the psychology of hand washing behavior, as there are different psychological reasons as to why people wash their hands. They can be divided into three kinds of control over behavior: automatic or habitual responses, motivated or goal-driven behaviour to satisfy needs, and cognitive causes which reflect conscious concerns. Other psychological factors that play a role in hand washing behavior are having the habit of hand washing at particular times of the day, the motivated need for personal or household cleanliness, and a lack of cognitive concern about the cost of soap use (Aunger, 2010). These are just some of the many psychological factors that can influence hand washing behavior.

There are also some behaviors that can be changed or improved by simply providing better service to bathrooms. Many women claim to not wash their hands because they use hand sanitizer, but the primary reason given by men for not washing their hands is the lack of soap ("Survey Reveals," 2014). The reason for not washing hands has also been cited as uncleanliness of the bathroom in general. This could all be improved if the bathroom was serviced better. There are ways to alert staff when soap is low, as well as get valuable information about how regularly bathrooms should be cleaned.

There are many tools that can aid in improving handwashing behavior. A simple one would be a written reminder posted in a restroom. Almost 40% of Americans claim they are more likely to wash their hands after seeing a sign that requires employees to wash hands before returning to work ("Healthy Handwashing," 2017). A more complex solution to the issue would be to use sensors to display real-time handwashing data on screens in bathroom, which is just what Initial Washroom Hygiene is doing. They claim it causes 50% more people to wash their hands ("MailOnline," 2015). The technology consists of sensors installed on bathroom doors and soap dispensers that monitor whether people washed their hands after going to the bathroom. The

real-time data is then displayed on an LCD screen in the bathrooms. Each sensor records the amount of people to come into contact with it, and a percentage is shown on the LCD screen indicating the percentage of people that used the bathroom and washed their hands afterwards. Seeing the live data encourages others to wash their hands. They also point out the importance of hand washing by explaining that a virus can spread throughout an office within two to four hours, but improving hand hygiene can stop the spread of that virus.

Technology definitely has the potential to play a big role in capturing hand washing behavior, ultimately giving commercial buildings insight into how to be more efficient. However, there are still limitations to this technology that have been pointed out. "The data from soap with motion sensors do not generate respondent-specific information, nor do they inform about rates of handwashing with soap at critical times, such as after defecation" (Ram, 2010). It is said that health researchers and public practitioners must frequently accept the limitations of the measures that are available. Still, technology can continue to improve the information we can retrieve about hand washing and hygiene in general.

The Internet of Things

The term Internet of Things, or IoT, was first coined by Kevin Ashton in a 1999 presentation at the well-known company, Procter & Gamble (Ashton, 2009). Since then, the IoT has grown to become a very popular term among the technology industry and IT departments within practically every company. Additionally, almost every consumer-based product, from smartphones to garage doors, is all connected to the IoT, which influences both consumers and businesses everyday, often without realization. The internet of things brings a level of connection between devices like never before, and its power will continue to increase as virtual technology continues to improve.

Many industries are currently using the IoT to improve business practices as well as B2B and B2C relationships. As one of the largest growing sectors in the United States, the health industry has noticed that the IoT helps with monitoring and controlling services within senior care (Pauget and Dammak, 2018). In a completely different field, the IoT is also being used to help create marine depth maps and an "environmental monitoring system" by collecting ocean data through a variety of sensors (Yang and Wen, 2018).

Even though there are many ways to apply the IoT to business, just the application alone is not enough to make an impact on business operations and solutions. To gain value from the internet of things requires the right resources and implementing the right activities in order to pull real value from what the IoT can offer (Metallo and Agrifoglio, 2018). One important activity is conducting data mining to analyze and separate the copious amounts of big data that is collected among the IoT. Once data is mined, companies must have the resources to store the data until it is needed for further use (Shadroo and Rahmani, 2018). Not only does a company need to focus on having the resources to mine and store the data, but it must also obtain the more physical resources, such as sensor nodes and wireless technology (Perles and Perez-Marin, 2017), to connect to the larger IoT network.

The internet of things has the ability to connect practically anything. As mentioned before, many industries since the term was first "invented" in 1999 are still continuing to figure out and master the network that is the IoT. SmartLink falls directly into the category of a system that is connected within this larger network, so its implications could potentially be very large and powerful when used and interpreted properly. As more companies connect devices to the internet of things, the more opportunities for business solutions become available due to devices within the space being able to readily connect with other similar devices.

Current Smart Technology Trends

Technology is already making an impact in many areas. Smart commercial buildings will be the highest users of the IoT in 2017 and are on pace to reach over one billion smart buildings in 2018 (Gartner, 2015). The McKinsey Global Institute predicts that, by 2025, interconnected WiFi enabled devices that collect data through sensors have the potential to generate over $150 billion of value for office buildings alone (Kimberly Clark, 2017). A smart building usually consists of sensors, actuators, controllers, a central unit, interfaces, networks, and smart meters. It must also have some sort of energy saving capabilities (Morvaj, Lugaric, Krajcar, 2011). Much of the technology is created to keep individuals in the buildings safe and out of harm's way, and one of the smartest building right now in the United States that is focusing on this goal is the Pentagon. The engineers behind this marvelous government building implemented millions of digital sensors around the building itself. These sensors allowed operators to close dampers and stop fans to control fires during the September 11th attacks. By doing this, the building was able to be open for business again the next day. If it wasn't for these sensors that told operators on the opposite side of the building what had happened and had already started shutting down fans, there may not be a Pentagon today (Snoonian, 2003).

Engineers have also worked with buildings in California and other places susceptible to large, devastating earthquakes. Sensors placed in the foundation of skyscrapers can sense when the ground begins to shake and redistribute the weight load that is carried by the internal structures of the building. This will help minimize casualties and damages from toppling buildings. Other sensors have also been placed into air ducts or HVAC systems to detect dangerous chemical substances that cannot be detected by smell, such as carbon dioxide. Once a

chemical is detected, the system immediately shuts and seals off the building's air ducts, sounds an alarm to evacuate the building, and contacts the local authorities (Snoonian, 2003).

These safety measures have also been taken within public restrooms. Touchless fixtures have been installed in many public restrooms around the United States to some capacity, whether it is a soap dispenser, faucet, toilet, dryer, or a combination of any of these. By using these features, public spaces can create an atmosphere where the individual using the restroom does not have any direct physical contact with any of the appliances. This will in turn create a high level of hygiene for all those involved, whether in use or cleaning. Some software can allow these fixtures to communicate with each other, and with remote sites. The building owner can then decide how they would like to use the data. They can use it for predictive measures so that users of the restroom always have soap, toilet paper, and a clean restroom. They can also use certain sensors to sense possible crimes happening in the restroom. If a soap, towel dispenser, or hand dryer gets bumped or jostled around in a manner that is unusual for the restroom, the building manager and the local authorities will be notified. If the restroom continues to be a hotspot for crime, the overall statistics will also be sent to the local law enforcement facility for further inspection (Mann, 2001).

The other major use for smart technology and smart cities is energy efficiency. Energy production accounts for between 30 and 40 percent of all water withdrawals. The use of energy is also responsible for approximately 75 percent of greenhouse gas emissions (Morvaj, Lugaric, Krajcar, 2011). There are multiple ways that a building, from a small home all the way up to a larger company campus, can utilize smart technology in order to save both energy and money. By simply adding a smart thermostat, a building can see a five to ten percent energy saving on their HVAC system, depending on the size of the building. If advanced lighting controls are

added to a building, there can be energy savings up to 45 percent, and if a building has a web-based management system for these smart lighting fixtures, energy savings can be as high as 75 percent (King and Perry, 2017).

These are just a few of the possibilities for smart buildings and technology that is being utilized by some buildings today, but many buildings do not have these features. A survey conducted in 2011 targeted at building managers of commercial buildings revealed the following things about the biggest obstacles that occur when implementing smart infrastructure. The number-one, most difficult obstacle was the initial set-up cost. Some of these programs cost companies thousands to millions of dollars to assimilate. Many smaller corporations don't have that much money to spend on a building, so even though most managers understood the technology options (only five percent of respondents did not), the costs outweigh the benefits of the technology. If more buildings were to acquire the technology, the costs would most likely go down, as the technology would be more widely available for use. The next most common difficulty with implementing smart technology was a lack of staff to evaluate and keep up with the new technology. Many companies would not have the money or the time to hire and train a new staff specifically to keep up with the smart technology. If smart technology companies were to create a consulting department specifically designed to help individual companies with setup and upkeep of their new smart technology, it would alleviate some of the risk factors associated with the technology (Olson, 2011).

Smart technology is in more than just buildings. When looking specifically at wearable technology, only 51 percent of online adults are interested in owning a smartwatch and 52 percent are interested in owning a fitness tracker (as of December 2017). However, sales are expected to increase for these products in 2019 (Mintel Wearable Technology, 2017). Even

though wearable technology only interests half of adults that shop online, some companies have been increasing ways to use wearable technologies such as smart watches, which are now used in a few larger airports as boarding passes. Some companies, such as Carnival and Disney, have created their own wearable technologies to make processes like check-ins, purchases, and information transfers more efficient for customers, but high costs to pioneer these customized technologies have made it difficult for other companies to follow (Mintel Travel Tech, 2017).

Going beyond just wearable technology is a budding interest in smart clothes that is increasing, mainly among millenials and early adopters. The category of smart clothes includes items such as shoes, shirts, and pants that have sensors embedded within them to provide more information to the consumer that ultimately promotes a better state of well-being. Some companies that have already created smart clothes are Vitali and Levi's. To reduce stress, Vitali created a sports bra that tracks breathing rate, posture, and heart rate variability to help the consumer avoid actions that may trigger stress. Levi's was more focused on jackets, as it partnered with Google to create a smart cycling jacket, but studies found that this jacket could only be washed ten times before the internal sensor was ruined. Even though interest in smart clothes is high, it has yet to become a major trend. However, if smart technology does begin to gain more popularity, it is likely that its use would be mainly to improve consumer well-being, similar to the purpose of introducing SmartLink into buildings (Sender, 2017).

Smart Technology in Airports

Airports seem to be piloting the introduction of smart technology into their business models in order to increase efficiency and enhance the consumer experience. A survey conducted in 2016 by the Airports Council International proved that global revenue for airports has increased, and because of that, IT budgets within airports were presumed to be over $9 billion.

At the time of the survey, it was expected by 58 percent of airport CIOs that IT budgets devoted to increasing customer satisfaction through the overall passenger experience would continue to increase into 2017. Additionally, 48 percent of airports are planning on tying in Bluetooth-based sensors and other smart technologies to their systems to ultimately create a "smart airport of the future" (Johnson, 2016).

Sensory technology is the basis for creating smart airports, and it is also the driving force behind GOJO's SmartLink. One type of sensor is called a beacon, which is a tiny Bluetooth radio transmitter that is used to connect signals from multiple devices to form a larger network (Kontakt, 2017). According to the SITA President in Europe, Dave Bakker, "beacon technology unlocks a world of opportunity for airports, with a clear view of who passengers are, and where they are in the airport." The main goal of setting up this larger network is to better streamline the customer experience and reduce stress among passengers (Johnson, 2016). For GOJO, this could potentially be a big opportunity. If airports have the mindset of enhancing customer satisfaction and efficiency, then introducing SmartLink would only add to this efficiency. Additionally, if IT budgets are continuing to increase, spending additional money on SmartLink technology would likely be less of a concern.

Potential Security Concerns

The internet of things is becoming increasingly relevant in today's technology environment. It refers to "objects embedded with technologies such as microchips, sensors, and actuators that often use Internet Protocol and share data with other machines or software over communications networks" (Britton, 2016). In simpler terms, it refers to the idea that an increasing number of devices are being given internet access, such as refrigerators, printers, and, in the case of GOJO with SmartLink, hand sanitizer dispensers. The internet of things has

introduced a plethora of ways to utilize technology, and has made many processes more convenient. For example, GOJO's SmartLink technology allows hand sanitizer dispensers to send pings over the WiFi that it is connected to when it is running low on supplies, thus allowing maintenance staff to refill that dispenser before it is empty, and also saving maintenance staff time because they no longer have to check each individual dispenser. However, with the internet of things comes new security risks.

One potential cause of increased security risk is the complexity of software. A piece of software's complexity can be measured by the number of lines of code that make up the software. As complexity increases, more vulnerabilities arise. According to a study done by Carnegie Mellon University, commercial software typically has 20 to 30 bugs for every thousand lines of code (Britton, 2016). A typical commercial software may have 50 million lines of code, which means that it could have over one million bugs to be exploited. As more devices become integrated into the internet of things, more vulnerabilities arise.

With the arrival of big data comes more security risks. "Every digital processor, sensor, mobile phone, GPS device, car engine, office key card, and hotel door lock produces data. If a device becomes linked to a customer in some way, it becomes a data point that can be tracked and mined for patterns in the customer's behavior" (Britton, 2016). All forms of technology, no matter how big or small, are potential entry points for hackers. Once these are breached, there is no telling how much damage the hacker will do before he is discovered.

It is very important that core systems and applications are protected. Hackers are less likely to target individual devices and more likely to target the core system that each device is connected to (Pollard, 2017). Thus, it will be imperative that the core system that each

SmartLink dispenser is connected to is very secure. Unfortunately, this likely leads to increased costs.

One common misconception is that hackers will not target IoT devices because they are too different from a computer and hackers would not know how to hack them properly. Unfortunately, this is not true. It is common for popular operating systems, such as Riot OS and Windows 10 IoT core to be ported to IoT architectures (Pollard, 2017). This means that hacking these IoT devices would be nearly identical to hacking a computer. Because of this, it is important that the devices also be well-protected.

As all of the above information suggests, ensuring that a device that is connected to the internet via smart technology is secure is of utmost importance, and developers must be vigilant in maintaining the integrity of the data that the device collects. This means that frequent patches will need to be released, and this sometimes brings a new set of problems with it. As Jeff Pollard details in *Computer Weekly*, "many IoT devices lack a physical user interface or screen, which makes it hard to notify a user about the need to deploy an update and steps to do so" (Pollard, 2017). Without a way for the user to realize that the device needs to be updated, it is unlikely that the device will ever receive the necessary update. This means that there are now exploitable security risks that hackers can take advantage of. This also has implications for the developer of the software in the device. The developers must be dedicated to continuously Imonitoring and patching the software if vulnerabilities are identified. "If the vendor only maintains it for a year or two, you are left on your own for the rest of the device's life" (Pollard, 2017).

Competition

Competition plays a big role in how companies ultimately decide to act. GOJO's main threat through their competition is the offering of paper products along with soap, and the ability to have an entire smart bathroom solution. GOJO currently only offers its SmartLink technology within its soap and hand sanitizer dispensers. One of GOJO's major competitors is ZAN Compute. ZAN Compute is a technology company that provides smart solutions for entire buildings. Their goal is to allow companies to use their maintenance staff and resources more efficiently so that they can save money in the long run. They collect analytics on objects such as air duct covers, garbage bins, paper towels, and soap dispensers using smart sensors. The smart sensors are placed outside the objects, which cause them to be slightly less accurate than those placed within dispensers. They share their data with customers through a web service, an app, or alerts to let them know when to service their bathrooms. ZAN Compute did a case study in which they studied their smart solution in multiple buildings. They found that it resulted in an average of 30 percent in savings for maintenance (Zan Compute, 2017).

The ZAN bathroom solution offers analytics on four different categories. The first category is a traffic estimate. This shows, based on the sensors, how often each restroom in a building is used. The second category is the cleanliness index, which uses the combination of data from the objects in the restroom and the traffic to estimate how clean the restroom is. The third category is the predictive maintenance, which uses analytics to estimate when each washroom will need to be cleaned. The fourth category provides information on personal hygiene. The data in this category looks at the correlation between the amount of times the toilet flushes and the faucet is used to estimate the level of cleanliness of employees (Zan Compute, 2017).

Another competitor of GOJO is Kimberly-Clark. Kimberly-Clark provides paper products and soaps for businesses and consumers. Kimberly-Clark Professional has a smart solution for bathrooms, which is mainly focused on class A office buildings. Their smart technology, Onvation, is placed inside soap, towel, and tissue dispensers. It provides real-time data and alerts on low products, dispenser malfunctions, use rates on dispensers, restroom traffic, and battery life (Kimberly Clark, 2017).

Kimberly-Clark did several studies dealing with the quality and cleanliness of restrooms. When interviewing American consumers on restrooms, they found that 75 percent of the respondents believed that a bad restroom was a sign of poor management. Employees of various companies were also surveyed about workplace restrooms. Sixty percent of the employees said that an unclean restroom leads to a lower opinion of the entire building (Kimberly Clark, 2017).

Another study focused on female employees of several companies. Kimberly-Clark added different amenities such as moist wipes, air fresheners, and seat covers to restrooms to see employees' reactions. The study found that women want their workplace restroom to be a clean, peaceful place where they can recharge for the rest of the day. The quality of bathrooms affected how much employees perceived their company cared about them. Women also reported the order of amenities they cared the most about was led by hand sanitizers, followed by air fresheners, facial tissue, and toilet seat covers (Kimberly Clark, 2017). Applying technology similar to SmartLink in this case study emphasizes the effect that efficient, clean bathrooms can have on consumers and employees.

Airport Industry and Restrooms

Based on findings mentioned previously and the current direction of our research, we decided to narrow our scope to focus on airports. In 2016, the top five busiest airports in the

United States were Atlanta (ATL), Los Angeles (LAX), Chicago (ORD), Dallas (DFW), and New York (JFK). Atlanta had around 46.7 million passengers, Los Angeles had 36.7 million, Chicago had 34.8 million, Dallas had 28.9 million, and New York had 26.8 Million (US Department of Transportation, 2016). Even with these already large numbers of passengers currently traveling by air, air travel is expected to increase over the next few years. In North America, there is an expected three percent annual growth rate per year in air traffic from 2017 to 2036. For the entire world, air traffic is expected to increase at 4.7 percent per year (Statista Survey (1), n.d.). "The increase in travel is being driven by factors such as low air fares, higher living standards, and the ongoing recovery in the world economy. Demographics play a large role as well because a higher working age population makes more trips than its older and younger counterparts" (Mergent, 2017).

Personal consumption expenses for U.S. airlines are also forecasted to grow at a rate of about four percent each year until 2021 ("Airlines", 2017). This growth in the airport industry means that there will be more foot traffic in the airport and more households will be spending their money at airlines in the coming years. Due to this increase in air travel, there is a demand for more air fleets. There will be an increase in the amount of aircraft fleets worldwide in the coming years. In 2016, North America had 7,060 aircraft in service. By 2036, North America is expected to have 10,130 aircraft in service (Statista Survey (6), n.d.).

In a recent survey, 20 percent of adults ages 18 to 29 said that they travel by air at least once a month for leisure travel, which was more frequently than the other age groups that were surveyed. For adults ages 30 to 59 years, only nine percent travel at least once a month and for adults 60 years and older, only four percent said that they traveled by air at least once a month (Statista Survey (3), n.d.). With the forecasted increase in personal consumption for U.S. airlines,

ages 18 to 29 may possibly be the age group that will have the majority of customers using the airlines and airports in the future as the airline industry grows.

Recently, nearly 1,000 United States citizens were asked to rate how satisfied they were with toilets at United States airports. The results showed that 54 percent were “rather satisfied” and 33 percent were “very satisfied” with the toilets (Statista Survey (2), n.d.). When the level of satisfaction with toilets was separated between male and female, results showed that 56 percent of females and 51 percent of males were “rather satisfied” with the toilets and 28 percent of females and 37 percent of males were “very satisfied” with the toilets (Statista Survey (5), n.d.).

Hobby and Bush Intercontinental Airport in Houston, Texas is monitoring their bathrooms extensively. They have implemented “smart restrooms” into their airport, which allows them to receive immediate feedback regarding the conditions of their restrooms. The decision to implement this technology was based off of surveys conducted by the airport that showed results of passengers ranking bathrooms as high priority. The “smart restrooms” in the Houston airports also have a predictive analysis tool. “The system’s predictive analytics allows staff to know exactly where to expect a rush, how long on average passengers visit, when to change flush valves [and] even which size fan clears the air best”. Since they have implemented the “smart restrooms” in February of 2017, complaints about the restrooms have gone down. This is important to Hobby and Bush Intercontinental Airport because it can give their customers a better experience, which in turn makes them more competitive compared to other airports. La Guardia Airport is currently the only other airport with smart restrooms, but Los Angeles (LAX) and Atlanta (ATL) are currently trying to see if they can implement smart restrooms as well (Seward, 2018).

Customer Satisfaction

"Customer satisfaction is considered a prerequisite of customer retention and loyalty, and can help to boost profitability, market share, and return on investment". An article from the Journal of Services Marketing showed that the "five factors of service quality that are of importance to the customer are as follows: (1) core service or service product – the content of a service; (2) human element of service delivery – aspects such as reliability, responsiveness, assurance, empathy, and service recovery that are part of the human element in service delivery; (3) systematization of service delivery – the processes, procedures, systems and technology that make a service seamless; (4) tangibles of service – the equipment, signage, appearance of employees, and the man-made physical environment surrounding the service, which is commonly known as the "servicescape"; (5) social responsibility – the ethical behaviour of the service provider. Since service quality and customer satisfaction are closely related, there needs to be more focus not just on improving customer satisfaction, but rather improving the "customer perceptions of overall service quality" in the five areas noted above. Improving the customer's perception will in turn improve overall customer satisfaction. This improvement in customer satisfaction can be applied to the growing airport industry" (Sureshchandar, 2002).

"Passenger satisfaction is a key performance indicator for the operation of an airport. The way in which airport operators choose to provide the diverse range of airport facilities can have a major influence not only on their economic performance but also on their relationship with an airport's users." Due to the growth in the airport industry, airports need to focus more attention on customer-oriented management practices. The Tourism Management Perspectives Journal discusses an area that research has gone into recently: information and communication

technologies (ICTs) and "how ICTs' services affect passengers' perception about the quality of service at airport functional areas" (Brida, 2016).

In 2013, a survey was conducted at the Santiago de Chile's Airport to determine what parts of ICT's travelers find most important. The results of the survey show that attributes in the airport related to information and communication technologies are "positive and significant." Some of the elements that are included in ICTs that the survey takers found to be significant are real time flight information, maps, and services. In order to improve customer satisfaction, airports are now looking at ways to improve their ICTs (Brida, 2016).

Conclusion

Based on the secondary research that was conducted, our primary research will focus on consumer preferences of public bathrooms as well as the needs of airports in relation to the maintenance of public bathrooms. We have proof that poor maintenance of bathrooms decreases customer satisfaction, so we asked ourselves how the SmartLink solution could be set up in a way that not only decreases dissatisfaction, but actually enhances satisfaction. The growth of the airport industry and its technology leads us to figure out through primary research how the SmartLink technology can fit into current airport technology and maintenance routines in a way that adds value in the most unique and beneficial way.

There were many factors that led us to choose airports as our focus, with one factor relating to hand washing behavior. Some reasons that many people gave for not washing their hands in a public bathroom included a lack of soap in the bathroom or uncleanliness of the bathroom in general. Both of these issues could be improved if the bathroom was simply serviced better. With airports being one of the highest traffic areas for many hours of the day, we decided that they have the potential to be a perfect candidate for technology like SmartLink that

alerts staff when soap is low while also providing valuable information about how regularly bathrooms should be cleaned based on their usage activity at specific hours. We have also pointed out research that shows that people believe that bad restrooms are a sign of poor management, as well as the negative affect an unclean restroom can have on a person's opinion of the building. With how much weight a bathroom has on people's opinions and possibly even choices of place to go, we thought that this would make airports even more interested in bathroom cleanliness, as customer satisfaction is a big deal for airports. From a security perspective, we have some concerns to address in our primary research as well. Smart technology always has the potential be a security concern. With security being extremely important in airports, how they handle security risks with smart technology will be investigated. Also, as mentioned, the airport industry is growing. This is another indicator that airports could be a good demographic to target. The growth in the industry means that there will be even more traffic through the already high traffic airports. Higher traffic obviously relates to more people using the restrooms, which in turn correlates to the restrooms needing serviced more. The SmartLink technology has the potential to aid this need. For these reasons, we will base our primary research on airports and the benefits that the SmartLink technology can provide for them.

Primary Research Methods

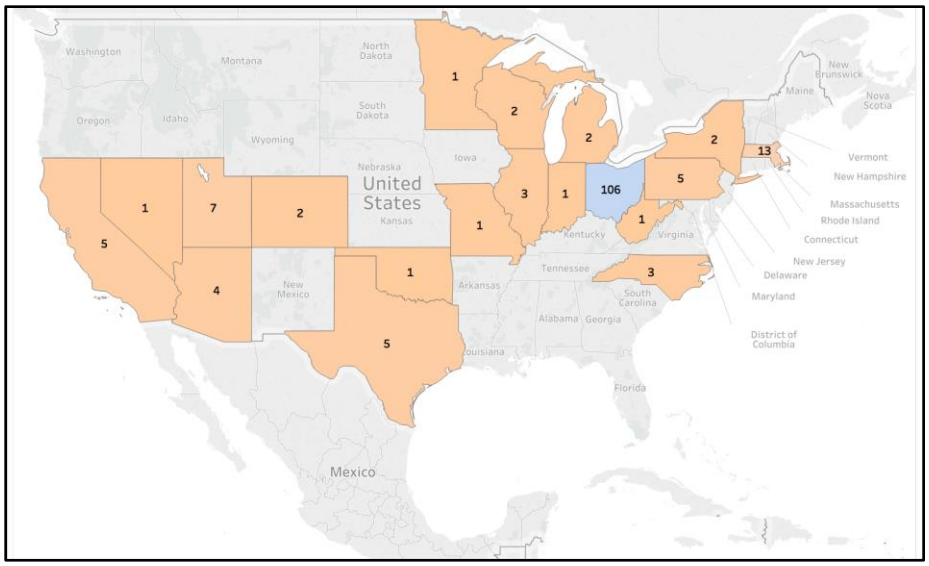
Our group decided to conduct two types of primary research in order to better understand the needs of airports and the consumers who frequent them. The first type was a 25-question survey that was sent out to frequent flyers through an email list that was purchased from V12 Data. The list contained over six thousand emails and allowed us to get better insight into the needs of these frequent flyers. The survey questions focused mainly on hand washing behavior,

bathroom cleanliness in relation to customer satisfaction, and the preferences of frequent flyers when it comes to bathroom features. Our second form of primary research consisted of in-depth interviews with maintenance and customer relations staff from airports from around the country. These in-depth interviews allowed us to understand the cleaning process of both large and small airports, as well as their opinions on the SmartLink technology. A greater explanation of the processes, as well as the findings, for both forms of primary research are explained below.

Primary Research Findings: Survey

With a limited budget of $500 and a target market that would be difficult to accumulate for a focus group setting, our team decided to create and distribute a Qualtrics survey. In order to be eligible for the survey, a participant must have at least been inside of an airport within the past ten years. Once a participant was deemed eligible, they were asked a series of questions on their preferences of airports and their level of cleanliness. We collected data from 239 respondents, with 154 of them being women. About half of the respondents were under the age of 25 years old, and most of this age group only flies about once per year.

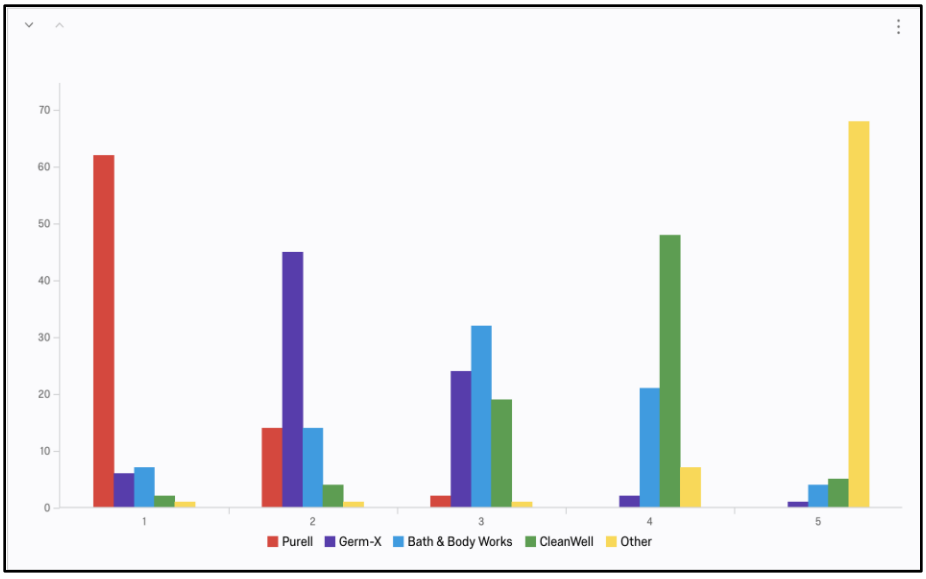
The first set of questions focused on demographics, such as which state the respondent currently resides in and what airport(s) they frequent. As shown in the graph, most of our respondents currently reside in Ohio; however, we did get at least one respondent from 18 other states around the country. This allowed us to gain some



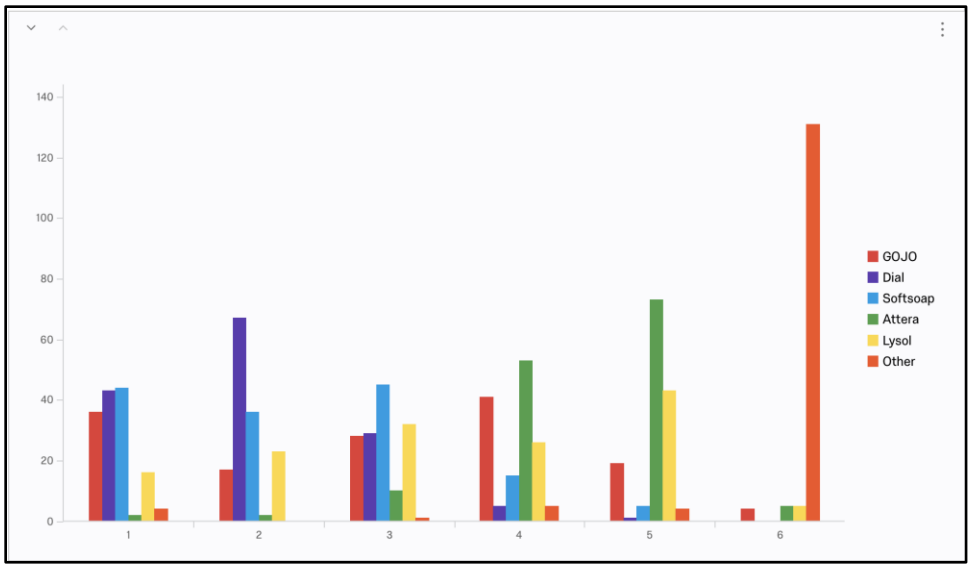
insights into smaller airports that we had not previously thought of contacting. Most of these individuals had no large complaints when it came to current airport and bathroom cleanliness, but did have some concerns with the crowds at the larger airports. One respondent said, "*in general they're clean but loud and crowded."* Another had no issues with cleanliness, but unfortunately had a personal item stolen from their luggage; *"for the most part it was good. Clean bathrooms. Friendly, helpful workers. However, I had an expensive straightening iron stolen out of my luggage somewhere between Burlington VT, Detroit, and SLC in Dec 2016."* This was a similar theme throughout the responses. We found this information interesting, as our initial thoughts and perceptions of airports would lead us to think differently.

The next set of questions focused on airport bathrooms specifically. We first asked participants about the effects of an unclean restroom. On a scale of one to ten (one being unaffected & ten being extremely affected), 79 percent of the respondents answered eight or above. Only 2.3 percent of respondents said that unclean bathrooms did not affect their overall airport experience. This is valuable information for GOJO and has possible implications for the future of the SmartLink technology, since SmartLink works to help commercial buildings achieve high customer satisfaction. This correlation will be discussed more in-depth later.

Our third and final section discussed our respondents' preferences and expectations when it comes to public restrooms. Since GOJO supplies both hand soap and hand sanitizer, we wanted to ask consumers about their preferences when they are in a public restroom. Unsurprisingly, most people (87.21 percent) indicated



that they would prefer to have just soap or both soap and hand sanitizer available for use. Only 12.21 percent said that they would prefer to use only hand sanitizer after using the restroom. Our team then decided to figure out how the GOJO brand-name items (GOJO and Purell) stood against the competition. One hundred percent of respondents placed Purell in one of the top three spots when compared to other sanitizers. Germ-X had the most second place spots, and the Bath & Body Works sanitizer took third overall. We also included the option "other" to see what brands could be competing with GOJO from under the radar. Most respondents who chose "other" stated that they were "*not concerned about the brand, just the availability."* This information shows that the Purell brand resonates well with consumers, and they enjoy seeing and utilizing that brand. Unfortunately, the GOJO soap brand did not boast the same results. Dial and SoftSoap were very close for the top spot. The GOJO brand name was pretty evenly split throughout the rankings. To our team, this shows that while some people may recognize the brand name, they may not realize how much they use the brand. Again the "other" category was added to gain additional insights into potential competitors. The two names that came up most frequently were "Dove" and "Bath & Body Works." The response to the "other" category for both was "no preference." This leads us to believe that many people do not even think about the soaps or sanitizers that they are using; they just know that they want them to be available to them. After finding out this information, our team



decided to turn to the airports themselves to find out about their maintenance and upkeep routines.

Primary Research Findings: Airport Interviews

The airports that we collected data from were Akron-Canton Airport, Pittsburgh International Airport, Palm Beach International Airport, and Los Angeles International Airport. The Palm Beach, Pittsburgh, and LAX interviews were conducted through email while the Akron-Canton interview was conducted through an in-person team visit at the airport.

Our group met with David Regula, the customer service manager, and Lisa Dalpiaz, the director of marketing, at Akron-Canton Airport on February 2, 2018. Akron-Canton Airport is a relatively small airport, having only five main restrooms, and they take tremendous pride in how they keep their facilities very clean. A main goal of the Akron-Canton airport is to become entirely "touchless," which is something that frequent flyers prefer greatly when it comes to bathroom features. Some of these touchless qualities include removing entry doors from their restrooms and implementing touchless faucets and paper towel dispensers. Another "clean" feature that Akron-Canton currently uses is a self-sanitizing mat that is placed on the bottom of bins that hold customer belongings when going through security. Customers place their belongings in the bin and the self-sanitizing mats do not allow any germs to be transferred from one customer's items to the next. Relating back to our other form of primary research, the frequent flyer survey truly underscored the importance of airport cleanliness. The Akron-Canton airport does a great job of recognizing the consumer preferences toward cleanliness by implementing these features that correlate directly back to the wants of the consumer.

Akron-Canton services their bathrooms based on the daily flight schedule of the planes. When it is known that a flight has just landed, they will send their maintenance staff to the

restroom in the area of that specific flight's gate. Along with flight trends, Akron-Canton also looks already looks at seasonality trends to determine the best overall times to service their restrooms and expect the most use.

Akron-Canton does not believe that they would benefit from the use of the SmartLink technology. Since they already have a system in place that allows them to know when to service their restrooms that works well, they do not think that adding the SmartLink technology will provide their staff with information that would significantly improve their current process. Akron-Canton was unable to think of any improvements to the technology that would benefit their maintenance process. However, Akron-Canton did suggest that larger carrier airports would possibly benefit more from the SmartLink technology. Larger airports tend to outsource their maintenance staff, have more flights occuring, and have more restrooms, which may suggest that just going off of flight schedule to service bathrooms is much more difficult. It is likely that the SmartLink technology would enable larger airports to better service their restrooms in a more efficient way.

Taking the information that we learned from Akron-Canton Airport, we collected data from a couple larger airports to see how they service their restrooms, what technology they may currently have in their restrooms, and what features can be added to the SmartLink technology that could possibly be beneficial to them. These questions were similar to the ones asked at Akron-Canton, which allowed us to compare the answers given to us on a larger, more congruent scale. We collected the following data via email from Pittsburgh International Airport and Palm Beach International Airport.

"Palm Beach International Airport has approximately 160 daily flights on 12 airlines offering non-stop service to over 25 destinations, with connecting service to destinations

throughout the world" (Arrivals at the Palm Beach International Airport, 2016). From our emailed questions, we learned that Palm Beach currently does not have any smart technology, but their janitorial staff, which is outsourced to Triangle Services, is interested in possibly pursuing some smart technology. Palm Beach recognizes that restroom cleanliness is one of the top priorities for customers and makes sure that they prioritize restroom maintenance. Palm Beach currently has 54 employees, with 16 on both first and second shift, and 22 on midnights. These maintenance employees are servicing the 24 restrooms within the airport.

When maintaining the restrooms, they currently have the restrooms being cleaned around eight times per shift during busy times and even more during the seasonal times. The airport uses frequency charts to log how many times the restrooms are checked per shift. According to Richard Roberts, the custodial contract coordinator for Palm Beach airport, the current process that Palm Beach uses does not have any issues. Palm Beach currently has $2.7 million budgeted for their overall janitorial contract, which includes restroom maintenance. Currently, the airport janitorial staff is interested in looking into learning more about the SmartLink technology. However, they are unsure whether it would be beneficial or not to their restroom maintenance.

Similar responses were received from the Pittsburgh International Airport, which is a much larger airport than Palm Beach. Having this size variety allows us to get an idea whether or not airport opinions change as size increases. Pittsburgh International Airport currently has 120 cleaners and a ten person plumbing staff, so it is not a surprise that they currently spend around $4.5 million on bathroom maintenance per year. Pittsburgh also recognizes that bathroom maintenance is a top priority and, similar to the Akron-Canton airport, they base their cleaning schedule off of flight schedule. Restrooms are cleaned multiple times per day, with a deeper cleaning occurring overnight.

Pittsburgh currently does have some technology in their restrooms and recognizes that technology is an ever-changing target. However, they do not believe that the SmartLink technology would be beneficial to them, since they currently do not have problems running short on sanitizing soap. Pittsburgh also did not have any recommendations on features that would make SmartLink more appealing, mainly because they have already investigated several systems that monitor traffic flow, frequency of service visits, towel usage, trash, and recycling management.

After receiving data from one small and two medium sized airports, we were able to receive some information from Los Angeles International Airport. Jocelyn Steele, the Public Relations Specialist at LAX, was able to provide us with some press releases from the smart technology that was implemented into their airport in early April 2018 (Los Angeles World Airports, 2018).

In terminal 4 of LAX, lights were installed above restrooms stalls that are red when the stall is occupied and green when it is vacant. These lights are called "Tooshlights" and will make the flow of movement more efficient for the passengers. The restroom also has touch screens at the doorway that allow passengers to provide feedback about the current state of the restroom and any issues that are currently in the restrooms, such as wet floors, lack of towels, etc. The real-time data will allow the custodial staff to respond more quickly to custodial issues in the restrooms. While this smart technology is only currently in terminal 4, if this pilot is successful, it will be implemented in other restrooms throughout the airport. LAX knows that restroom cleanliness is very important to passengers and LAX wants to improve their customer's experience at their airport.

Overall, the small and medium sized airports we received data from tend to base their maintenance schedule off of the overall flight schedules, which is why they are not very interested in the SmartLink technology. Specifically, there were not any feature recommendations from the airports that they believed would improve the current technology to make it more appealing to them. This primary research shows that the SmartLink technology that GOJO has in its current state will most likely not benefit the airport industry. Also, this primary research shows that there are not any clear-cut, simple improvements to the SmartLink technology that could be made to encourage airports to purchase the technology. While our secondary research showed that the airport industry is looking more into Smart technology, our primary research has shown that the Smart technology that GOJO offers, specifically smart technology that is used in restrooms, would not be beneficial to the airport industry since the systems that airports currently have in place are working very effectively for them. However, with our primary research, there were numerous limitations. While we were able to receive data from one smaller airport and two medium sized airports, we were only able to receive minimal data from a larger airport. We were only able to receive press releases about their new smart technology that was implemented.. Because LAX has already implemented smart technology to make their restroom maintenance more efficient for both themselves and their customers, it is possible that larger airports could benefit from the SmartLink technology that GOJO has to offer since they have so many flights and passengers.

Recommendations

After analyzing the primary and secondary research findings, there are several recommendations that GOJO should consider for improving their SmartLink business model. If GOJO still decides to pursue airports as a potential commercial building, we recommend that

GOJO only target large airports. Based on our primary research, we found that small airports typically use the pattern of flights leaving and coming in to track when the restrooms need to be cleaned and restocked. Small airports, on the other hand do not have enough bathrooms for them to require a system such as SmartLink to track their maintenance. This means there is little to no use for SmartLink for small airports. However, there may be more use for SmartLink in bigger airports because there are more restrooms and many more flights throughout each day. Big airports also spend much more money on maintenance, so there is a greater opportunity for savings. Unfortunately, we were unable to hear from many larger airports to see whether they use similar maintenance routines, but the insight we gained leads us to believe that this route of business pursuit would provide the highest return.

In regards to a new business model for SmartLink, we recommend offering a free one-year trial at a select few of the biggest airports to ultimately track the annual savings for each airport selected. For example, GOJO could give away its SmartLink technology for one year at New York and Los Angeles airports, and at the end of the trial they could determine and strongly highlight the amount of money that each airport saved on maintenance costs over just that short time period. This demonstrates in a real-time scenario the major cost benefits that are apparent with the use and analysis of the SmartLink technology. The trial period will also allow the airports to see the inefficiencies in their current maintenance patterns. We found from our primary research that even small airports spend a lot of their budget on maintenance. If airports can see for themselves through this trial run just how much SmartLink can decrease their maintenance costs, then they will be much more likely to purchase it. Additionally, once it has been proven that a number of major airports have benefited from using this technology, other airports will be quick to catch on. GOJO could highlight testimonies or even provide case

studies to prove this cost-savings even more. After the free trial has ended, GOJO would provide the option for these airports to buy SmartLink for either a one-time charge or an annual fee. It is also recommended that the product being used within the SmartLink dispensers be soap as opposed to hand sanitizer, as this is what our survey results showed that most people seemed to prefer.

We also believe that an important part of SmartLink is the education of how to use this tool properly, so creating an education program centered around teaching businesses how to use and analyze the data that SmartLink provides is of high importance. One of the major problems with SmartLink right now is that the companies who have it installed do not realize its capabilities and do not utilize it to its full potential. Businesses need to be educated on the analytics SmartLink provides and how the system can be used to lead to cost savings and improved efficiency. If the maintenance staff does not know how to read the data, it is unlikely that they will be able to save any time or money from using SmartLink, which could likely result in a negative opinion of the system's capabilities. For a trial to succeed, GOJO must make sure that these companies know how to use the technology properly so that it can lead to maximum savings. We believe that offering an education program would allow many more companies to maximize their savings through SmartLink, which would ultimately lead to better product recognition and more involved, interested customers. An education program would work best if an education team at GOJO would work with the company at the start of the SmartLink trial run to educate on usage. Then, after one year, the education team (or individual) from GOJO would meet again with the airport to discuss how to interpret and analyze the results of the data collected SmartLink over that past year. Additionally, this education team would be able to be

contacted throughout the year if any questions arise about the technology or data being collected during that time.

In conclusion, based on our findings from the primary and secondary research, we do not believe that airports are the best channel for GOJO to focus their efforts on for SmartLink because of the success of current maintenance routines. However, if GOJO does decide to target airports, we recommend that they focus on very large airports such as New York or Los Angeles. Because the airports that we contacted do not currently believe that SmartLink is worth the extra cost, GOJO must change the SmartLink business model by implementing this education system to show that the technology truly is worth the extra cost.

Alternative Solutions

No problem has only one solution, and this is no exception. If our primary recommendations are not feasible or of interest to GOJO, we have come up with alternative solutions to fulfill GOJO's needs. Rather than selling directly to airports, GOJO could instead partner with companies that already act as intermediaries between manufacturers, like GOJO, and airports. Essentially, GOJO would be participating in more of a business to business relationship than a business to consumer relationship (consumer in this case referring to airports). There are two potential options with this recommendation. The first option would be for GOJO to sell to large distributors that can be found on websites such as globalindustrial.com or sustainablesupply.com. The second option would be for GOJO to partner with these distributors, which could decrease the risks and costs associated with operating alone. GOJO could even capitalize more on the SmartLink technology by offering to sell SmartLink with other companies' dispensers. This could help increase their market penetration, as there are certainly some airports that do not buy their dispensers from GOJO and would not be willing to switch

suppliers. If GOJO were able to partner with these suppliers and include SmartLink in their dispensers for a share of the sales revenue, they could benefit immensely.

The adoption of our recommended education program would incur many costs. Some of these costs would be associated with hiring new employees, training them on how to use SmartLink so that they are in turn able to train others, and more. It is possible that GOJO would not want to pursue this option due to the these costs. In this case, GOJO would not have any way to train potential customers on how to use SmartLink, and as a result, many customers may be deterred from purchasing SmartLink because they simply do not know how to use it and do not want to dedicate the time and resources to teach themselves how to use it. In order to make SmartLink more attractive to these potential customers if an education program is bypassed, GOJO could consider offering a discount when a certain number of dispensers are bought. For example, if an airport buys 100 dispensers, they will be able to purchase the addition of the SmartLink service for 25% less than it would normally cost. These numbers are purely for example; GOJO would be able to determine the discounts that they deem most appropriate. Implementing this recommendation would increase the perceived value of SmartLink and would result in an increased likelihood of customers purchasing SmartLink.

Future Research

Our recommendations and alternative solutions not only describe the most beneficial and plausible strategic paths for GOJO's SmartLink technology, but they also bring about ideas for future research and strategies. The secondary research showed that a lot of airports are active within the internet of things with various features of airport activities. This creates a network of data that is efficient for airports and builds an easier experience for customers. When discussing

bathrooms in particular, data on bathroom maintenance and usage trends can prove to be just as useful and efficient.

As discussed earlier, the SmartLink technology in its current state is not a feature that airports seem to want or need, but often a company must make a solution that consumers did not even know that they wanted. This strategy proved successful for Apple's original introduction of the iPod and iPhone, as consumers had never thought of that technology before, yet it ended up becoming a "need" among everyday life. When survey participants were asked about what improvements they would like to see within public bathrooms, answers involved a variety of different bathroom appliances, which shows that there is not one single problem point for public bathrooms. Since GOJO only focuses on soap and hand sanitizer, we believe that putting future research into creating the idea of a "total bathroom solution" could potentially be a very big opportunity for the company.

We define the "total bathroom solution" as one where all bathroom appliances are virtually connected in a way that consolidates maintenance efforts and maximizes efficiency. To do this, GOJO would want to seek out other top-performing brands in the commercial bathroom products industry for partnerships. One of the top companies to create a partnership with would be Kimberly-Clark, which is a company that focuses on paper towels. As found in the secondary research and supported in the primary research, consumers typically prefer paper towels over hand dryers, so this is where the focus would lie. Our secondary research talked about Kimberly-Clark's current use of smart technology within some of their products, making them a competitor of GOJO. However, GOJO stated that they were open and willing to potentially partner with competitors if it meant increasing efficiency and brand power even more. Kimberly-Clark would be a beneficial company to partner with, not only because of their

powerful brand name, but also because they already have experience and an interest in smart technology offerings.

Another top company to begin a partnership with would be Rubbermaid, since it sells trash cans for commercial use. Like Kimberly-Clark, Rubbermaid is also a highly recognized brand name and would likely have the resources to carry out a partnership with GOJO and Kimberly-Clark. GOJO currently partners with Microsoft to create the SmartLink technology, so if these three companies came together to create one large partnership, Microsoft could work to implement the SmartLink technology within the other brands' dispensers as well. Once this technology is integrated into each brand, the companies would then market themselves together as a total bathroom solution. The data for each appliance would be tracked and usage notifications of the products for regular maintenance would be documented. Alerts for the maintenance staff would also be provided. GOJO's SmartLink technology is on the right track, but to be able to create a completely harmonious bathroom with the right research has the potential to significantly increase the value of all brands involved while taking full advantage of the rising internet of things.

Other important features of this total bathroom solution would be all touch-free appliances, as well as a live hand washing data screen. When deciding who to partner with, GOJO needs to ensure that the other companies are on board with only implementing SmartLink technology within their touch-free products. When talking with Akron-Canton Airport, they mentioned that a major goal was to make their bathrooms entirely touch-free, so it is likely that other airports would value this feature as well. Similarly, as our survey results showed, consumers greatly prefer a touch-free bathroom as well, so this could lead to increased customer satisfaction for airports. Adding this feature to the total solution increases the value of the

solution even more. Additionally, as stated in the secondary research, a company based out of the United Kingdom introduced LCD screens within bathrooms that had a live data feed on every person that washed their hands. People are able to see how many others have washed their hands after using the bathroom, which increases the likeliness that a person will wash their hands due to social pressure. If this was part of the total bathroom solution along with SmartLink and the other brands, users of bathrooms will be less likely to transfer sicknesses between one another, thus increasing the health of bathrooms and commercial buildings.

It would be worth GOJO's time to research this idea further to see if it is even a feasible partnership and if the potential return would be larger than the costs. It is a project that would definitely take years to successfully create, launch, and track. The ultimate goal of the total solution is to increase efficiency, increase the total value of the GOJO product through powerful partnerships, increase buyer demand due to the previous unknown need for conclusive, all-including data, and create a cleaner experience for customers.

References

Arrivals at the Palm Beach International Airport. (2016). Retrieved April 13, 2018.

Ashton, K. (2009). The 'Internet of Things' Learned. RFID Journal. Retrieved April 14, 2018.

Aunger, R, (2010). Three Kinds of Psychological Determinants for Hand-Washing Behaviour in Kenya. Social Science & Medicine Journal Volume 70, Issue 3, February 2010, Pages 383-391.

Brida, J. G., Moreno-Izquierdo, L., & Zapata-Aguirre, S. (2016). Customer perception of service quality: The role of Information and Communication Technologies (ICTs) at airport functional areas. *Tourism Management Perspectives, 20*, 209-216. doi:10.1016/j.tmp.2016.09.003.

Britton, K. (2016). Handling Privacy and Security in the Internet of Things. Journal of Internet Law, 19(10), 3-7.

Gartner Says Smart Cities Will Use 1.6 Billion Connected Things in 2016. (2015, December 7). Retrieved February 08, 2018.

Healthy Handwashing Survey. (2017). Retrieved December 13, 2017.

Johnson, L. (2016, December 1). How Digital Solutions will Help Design the Smart Airport of the Future. Retrieved December 14, 2017.

"Kimberly-Clark Professional." Kimberly Clark, Dec. 2017.

King, J., & Perry, C. (2017). *Smart Buildings: Smart Buildings: Using Smart Technology to Save Energy in Existing Buildings* (pp. 1-36, Rep. No. A1701). Washington DC: American Council for an Energy-Efficient Economy.

Kontaktio. (n.d.). What is a Beacon? Retrieved December 14, 2017.

Livescience. (2013, June 10). Gross! Just 5 Percent of Bathroom Users Wash Hands Correctly. Retrieved December 14, 2017.

Los Angeles World Airports. (2018, April 4). LAX LAUNCHES “SMART RESTROOMS” PILOT PROJECT [Press release]. Retrieved April 18, 2018.

MailOnline, M. D. (2015, February 27). Do YOU always wash your hands after going to the loo? 62% of men and 40% of women admit they don't bother. Retrieved December 13, 2017.

Mann, W. (2001). *U.S. Patent Application No. 09/944,429*.

Masterson, R. (2016, October). Hand Sanitizer Manufacturing in the US. Retrieved December 15, 2017.

Mergent. (2017). Airlines. Retrieved December 14, 2017, from Mergent. (2018). Airport Operations. Retrieved February 08, 2018.

Metallo, C., Agrifoglio, R., Schiavone, F., & Mueller, J. (2018). Understanding business model in the Internet of Things industry. *Technological Forecasting and Social Change, an International Journal.* Retrieved April 14, 2018.

Mintel. (n.d.). Travel Tech - US - July 2017. Retrieved December 14, 2017.

Mintel. (2017). Wearable Technology - US - December 2017. Retrieved December 14, 2017

Morvaj, B., Lugaric, L., & Krajcar, S. (2011). Demonstrating smart buildings and smart grid features in a smart energy city. *Energetics (IYCE), Proceedings of the 2001 3rd International Youth Conference* . Retrieved February 8, 2018.

Olson, C. (2011). The State of Smart Technology in Commercial Buildings. *Buildings*, *105*(11), 34-40.

Pauget, B., & Dammak, A. (2018). The implementation of the Internet of Things: What impact on organizations? [Abstract]. *Technological Forecasting and Social Change, an International Journal.* Retrieved April 14, 2018.

Perles, A., Perez-Martin, E., Mercardo, R., Segrelles, J. D., Blanquer, I., Zarzo, M., & Garcia-Diego, F. J. (2018). An energy-efficient internet of things (IoT) architecture for preventive conservation of cultural heritage. *Future Generation Computer Systems Journal*, 81, 566-581. Retrieved April 14, 2018.

Pollard, J. (2017). Meet IoT Security Challenges Head-On. Computer Weekly, 15-18.

Ram, P. (2010, March). Practical Guidance for Measuring Handwashing Behavior. Retrieved December 13, 2017.

Ray SK, Amarchand R, Srikanth J, Majumdar KK. (2011). A study on prevalence of bacteria in the hands of children and their perception on hand washing in two schools of Bangalore and Kolkata. Indian J Public Health 2011;55:293-7.

Research Reveals Poor Handwashing Practices. (2011, October 21). Retrieved December 14, 2017.

Sender, T. (2017, October 20). How far has wearable technology in fashion come in the last year? Retrieved December 14, 2017.

Seward, L. (2018, January 09). Bush, Hobby airports have 'smart bathrooms'. Retrieved February 01, 2018.

Shadroo, S., & Rahmani, A. M. (2018). Systematic survey of big data and data mining in internet of things. *Computer Networks Journal*, 139(5), 19-47. Retrieved April 14, 2018.

Snoonian, D. (2003). Smart buildings. *IEEE spectrum*, *40*(8), 18-23.

Statista Survey. (n.d.). Estimated annual growth rates for passenger air traffic from 2017 to 2036, by region. In *Statista - The Statistics Portal*. Retrieved February 2, 2018.

Statista Survey. (n.d.). How satisfied are you with the toilets at the airports you have been to?. In Statista - The Statistics Portal. Retrieved December 15, 2017.

Statista Survey. (n.d.). Leisure air travel frequency in the United States as of April 2017, by age. In Statista - The Statistics Portal. Retrieved December 15, 2017.

Statista Survey. (n.d.). Percentage of adults in the U.S. who were prone to select symptoms as of 2017, by age. In Statista - The Statistics Portal. Retrieved December 15, 2017.

Statista Survey. (n.d.). Percentage of U.S. respondents that are satisfied with the toilets at U.S. airports in 2017, by gender. In Statista - The Statistics Portal. Retrieved December 15, 2017.

Statista Survey. (n.d.). Size of aircraft fleets by region worldwide in 2016 and 2036 (in units). In *Statista - The Statistics Portal*. Retrieved February 2, 2018.

Survey Reveals Hand Washing Habits Of Men & Women In Public Restrooms. (2014, October 15). Retrieved December 13, 2017.

Sureshchandar, G., Rajendran, C., & Anantharaman, R. (2002). The relationship between service quality and customer satisfaction – a factor specific approach. *Journal of Services Marketing, 16*(4), 363-379. doi:10.1108/08876040210433248.

US Department of Transportation. (n.d.). Busiest U.S. airports in 2016, based on the number of passengers enplaned (in 1,000s). In *Statista - The Statistics Portal*. Retrieved February 2, 2018.

Yang, J., Wen, J., Jiang, B., Lv, Z., & Sangaiah, A. K. (2018). Marine depth mapping algorithm based on the edge computing in Internet of things. *Journal of Parallel and Distributed Computing*, 114, 95-103. Retrieved April 14, 2018.

"ZanCompute Custodial CaseStudy." ZAN Compute, 2017.