Management 490 - Capstone Service Learning and Consulting

Final Report

Organization: Telivity

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Introduction to Telivity

Over the last decade, consumption of natural resources has seen an exponential increase, mainly due to the increase in global population. Canada is very fortunate as compared to other countries, we have a lot of land and access to significant natural resources, with a relatively small population. With increased immigration and drive towards urbanization, major cities are growing rapidly, with Kelowna being one of the fastest growing cities in Canada. Being based out of Kelowna, the team at Telivity approached our Capstone group in order to research and identify specific verticals where an Internet of Things (IoT) and Machine Learning (ML) based application can address the climate-based challenges. With the Telivity software being able to identify macro and micro trends within data sets, there is an opportunity to leverage this software and its predictive analytics capability. Hence, the goal of this Capstone project is research and identify addressable markets locally, that can also be scaled and are dependent on critical natural resources such as water.

Idea and Problem

With Kelowna growing dramatically, a concern that was highlighted was the reliability of water demand and supply. Global warming is increasing temperatures and affecting the amount of water available to local residents and commercial users. We have observed that long term studies have shown water consumption potentially outpacing the fresh water supply available in the Okanagan, indicating that the region will have to consciously monitor and address water consumption in the region, as well as other arid agricultural regions. When observing the various users of water in the region, we have observed the two main user groups to be residential users, as well as agricultural users. However, these two addressable markets would drastically differ in the potential offering Telivity can provide.

Water consumption appears to be quite cyclic in nature, as both residential and commercial users use significantly more water from April to September. This can be explained due to the water temperatures, causing increased residential consumption due to landscaping, and an increase in agricultural consumption due to the fresh harvest. And before we analyze potential product offerings, we have to understand what exactly is resulting in the disconnect between water supply and demand in the region. The Okanagan is fortunate that there are larger lakes and

water bodies that directly contribute to the basins from which water is extracted, and this source affects both the residential and commercial users when it comes to water supply.

Unlike other regions where water supply is dependent on a few water boards, the Okanagan has roughly 100 water boards. This creates a challenge as collectively, change needs to be implemented as we are going to exceed water supply over the next 10-20 years driven by growth in the region. However, each water board has its own goals and has different beliefs in regard to how water needs to be managed, as they are supplying water to local users. A lot of these water boards don't monitor consumption levels very closely, and don't have a good idea of trends that may be forming in regard to increased consumption. This highlights the need to develop a product that could track and predict water supply and demand based on the consumption of both residential and commercial users. Not only to try and optimize water consumption, but to provide more insight to the stakeholders that make decisions affecting the future of water basins, such as the Okanagan Basin Water Board (OBWB).

The "*Okanagan Water Supply and Demand Project*" was conducted by the OBWB with the help of consultants, and analyzed supply and demand trends throughout the Okanagan's water basins. Utilizing this data, the study showed projections of water consumption and water sustainability between 2011 up until 2040, to better understand what decisions the OBWB needed to make to ensure water sustainability. From a macro perspective, the study observed that although water supply and demand is not an immediate concern, however, over the period of 20 years, the increasing population in the region and the changing climate will alter the sustainability of water in the region. As observed by Cohen & Kulkarni (2001), over the last 100 years, the region has seen a change in minimum and maximum temperatures, along with the precipitation in the region. Suggesting that although there are increasing challenges for agricultural users, there is an increase in growing days, farms are able to move up in elevation and the increased precipitation reduces the reliance on irrigation systems. However, a key element to the supply and demand equation is the use of reservoirs in the region as the basin relies on replenishing these gravity assisted natural reservoirs. Upon reading and analyzing the data given, there are some staggering statistics, coupled with future projections that really show how there is a gap in the market for a company like *Telivity*.

The data provided by the project is vast and relevant for our community in showing the need to conserve water consumption, in order to reduce the stress on the regional reservoirs and infrastructure due to the increased variability in the climate. Presented are several key findings, the entire report can be located in the appendix.

- Average annual use of water in the Okanagan is 210,000 ML (Million Litres)
    - Agriculture: 18,300 ha require an average of 120,000 ML
    - Golf courses: 1,060 ha require an average of 10,000 ML
    - Parks and open spaces: 590 ha require an average of 5,000 ML
    - Domestic outdoor: 5,935 ha require an average of 53,000 ML

The statistics above show how much water is used on average by each sector per month in the Okanagan basin. It is clear to see that the agricultural sector is the biggest user of water in the Okanagan, and pairing this with their low rates, it is one of the most impactful areas to address in regard to water consumption. After analyzing the data as well as meeting with key stakeholders in the water sector here in the Okanagan; It is the agricultural sector that has drawn the attention of both ourselves (Group 22) and *Telivity*. Data taken from *OK Waterwise* shows that the Okanagan has one of the “highest water usage rates in all of Canada”. Mainly due to high irrigation use on crops throughout the summer months. The second largest user group, the residential users, are also observed as consuming significant amounts of water for landscaping purposes during the summer months.

In addition, and arguably one of the most staggering facts uncovered in the OBWB study was the drastic amount of water that was being “lost” or “unaccounted for". The study continued by saying that approximately “51,000ML or 23% of all water extracted, imported or recycled in the basin is lost or unaccounted for”. With the largest component of this “unaccounted” for water being “over-irrigation resulting in deep percolation of water below the root zone”. Likely due to the soil conditions not being able to withhold and maintain water levels. And since many agricultural users only have one water meter, there isn’t enough data to understand where this water is going. Having spoken to a couple farmers, they’ve mentioned that at times they have just left water running in the morning for hours, as this is what has worked for them in the past.

This could suggest that if we can assist agricultural users in efficiently managing their irrigation timing to maximize yield, inherently we would see a reduction in water consumption, resulting in a reduction of over-irrigation.

Data taken from the OBWB and Okanagan Waterwise studies cement that there is a gap in the market for a product that is better able to track, relay and store information on water use. Each and every year water is being used at a rate higher in the Okanagan than almost anywhere in Canada with few major initiatives implemented to gain a stronger hold on the issue. It is time for a product to enter the market that is able to change the minds of consumers and push everyone to help save water. Not only can *Telivity's* proposed technology help get a grasp on the issue of water use and control but the technology may be able to aid in the large percentage of water that is seemingly going missing each and every year. One main key to consider during this process however, is how to create perceived value for the user, whether residential or commercial. Although sustainability is on the mind of most people, and some may be aware of their consumption habits, ultimately this awareness is diluted through a consumer's actions (Duran-Baraso et al., 2020). Suggesting that a compound approach be administered, one compromising of public education and awareness, as well as providing additional value on top of reducing water consumption.

Verticals

Having established that the Okanagan region is facing a long-term water supply and demand challenge, we should be focusing on applications for the two largest user groups: Residential users, agricultural users. Although we have deemed these two segments to be the main markets to address, there is a strong municipal component to this challenge as well, given that they invest in the infrastructure for these user groups, as well as developing pricing policies accordingly. As well, there is a shared interest for the municipalities to support Televities interests as ultimately it would reduce the stress on their infrastructure moving forward.

Residential Application

In order to understand what value a product can offer to a residential user, understanding their challenges and touch points with water consumption is useful. As observed in the Waterwise study, residential users are the second largest user group, however, most of their consumption occurs throughout the summer months, mainly due to landscaping. Suggesting that although showers and toilets consume significant water, water sprinklers contribute significantly more to this consumption. The main household uses of water such as washing dishes, clothes, or showers, are not hard to monitor, and any smart device would show the consumer how much water they are consuming. However, the challenge with landscaping is that variables can be taken to account for the varying temperature, weather patterns and soil conditions, predicting the ideal times and amount to water a lawn. This would be the main pain point for a consumer relating to their seasonal water consumption. When and how much water is ideal for a lawn?

Although water use is of its highest volume in the agricultural sector, we cannot ignore the need for more efficient water practices in the residential segment. It has been noted that households in the Okanagan use on average "1032 Litres" per day (One Valley one water, OK Waterwise); which has been found to be one of the highest in all of Canada.

The City of Kelowna has attempted to bring in new initiatives to mitigate the incredibly high use of water in the Central Okanagan. These new initiatives may be an avenue for *Telivity* to explore into, and venture forward with their application technology; this will be addressed further in the recommendation section. Two of the initiatives observed in the City of Kelowna are the: Rain Sensor Rebate, and the Smart Water Meter initiative. With the installation of smart water meters in all homes over the next few years, the City aims to get real time data into the consumption of consumers, allowing for hourly reports as well as monitoring leak detection. Pairing this with their EyeOnWater app, users are able monitor their consumption, historical trends as well as their billing information. On the other hand, the Rain Sensor Rebate is intended to incentivise users to purchase rain sensors for their irrigation systems. According to Capital News, the city is offering $35 rebates (Gilmore, 2019) per property in exchange for the use of an outdoor rain sensor to monitor and shut off irrigation use when enough rainfall is present. With the current water usage among households being dominated by the landscaping and gardening sector during the summer months, the City hopes that these initiatives will optimize water

consumption and awareness while reducing use. This is an excellent example for how the city is looking to mitigate water use in the residential segment. However, it is crucial to note that many other smaller towns and cities are not all adopting this technology. Speaking with Jennifer Miles with the Municipality of Vernon, she too had mentioned Smart Meters for agricultural users but not for residential customers. Utilizing *Telivity's* AI and ML platform would be useful in identifying trends present in the data collected, however, there may be some privacy issues restricting involvement by *Telivity*. Albeit an opportunity to further explore.

Badger Meter, a leading smart meter company is expanding its reach, so it may be difficult to manufacture hardware, however, there may be an opportunity to provide data analytics to municipalities and users who may not know how to efficiently analyze their data sets. Although we believe that the current approach is best suited in the agricultural vertical; keeping in mind the vast up-side potential in residential water management is also very important.

Agricultural Application

Unlike most residential users, agricultural users are reliant on natural resources for their income, and hence they interact with them differently. With the climate evolving globally and especially in the Okanagan, farmers have been challenged to alter their practices. Regardless of their selection of crops, there are a few key variables they have to balance: soil makeup, soil moisture, ambient temperature, sunlight, humidity and air pressure. Historically, through trial and error, most farmers have learned how to precisely manage these variables to optimize yield, although their decisions aren't made utilizing real time data. Having spoken with a couple farmers, their co-op monitors their soil conditions a few times a year, they fertilize accordingly, irrigate in the mornings while monitoring the weather for the next few days through weather apps. Many of them just turn the water on in the morning for a few hours as this is what they have always done. We were advised that the old-school farmer operated via "feel" and would monitor the soil around the base of their plants periodically, altering their practices accordingly. However, there is a huge gap here when it comes to monitoring different growing variables. Having spoken to small-medium sized farmers, there are two points holding them back: system

cost and technological complexity. This becomes increasingly challenging when growing high value crops such as cherries, as there needs to be a fine balance of temperature and humidity to prevent splitting.

As mentioned in the residential research, the Okanagan is starting to face challenges in regard to water supply and demand for residential and agricultural purposes. Agriculture use is the largest component of local consumption, and at some of the lowest non-potable water rates in the country, consumption has been a challenge in the past. Over the last few years water allocation in the region has become common practice, with water allocations being implemented in the regions. Allocations are contingent on the size of land, type of plants being grown, as well as typical consumption on an annual basis. Water rates are exponentially increased for over consumption with potential fines for excessive use cases.

Followed by the processing of research, we found that little monitoring if at all on smaller farms because of the cost limitation in irrigation monitoring and soil/nutrient monitoring. Based on that, we narrowed the scope of the market research into small/medium sized family farms, which we consider as potential markets. A lot of commercial systems are cost prohibitive and not feasible to these farms, hence they manually monitor weather patterns via weather apps and then make irrigation decisions. Therefore, our direction is to develop a cost efficient array of sensors that integrate into a central database with different dashboards, we would be able to drive significant value to these farmers and potentially cooperatives due to their vested interest in the success of these farms. However, we also notice that there are similar monitoring products in the market. To pressure from competitors and substitutes, we will still focus on the development of applications, which could be function on the phone or related product.

Municipal Research

To the municipal research, one of the main challenges is distribution. The district of North Okanagan (Vernon) limits the water the farms are able to use. Water for agricultural irrigation is provided only throughout the growing season, unless the farm applies for an additional permit, with this period being from mid-April to mid-September. Aside from this,

water allocation also differs based on multiple factors. The size of the land and the crops that are grown are two major factors that affect this allocation. If farms go over their water allocation, their water bill increases exponentially. For consumption that is 0-20% over allocation, the price of water increases to $0.46/cubic metre, and up to $1.82 if the consumption is over 50% above allocation. Big cities may be better at managing their resources, such as kelowna. But other townships with less funding might not be. With over 100 irrigation districts in the Okanagan, coordination is extremely crucial as each party has different opinions and goals for the region. This could suggest that municipal governments might not have enough control over regional policies, and provincial governments might have to control the narrative.

As a result of so many districts, it is challenging to aggregate data into a central database, although the Okanagan Basin Water Board (OBWB) has an initiative to monitor consumption and supply to basins. City and town councils in the region have acknowledged a need for cohesive action to prevent unfavourable conditions moving forward. Therefore, City of Kelowna has started a 5 year initiative to install new smart water meters in Kelowna, allowing for real time consumption monitoring, and a third-party app/dashboard for the end user. This platform is called EyeOnWater.

Overall, The City of Kelowna and surrounding townships have started to recognise the importance of water security in the region. Current focus seems to be on residential supply and monitoring, with little initiatives for commercial use. OBWB is monitoring 20% of basins for replenishing levels, but they don't have much data as to where exactly pockets of consumption are. Further highlighting a need for a centralized system catered to the commercial component.

Findings

After analyzing the two main user groups, their challenges, stakeholders involved and opportunities, we feel that Telivity should focus on the Agricultural segment. Although awareness about water conservation is important for residential users, we feel that the biggest material impact can be realized in the agricultural segment. Over the last 35 years, there has been a global trend realized of increasing urbanization and total population growth (Fao). Compounded with the effects of climate change, there has been a greater emphasis placed on

food security. Compounded by over-cultivation, we are slowly running out of nutrient dense land, and our current practices will lead to hundreds of millions of people undernourished by 2030. We are slowly approaching a point of no return and as a population have to rethink how we manage our critical resources. If we can't rapidly replenish resources, we have to learn how to manage with what we have, and the key variable is efficiency. Due to political changes, New Zealand's farming community had to quickly adapt technology, and have seen amazing results including a reduction in pesticide use (CITE). New Zealand has also invested heavily in Agriculture Technology (agri-tech), with a focus on maximizing returns on crops with the aid of IoT. Thus we feel that a focus on monitoring crops is something Telivity should focus on, not only to optimize yield for farmers, but also to conserve water in the process. We don't feel smart water meters for agricultural use have much value as in the Okanagan grey water is extremely cheap, and farmers are more worried about their crop than how much water they are consuming. By providing additional value, we feel that there is an incentive for farmers to optimize production, reducing water consumption in the process.

Recommendations

As a result of our findings, we believe that the residential smart water segment is concentrated and hasn't seen much buy-in from users. And given the need to optimize production in the region and the changing extrinsic conditions, developing a predicative analytics tool will be ideal for Telivity. Given that Telivity has already developed an AI and ML integrated software platform, we would have to identify a host of hardware sensors that we can integrate with the software. In doing so, the "product" would monitor soil and weather conditions on the farm, send live updates to the Telivity platform, which would outlay information on a user-friendly dashboard. The predictive analytics component is crucial as this is where we feel the value is, by extracting data and conditions present on a farm/orchard/vineyard, we would be able to predict what actions a farmer/operator would have to take on site. This would allow an operator to actively know which plants need more attention, potentially reducing spoilage. There are various benefits to this, including a reduction in manual labour, an efficient use of resources, as well as being able to preserve crops through adverse weather.

For such a “product” to be effective, there are a few actions that have to be taken in the short term; identifying 3rd part sensors to use, developing a predictive model and back-testing data. One of the issues identified with sensors is data integrity. For a model to be accurate, the data utilized has to be accurate, and reliable over a long period of time, especially under adverse weather conditions. A company that Telivity might want to engage with is Sensoterra, in regard to their Multi Depth Sensor, which monitors soil moisture at 6 different depths, providing a good understanding of the conditions under the plant. Pairing this with a multi-variable sensor such as the Weihei JXCT wireless digital soil sensor, would allow for monitoring of: soil temperature, soil pH, along with nitrogen, phosphorus and potassium detection. This combination would allow for extraction of critical variables, and both products have an Application Programming Interface (API) that would work with the Telivity platform. JXCT also has a weather station that could be utilized at an individual plot of land, to determine weather patterns along with pressure and ambient temperature, both important variables for growing. The benefit of these products is that they are all LoRaWAN enabled, allowing for a few central hubs on each farm/orchard/vineyard. The LoRaWAN protocol is ideal for this application as it is low energy and enables wireless sensors that can communicate to a central hub or network, which would then upload data to a server for Telivity.

Although sensors are a crucial part of this system, arguably the most important aspect in building a reliable predictive model, is the effectiveness of the model. We aren’t too familiar with horticulture, however, we suggest that Telivity approaches researchers at the university, as well as horticulturists locally to better understand the various attributes affecting farming in the region. By understanding the ideal growing climate, and nutrient profile for optimizing yield, Telivity’s programmers would be able to develop a predictive relational model that would equate these factors to the quality of yield. Although not easy by any means, the model doesn’t have to trigger actions, that level of automation is an opportunity in the future, but too complex of scope for the current application. Secondly, after the development of a model, back-testing is crucial to ensure it is not only accurate, but reliable under various circumstances. This may be challenging as Telivity would need access to data spanning back a few years, to understand how weather patterns and climate conditions affected crops and their yield. Through back-testing, Telivity would be able to gauge how accurate their model was, a factor crucial to the viability of the

product. Pursuant to the completion of the above-mentioned steps, Telivity should approach a community sponsor to establish a pilot project. Having spoken to Ben Stewart, we feel that Quails Gate would be open to such a project, as well as other major vineyards in the region. For Telivity to build a project for small/medium sized farms, the cost of the product has to be reasonable, and we don't believe that is attainable until a proof of concept is established with larger stakeholders.

Risks & Mitigations

This project is quite ambitious, however, we feel that it is needed in the Okanagan, as well as other communities that have an agricultural presence. Having received feedback from farmers & orchardists, there are two main points of resistance: system cost and technological change. Majority of the small & medium sized operations we had approached, explained that their budget was not supportive of expensive sensors or automation. And with a majority of farms in the Okanagan falling under the small/medium category, Telivity will have to be cost prohibitive and bring down their product costs over time. We believe partnering with larger farms/orchards/vineyards at the start is instrumental to this change, as building out a large-scale system for an operator who is well funded, will allow Telivity to scale faster. And in doing so, Telivity would be able to reduce their product costs by purchasing in greater volume through their suppliers.

The major risk that Telivity needs to address is the risk that an operator's crop may be destroyed under guidance from the Telivity product. Although IoT presents an opportunity to optimize production and operational processes, data integrity is a huge risk. Telivity needs to be extremely confident that their prospective predictive model is accurate, and provides positive results in 99% of situations. As well, there is a lot of trust placed on the suite of sensors, and it shouldn't be assumed that they will always perform reliably, especially under the adverse weather conditions Canada endures. Furthermore, the agri-tech space is seeing increasing investment into IoT, and with there being more competition, reliability will be a big factor. Some of the smaller farmers we spoke with mentioned that they lost their crop and were unable to recover, so for the small farmer they are hesitant to change. In order to mitigate this risk, it is imperative that Telivity takes an iterative process while developing the predictive model and

platform. Just like with any successful product, an iterative process allows for the design team to develop a product that is aligned with the needs of the customer, and factors in all of their concerns or pain points. Hence, spending considerable time in the front end of development will help ensure that the model is well thought out. Additionally, several fail safes should be implemented. Such that, if a sensor is reading incorrectly, an alert is sent out for maintenance and the model does not read that information. Following initial development, the back-testing process should be carried out thoroughly, at various different elevations and regions across the Okanagan. Back-testing is key to actually check if the model would derive the correct results given historic data, and is a good way to validate such a system. By doing so, we feel that Telivity can mitigate the majority of this risk, however, it can't be totally mitigated. Performing monthly quality checks on sensors would be a method of mitigating this risk further, all though time consuming.

Continuing Forward

Throughout this process our team learnt a lot about the agricultural sector and technologies emerging in the space. We believe that even through Covid-19, we were able to manage meetings remotely and this was sufficient. Moving forward we recommend Telivity to stick with the Capstone program at UBCO, as it is a good tool for the organization, especially in its infancy. It may be beneficial to approach the Engineering department as well, given that the Engineering students in their latter years have basic coding skills in c++ and take various electronics courses, and we believe that it may be extremely beneficial for both parties. Although we addressed the majority of the requirements as per the scope, there was one component that we struggled with: outreach and surveying. We feel that getting community feedback from end-users is critical, as this increases the credibility and robustness of a product, and being remote did not help. We have shown that there is a need for such a product in the region and globally, and that there are well-regarded growers in the region Telivity could work with. We also suggest that Telivity visit and approach some of the large vineyards such as Quails Gate and Mission Hill to gauge their needs, and establish a relationship.

Should Telivity work with the Capstone program moving forward, we suggest focusing on a proof of concept at this stage. We have established that various parties are interested in the technology, and now it's Telivity's time to shine. Developing a proof of concept will also help create awareness of the business and assist in attracting funding in the early stages. We will be following up with a care package that has all our documentation and research so that the transition to the next Capstone group is smooth.

Appendix

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Appendix A - Interview Transcripts

Interviews

Much research has been done in regards to municipality feedback. As it currently stands, we have interviewed two people from two different local water municipalities. This is to get a perspective on what their current issues are, and where they see themselves going in the short and long term future.

Overall these two had provided valuable feedback into the problems municipalities are facing. These interviews created insight in how a Televity based product would fit into the Okanagan water usage landscape.

Jennifer

The first of the two interviews was done with Jennifer, who works with the Vernon regional water municipality. This interview was done on February 25, 2021.This interview was done on February 25, 2021. With the Vernon water municipality, agriculture is their main customer. The distribution and the infrastructure itself is placing pressure on supply, a strain has been caused by sharing old infrastructure with both agriculture and the growing residential. Current goal of understanding how to share current infrastructure is underway. Any addition to the underground piping is expensive, and would be used if really needed.

Vernon is almost all potable water. There is some raw water in the system, raw water is transported straight from the lake to some orchards and farms.

Having enough water for future water demand is an important part of her job. However, much of future water amounts, and tracking of hitting those targets are mainly done by Environment Canada and OBWB.

Water allocation to agriculture is based on estimated demand, what they expect a farmer with a high water consuming crop would need. This water allocation base is sufficient, of the 600 farmers in the region, only 20 apply for more water.

Water loss is hard to track, both for farmers and the municipality. This is extremely hard for leaks. The municipality has online flow monitoring, where they can track water activity. If a certain property is using 24/7, if there is a leak, the municipality knows about it. The problems come from two different reasons. The first is that some agricultural properties water non stop at certain times of the year, and don't notify the municipality. Though not harmful nor illegal, it makes it difficult for the municipality to figure out if a farm is watering purposefully or has leaks. The second reason for the difficulty is the lack of communication channels between the two parties. The municipality for many of their clients only has a physical mailing address on file. If there is a leak, the client would be sent a letter in the mail days later. Vernon has many tools at their disposal to help notify clients of water leaks and other problems they may have, but many clients do not know of these tools. One response Jennifer gets alot is the client being surprised the municipality mailed them instead of emailing or phoning, after a conversation of what tools are available, the client is then surprised of what they could use and wicked they knew sooner.

All data is controlled by the municipality. The Vernon local water municipality is protective of their clients privacy. There is hesitation of allowing third parties access to the full data. Part of that reason is the fact that the data is all linked together, making it difficult to give minor parts only. This data is also stored for short periods of time. Each client’s file only hold 1 year of summary data, and hourly data is only backed up to 40 days.

She mentioned that higher end crop farmers have more resources, and therefore are more able to hunt for water reducing products. Many are opting for water metres. New technology comes at a cost, with difficult learning curves on top of already busy schedules creates a hesitation to try new things on the farm.

Overall she was not too concerned about water habits in Vernon, and pleased with the tools they have used. One goal that has had great success was the ability to adapt peoples water habits with tiered water billing. This was done in stages, with the first being no changes but adding a line of what customers' bills would cost in the future if they didn't change their habits.

Next they introduced the tiered billing system, where the 1st amount of water was billed at $0.80, next range of litres was billed at $1.20, and the final amounts billed at $2 if people used over the first two ranges. Since the change to the tier range, the system has not reached 2011 levels of water usage.

Ed

The second interview was with Ed, who works for the Kelowna water municipality. This interview was conducted on February 26th. The Kelowna water municipality tends to do 5 - 10 year plans, but has not done one in a while, however one of their current goals is to better handle wasted water, or in other words reduce it. Though not an official 5 year goal, kelowna hopes to have installed sensors on all Kelowna residential water users in that time frame.

Kelowna currently uses a non potable system for most of its agriculture with a price of $0.04 a litre, an extreme low cost. This makes caring for wasted water very hard as it is extremely cheap to pay for extra water.

The Kelowna water board aims to have water metres on all agricultural users soon. This is a current goal they have, and hope to achieve in the near future. This would allow continuous water monitoring. If someone has continuous use of water, non stop for a certain duration, the water board would be able to notify that individual. This would aid the city in hopefully cutting down on wasted water. Notifying the users would have some of the same problems as in Vernon, some users notified may be purposefully using water nonstop for a certain season. Giving users the power to know when their water is on now stops still giving them the knowledge to know if their system has a leak or is wasting water.

They use several types of sensors currently for water sensors and monitoring. Badger metres, as well as Beacon Advanced metering analytics are used by the Kelowna water board. Ed had stated that the city cannot use only one company or one sensor for their monitoring, this is a regulation passed onto them.

Ion Water programs are advertised by the city to its users. These programs allow users to see their individual water usage. This data is owned by the city. There are the same challenges around using this data like seen with Vernon. Ed had noted that Kelowna water municipality would be okay with sharing parts of the data with third party companies, as long as there is an agreement or contract in place.

The municipality uses sensors for residential users as well. These sensors can detect flow, temperature, and pressure currently. Most of these sensors are installed to detect flow only, as it is costly to program for all three. Ed noted that there are two types of monitoring technology: cellular or radio. He had emphasised that cellular is better, if future sensors were to be pitched to Kelowna water municipality, they would be more open to cellular integration.

When Televity ideas were pitched to him, it had piqued his curiosity of what it could do. The creation of an app would be beneficial for the water board. One of the possible hurdles would be pitching it to farmers. He noted that farmers in the region are old school, and not too open about new technology and ideas.

Kelowna is having a difficult time showing the true value of water. This has the problems of users over using water and wasting it as it doesn't cost too much for such mistakes. The municipality is using different allocation rates based on the crop used. Different crops need different water amounts, which in turn would be charged different rates. This tool has seen some success in reducing water wasted. The water board is also starting to use reclaimed water to lesser success. They wish to use more, but the infrastructure is not there, and it is quite costly to install.

Some of the other tools Kelowna has for its users is QWEL, a website tool able to aid in reducing water usage and water conservation. The city also provides users with free irrigation assessments. Sadly this free program is not really used by the public. Finally the city provided users with a water calculator, where users can calculate how much water they would use in a season based on the metrics the users provided.

Appendix B - Okanagan Water Supply and Demand Project

The "*Okanagan Water Supply and Demand Project*" or "*OBWB*" was developed in order to show projections of water use and water sustainability between 2011 up until 2040. Upon reading and analyzing the data given, there are some staggering statistics, coupled with future projections that really show how there is a gap in the market for a company like *Telivity*.

The data provided by the project is vast and relevant for our community in showing the need to cut down on water usage. Presented are several key findings, the entire report can be located in the appendices.

- Average annual use of water in the Okanagan is 210,000 ML (Million Litres)
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    - Domestic outdoor: 5,935 ha require an average of 53,000 ML

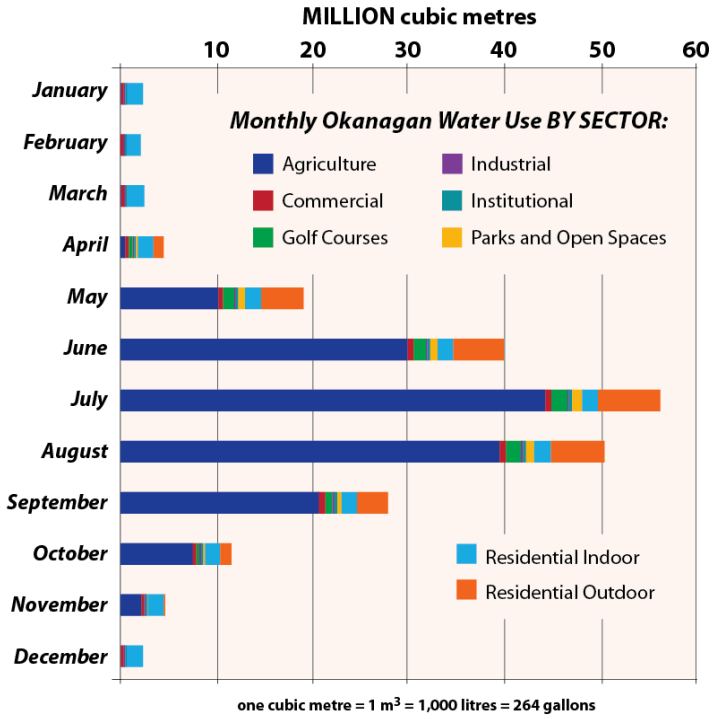

Figure 1.0 Courtesy OKWaterwise.ca

The above graph (Figure 1.0) shows how much water is used on average by each sector per month in the Okanagan basin. It is clear to see that the agricultural sector is the biggest user of water in the Okanagan. After analyzing the data as well as meeting with key stakeholders in the water sector here in the Okanagan; It is the agricultural sector that has drawn the attention of both ourselves (Group 22) and *Telivity*. Data taken from *OK Waterwise* shows that the Okanagan has one of the "highest water usage rates in all of Canada". Mainly due to high irrigation use on crops throughout the summer months.

In addition, and arguably one of the most staggering facts uncovered in the OBWB study was the drastic amount of water that was being "lost" or "unaccounted for". The study continued by saying that approximately "51,000ML or 23% of all water extracted, imported or recycled in the basin is lost or unaccounted for". With the largest component of this "unaccounted" for water being "over-irrigation resulting in deep percolation of water below the root zone". Likely due to the soil conditions not being able to withhold and maintain water levels.

Data taken from the OBWB and Okanagan Waterwise cement that there is a gap in the market for a product that is better able to track, relay and store information on water use. Each and every year water is being used at a rate higher in the Okanagan than almost anywhere in Canada with few major initiatives implemented to gain a stronger hold on the issue. It is time for a product to enter the market that is able to change the minds of consumers and push everyone to help save water. Not only can *Telivity's* proposed technology help get a grasp on the issue of water use and control but the technology may be able to aid in the large percentage of water that is seemingly going missing each and every year.

Appendix C - Water Saving Websites

https://cuesa.org/article/10-ways-farmers-are-saving-water

Site dedicated to reducing water usage for farming. Multitudes of external links dedicated to programs and tools for reducing ones impact on the environment and water usage when farming

https://www.obwb.ca/ag/increase-water-use-efficiency/

Programs that aim to reduce farms' impact on the environment. This includes programs in water management and soil management.

http://ardcorp.ca/programs/environmental-farm-plan/

Calculators to determine how much water is needed for each system of watering. Tool to aid in reducing water usage.

https://www.irrigationbc.com/page/irrigation-calculators

WEAP ("Water Evaluation And Planning" system) is a user-friendly software tool that takes an integrated approach to water resources planning. It allows farmers and others with water needs to simulate what different plans and actions would have on their water needs.

https://www.weap21.org/

Tips on how to reduce water needs for farming. Among the tips offered is monitoring real time weather. Main site advertised is www.Farmwest.com a place where real weather patterns and additional other items farmers would want to monitor are available.

Appendix D - Jeff's Questions

Among the last deliverables requested by Televity was a set of questions for us to answer. This was to better help understand where Televity could go in the future with this project. Below is listed the question, then our response.

What do you feel are the main critical issues to address in the watering / irrigation app for the end user?

Access to credible and reliable data. Municipalities are going either way on whether to give access to users data. This access would determine the success of the app as much as understanding an individual's water needs would be hard to tailor to if Televity doesn know what those needs are.

Users knowing about the app service, as well as existing local incentives are difficult to advertise. Finding out a way for customers to know the tools that are available to them will be a challenge. Unless customers know their water usage could be improved upon, they might not give it a second thought.

What features do you think this app should have to address those issues?

Perhaps if municipalities are concerned about the users privacy, Televity should be up front and asking end users for their permission. Municipalities might be more open to data sharing if end users are requesting to pass that information along. This would be in conjunction with agreements with local water boards about third party's data access already in place.

The app could also attempt to reduce its need for municipal data by relying on other applications available. Linking up with a weather website could allow the AI to predict reduced need for water on certain days, regardless of access to user data.

Creating space for municipalities to advertise local incentives on the app may help customers know the available tools in their neighbourhood. This may also allow municipalities to recommend such apps over others if available, creating a feedback loop.

How would you design the app to accommodate the issues. ie: alerts, charts, infographics?

Space management would help, creating an easy to navigate app would allow users to quickly know what data they have given, and what features would work better with additional information. This design would allow for local incentives to be easier to find too.

What hardware or services would you use for the sensors and data feeds?

The type of sensors is still up for debate. At the minimum there would be need for soil moisture and water pressure/flow sensors. How much more advance Televity would need to go would depend on community feedback.

Data feeds needed for Televity would include weather, municipal usage, municipal location, and real time data. Municipal location would be in regard to localized incentives based on customer location.

What benefits do you think the app should deliver in resolving the issues?

Though water conservation is a big part of why Televity is doing this project, it is hard to present that to end users in a positive spin. This could quickly turn into a conversation of “reducing my water would potentially kill my crops, and kill this farm” senario.

At its core, it should have a cost saving, and produce an increasing mindset promoted in the product. Saving water is important and part of the main focus, but would be advertised as an effect from an efficient product. Timing water usage more precisely would reduce farmers water bills, while producing lease over and/or under watered crops.

How would you monitise the service? subscription? monthly, annually; flat fee for installation of sensors equipment?

It is unknown at this point which option would be best. There were limited responses to our surveys, making an educated guess hard to make. The group as a whole believes if either a monthly or flat fee are in place, that Televity should use a tier system. One where a barebones model is free (or close to free) for users to try. If said users enjoy it, a premium with all features would be presented. Free could be more of a presentation of the users data, where premium is where the Televity AI works to predict users actions and aid in helping in said actions.

Appendix E - Survey

Two surveys were created to get feedback on water issues in the local area. One was created with end users in mind, specifically local farmers and orchardists. Questions range from the type of watering device they have, how often they water, to confidence in third parties and local municipalities. There are 21 questions in total for the end user survey. It was sent out to local farms and orchards in the Okanagan. As now the group had an aquatenance in the local farming community, some group members resorted to cold calling local farms.

The second survey was with local water municipalities in mind. It was intended to understand Televitiy’s limit to what can be accessed. Another reason was to find out what are

some local issues water municipalities are facing, and how Televity could fit into the solution. This was a bit shorter of a survey, with only 11 questions in total. The same issue occurred as with the end user survey, none of the group had any aqatenances to offer the survey to. Cold calling became the method of distribution.

The results of both surveys are inconclusive. Not enough people had responded to either survey as of yet. The end user (farmers and orchards) survey received 7 responses, not enough to make any projections. The local water municipality survey has yet to receive a single response.

It is in our best judgement that we should allow future groups to use these surveys. As they are set up, all the next group would have to do is send them out to get more responses. Televity would benefit greatly from receiving results back from these two surveys, maybe even more surveys if future groups see fit.

Appendix F - Current Products on the Market

Overview of the market

As researching key word “water sensors” from the internet, people could see the water sensors are already considered as the mature product. No matter the style or function, water sensors are more likely to relay to the daily work. Based on the research from the online market, the water sensors/monitoring devices have some common functions, such as connectable with wifi or intelligent systems. Here is the brief explanation of the most common function.

- Intelligent system: the intelligent system provides the function of transformation of data between multiple devices. People could control the devices with their smartphone. At the same time, if you already have other smart home gadgets, the intelligent system can make connections between devices.
- Automatic water shut-off: The ability for the system to automatically shut off the water source if a leak is detected. It will avoid leaking damage to other equipment and raise other costs.
- Temperature monitoring: For the people who live in cold weather climates, look for a system that can also monitor freezing temperatures so they will be alerted to potentially freezing pipes. Some also sense excess humidity which, unchecked, could cause mold.

Non water senor related products

There are some limited products on the market with aims at reducing water usage, and reducing water related costs. Many are basic designs or principles, with no monitoring or smart technology involved. Many of the ideas are not centralized under one company, and would be dependant on local supply.

Tree T-PEE

The Tree T-PEE is a device that wraps the bottom of the trees and individual plants, with the intent to reduce water needs. It is normally used with sprinkler systems that sprank water in every direction, or ones with individual openings at each tree. It acts as both a wind break, and a

mini greenhouse for each tree. This system could increase tree growth by 30% (Tree T-Pee, 2016).

The device itself looks like a large plastic planting pot flipped upside down. Sprinkler heads are placed within the trapped area. Water is now only sprayed in a closed off area surrounding each tree, and not on unused ground. Wetted soil surrounding the tree is also protected from the sun, leading to less water evaporating. On its own website, it states water waste can be drastically reduced. Average sprinkler delivers 10% of the water to trees, where Tree T-PEEs deliver 100% (Tree T-Pee, 2016).

Mulch

Mulch is an excellent way to reduce watering needs in both agricultural and garden settings. It can reduce evaporation from soil by up to 70% (Smart Approved WaterMark, n.d.)

. This would reduce the need to continuously water, as well as the amount needed to water all the time. It also moderates soil temperatures, inhibits weed growth, and improves soil health in the long term.

From personal experience, mulch was used continuously for my parents garden in the north. There was a great difference between plots of garden with or without it. A huge factor to consider when looking into mulch is the cost. Bags can be quite pricey in the on season, and reduced in winter. Even at cheap prices, it requires a significant amount to cover a moderate sized garden, much more to cover a field. We were able to use quite a bit due to a public pile being available to us for free, a local lumber mill dumping the mulched wood for people to use

Water Saving Websites

Many sites and tools are available for farmers to use to help reduce their water usage needs. Not much is talked about in regards to physical monitors and AI software monitoring it. Alot is more to do with the habits and practices that would have the best impact. Monitoring weather and watering accordingly is something with multiple sites already available to farmers. These sites provide many tools and tips to help people gain a wide range of knowledge to reduce water usages. Several links provided in the appendix.

Water sensors

After conducting a thorough review of the market, it is clear that there are a number of excellent products on the market that *Telivity* should consider utilizing in the consideration of our recommendations. The current market shows a variety of different soil moisture sensors and agricultural technology that allow both farmers of a small and large scale the ability to better track their crops. It is important to note that the technology varies based on what is needed by the final user. All the technology included has some form of cloud-based data storage that allows farmers and end users alike to access their crop and agricultural data to either help improve crops or attempt to increase the yield.

The following will be a list of products for *Telivity* to consider. Included will be a brief description of how the sensors work, how advanced they are and whether or not we (group 22) believe that the technology would be a good fit for *Telivity's* purposes moving forward.

IOTSENS: Soil Moisture Sensor

- An IOT sensor that collects agricultural data on a "wide variety of applications". The company is based in Spain and seems to use advanced IOT technology. IOTSENS is also involved in *Smart City Solutions* and looks to be headed in a similar direction to that of *Telivity.* We rank this sensor company highly. Website: https://www.iotsens.com/soil-moisture-sensor/

MONNIT

- Monnit supplies a wide variety of different sensors for different solutions, whether it be their wireless temperatures sensors, humidity sensors, moisture detection sensors, or even their soil moisture sensors. In addition, Monnit have Monnit sensor management software. Which utilizes a cloud-based system as well as API technology to better track and store data picked up by the sensors. Again, we rate this sensor technology very highly for *Telivity* to consider. Website: https://www.monnit.com/products/

SENSOTERRA

- Sensoterra also utilizes IOT technology along with its sensors. In addition, they have a fully functioning app that helps track data and give real-time feedback to farmers. Sensoterra combines its sensor technology and cloud-based storage setup with the *Lora Alliance* who are involved in several verticals within the IOT sphere. Websites: https://www.sensoterra.com/en/product/ , https://lora-alliance.org/

HOSKIN SCIENTIFIC

- Locally based BC company out of Burnaby. Offering a variety of services. Specifically for what *Telivity* are interested in. Hoskin has both Environmental monitoring systems as well as "Integrated systems". They are using radio, cellular and satellite information coupled with sensor technology to give farmers and end-users alike the ability to track and store data to boost crop yield and quality

Overall, there is an abundance of technology available on both the local and global markets. The four companies identified above show what is available, while in-line with what we are trying to achieve with *Telivity.* Bringing together sensor products coupled with cloud-based information storage and sharing; the above examples exemplify how this technology exists and works. Our recommendations will include different avenues we can adopt these technologies and move into the agricultural space.

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