Making the Case for Simulated Based Training in the Water Utility Sector

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ABSTRACT

Benjamin Franklin (1746) once said, "When the well's dry, we know the worth of water. Water is life and without it, we cannot exist. Yet due to the ever-increasing global population and climate change issues, we are facing a dire shortage of this vital resource. This is the reason why today the water and wastewater treatment industries are booming and were globally valued at $4,950 million in 2018 and is expected to reach $6,520 million by 2025. There is a growing demand for new water resources, water quality, public health and a need to effectively treat industrial wastewater.

As the population continues to grow, it places a lot of pressure on water supplies and waste management. Coupled with experienced professionals retiring, there is a massive need for trained expertise. However traditional on the job technical trainings are tedious and time consuming and leadership trainings are ineffective (McKinsey, 2014).

It is a global challenge and immersive learning is the perfect solution. Simulated trainings provide a safe interactive space for learning while building muscle memory, which is more effective and quicker than learning from pen and paper.

The scope of water related training includes:
1. Awareness & Sustainability: water use, reuse, conservation…
2. Training: Technical, soft skills, upskilling...
3. Innovations: Desalinization, Rain harvesting …

The results of simulated based training are:
- Improved retention and recall
- Saving of time, money, and travel
- Scalable & Repeatable
- Safe and realistic

ABOUT THE AUTHOR

Marryam Chaudhry is the CEO/Founder of XR 2 LEAD, an immersive learning solutions company. She is a tech savvy professional with 23+ years of experience. Her fascination with AR & VR, combined with her expertise is in the area of learning, coaching, change management, leadership development and instructional design, has opened up an exciting new era of XR enterprise learning that is fun and effective. Her focus is on exploring the creative potential of upskilling and reskilling the workforce through AR & VR, along with making an impact in the water utility infrastructure, military and defense sectors .Prior to XR 2 LEAD, Marryam had founded a very successful training & HR consultancy firm and was exclusively featured in an international women's CEO magazine for her work. She has worked with clients Nestle, Haier, Pepsi, Tetra pack, USAID, Volvo, and Nissan, as well as public sector organizations. She has authored an audio/ visual learning program for "Developing a High-Performance Mindset" and was nominated for "The Global Training and Development Leadership Award" in 2017, by the World Training and Development Congress governed by the Global Advisory Council.

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THE IMPORTANCE OF WATER

Amidst the numerous issues that affect economic growth, it is clear that water is the single most influential resource that has the ability to help or hinder the economic development of a region. Every living being needs clean drinking water for survival. Without it, daily life and health would become a challenge.

Eighty Percent (80%) of illnesses are linked to poor water and sanitation conditions as could be seen in the issues faced by the residents of Flint, Michigan. In 2015, Environmental Protection Agency (EPA) and Virginia Tech ran tests on the water and found dangerous levels of lead in the water being supplied to the residents. Lead consumption can affect the heart, kidneys, and nerves. This example alone shows the importance of having access to clean and safe drinking water.

Importance of Water and Wastewater Services

The value of water is most felt in developing countries where lack of sanitation and resources along with adverse effects of climate change contribute to make it scarce and coveted commodity. However, in developed nations this resource is often taken for granted as the water distribution services provide a constant supply of clean water. It is only when there is a disruption in service like opening the faucet and no water/dirty water comes out or there is a sewage backup, that we take notice of how important these systems and their reliability are.
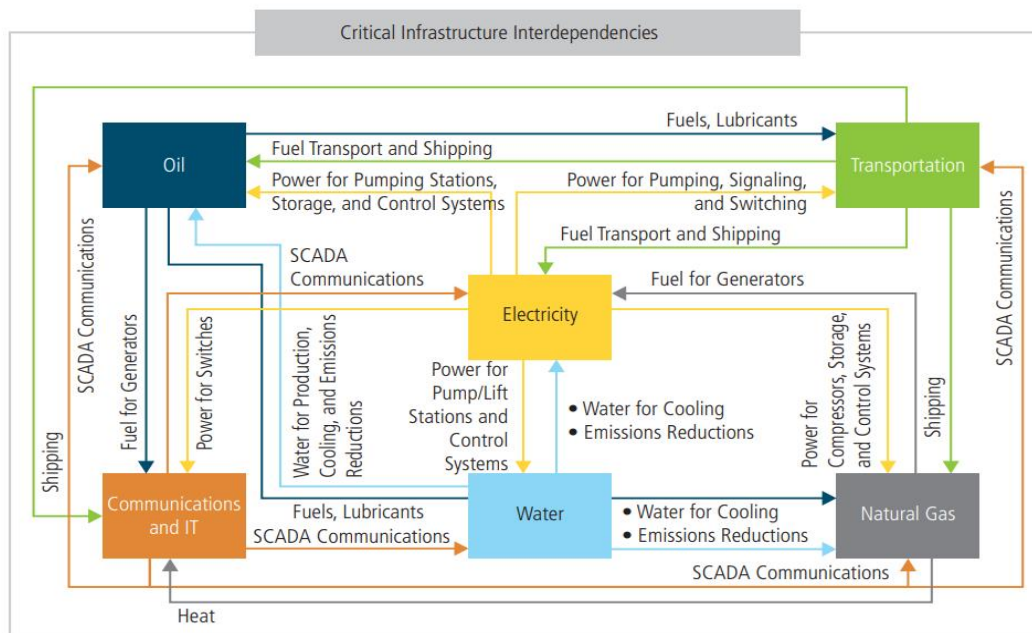

Figure 1. Critical Infrastructure Interdependencies
Source: DOE Quadrennial Energy Review 2017

The water industry includes water engineering, operations, water and wastewater plant construction, equipment, hydraulic modelling plans and specialist water treatment chemicals, among others. Figure 1 shows how vast the industry is and how it is interconnected with numerous other industries. Not only is the water industry itself vast, it is also connected to other critical infrastructure. These interdependencies make it all the more important to ensure the effective management and system /infrastructure reliability.

Role of Water Utilities

Water utilities serve the important role of protecting, effectively distributing, and safely supplying clean drinking water to their community. Wastewater and stormwater also need to effectively be managed so they ensure both environmental and human health. Since the utilities serve such an important purpose, it is necessary that the management of these water and wastewater utilities be efficient and agile. It doesn't matter if the utility is public or private, both perform vital services that affect every aspect of our daily life.

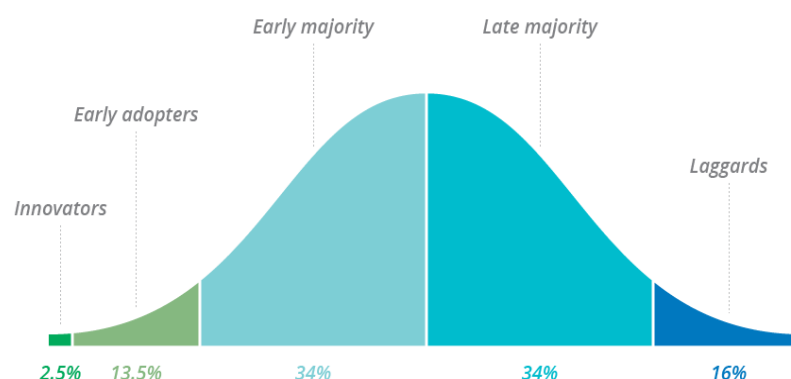For utility companies, enhancing operations and digitizing systems can create substantial value:
  o A reduction in operating expenses of up to 25 percent.
  o Performance gains of 30 to 40 percent in areas of safety, reliability, customer satisfaction, and regulatory compliance.

These prospects have led utilities to realize the many benefits of shifting the focus from assets to technology enabled services for the employees as well as the customers. Some of the areas driving the need for change are:
  ▪ Customer demands for service reliability.
  ▪ Low tolerance for service interruptions.
  ▪ An ageing workforce leaving with years of knowledge and expertise.
  ▪ High turnover and skilled labor shortage.
  ▪ Multiple generations working together.
  ▪ High focus on operational improvement and efficiency. (McKinsey, 2018)

However, despite the many reasons justifying a need for the quick adoption of these tools and technologies, utilities have a history of being resistant and slow to adopt change. There are justifiable reasons for this such as:

  ▪ Utilities are very asset intensive and their main focus has been around the protection, maintenance, and efficient working of these assets. Most of the assets are buried underground and therefore utilities avoid making any major changes in any of their processes for the fear of disrupting service to the customer. They tend to avoid implementation of anything new unless they know for sure it will enhance and not hinder their performance.

Figure 2. Technology Adoption Cycle

- The importance of water industry and utility sector it is often overlooked.
- People do not look forward to working in this sector. Ever hear anyone say they want to grow up to be a wastewater operator? The image and importance of this industry needs a major facelift.
- The image of this industry has not changed with time and people don't realize the potential benefits of working in these companies That is why utilities find it hard to recruit for highly technical roles like data managers, GIS experts etc. This results in shortage of skills needed for the utility to digitally progress.
- Another factor involved is that this is a highly regulated industry that must be compliant with the set regulations and has zero tolerance for safety and performance deviations. (McKinsey, Digital Utility, 2018)
- Another overlooked challenge is that this sector is still led by senior leaders who are close to retiring and very set in their ways. They do not see the need to change things and possess the mindset of "We have always been doing it this way and it works fine". They do not want to embrace technologies they do not understand, in the fear of becoming redundant before their time.
- The above may be reasons the companies use to defer the inevitable, but these are also the reasons why they should take a step forward and embrace the digital trends. Technology is not here to hinder us or replace us. It is here to help us and there is a need to embrace it as an early adopter rather than a late majority or laggard as seen in Figure 2. (Water Finance & Management, 2019).

Workforce of the Future

In this time of rapid technological transformation, it is increasingly important to understand the potential impacts on the workforce and the skills required in the workforce of the future. The water sector is vital to everyday life and needs to ensure its workforce is prepared to meet the challenges ahead. This means that the leadership needs to stay on top of and adopt new and innovative tools and techniques. They need to also realize that the nature of the jobs and job skills are also rapidly progressing. For example, in the past you may have needed people who could draw and read maps. Now with geographic information system (GIS) and Global Positioning System (GPS) type location service tools, that process and the associated skill set of mapping, is redundant. There are similar examples in each and every aspect of the water industry.

It is imperative that these skill gaps be addressed now, otherwise going forth, the utilities will not be able to support clean and safe water and wastewater services at affordable prices. This need has to be translated into a strategic approach to workforce planning, without which these organizations will not be able to sustain themselves, nor provide services required.

As for the existing IT workforce in the water industry, currently they have a good understanding of business processes and are experts in them. Despite the fact that the working of the old system will be invaluable in developing the new one, it will not be enough. That is because modern approaches to system development, such as distributed databases, do not adhere to the same principles or best practices. New technology means new systems and with that comes a new set of benchmarks and best practices. Therefore, utilities need to find manage the delicate balance of retaining the existing talent, while introducing new thinking and call out blind spots and unconscious biases.

Naturally, this makes learning and development in the water industries mission critical, not only for talent and recruitment, but also for the upskilling and retention of the workforce. Virtual training and Augmented Reality can provide new opportunities for learning and skills development.

WATER SECTOR CHALLENGES AND AR/VR SOLUTIONS

The Advent of GIS Tools

The water sector infrastructure is extremely asset intensive. However, most of the assets are underground, making it harder to repair and maintain the assets. That is where technology comes in. Systems like satellite monitoring and GIS are great tools that are being used by utilities to become more data driven and enabling them to have the vital location information at their fingertips when in the field. Using GIS data and mapping tools are extremely advantageous to the utility sector as a whole.

For the water industry 90% of the important information is location dependent. The location of the hydrants, valves, pumps, meters, stations, etc., are vital pieces of information that water works need to perform their duties. In the past, these field employees had to drag around huge maps and layouts to the site to be able to find the valve/ pipe, they are looking for. If already in the field, they had to come back to the office from a remote site location to retrieve the needed data.

Another important element is to know which crews are working at which locations on a certain day. This enables the team leads to mobilize the closest crews in times of crisis and emergency, like a water main break or pipe leakage. All the planning, inspections, repair, maintenance, and collaboration efforts require a comprehensive tool that can provide the data needed and be readily available while workers are int the field. GIS is the perfect solution and VR/AR software's like vGIS provide such data (see figure 3). Software tools such as these benefit the workforce in terms of locating and responding faster, improve safety, see complete asset layouts and best of all it works in the field, where they need the data.

Figure 3. GIS data in Augmented Reality
Source: (vGIS) https://www.vgis.io

VR for Vocational Trade

The water utility industry is facing a shortage of skilled people involved in the daily operations of the wastewater and water delivery systems. In the January 2019 issue of Water Finance & Management , an article mentioned that another challenge across the utility sector is the issue of an aging workforce with a large portion of the employees in the "retirement zone" – between the ages of 59 to 63. Some of these employees joined right after high school and have served the utility straight for 30-45 years.

In the September 2004 issue of the Harvard Business Review, Dorothy Leonard and Walter Swap noted that "throughout an organization, there are people with 'deep smarts.' Their judgment and knowledge – both explicit and tacit – are stored in their heads and hands. Their knowledge is essential. They are the 'know-how' people." The dilemma is when these experienced employees walk out the door, 35-45 years of expertise and invaluable knowledge goes with them.

One solution is that the colleges/ trade school need to provide more technical hands on training for vocational trades. Some vocational education trade schools are trying to attract new students to such exciting industries as welding and fabrication, through the use of VR and 360 technology. One such school is Tulsa Welding School in Oklahoma. The induction of VR technologies into the curriculum has been a game changer for them as the students get a feel of what the welding trade requires and emerge with a better sense of comprehension and retention of the material. The water sector requires a lot of conceptual learning along with skill building that is not always safe for a new employee and may even cause damage to the asset, as they do not yet possess the proper expertise to do the job. Some examples are forklift training, water pump maintenance, confined space, arc flash, etc. VR is the perfect skill building tool for the student to visualize being in an actual workplace scenario and building the skill, while being totally safe and no damage to the equipment or machinery.

VR for Upskilling/ Reskilling /Employee Training

The average employee requires 40-50 hours of training every year (E. Mazareanu, 2019) and the cost is an average of $4000 for their hiring (Glassdoor,2019) By contrast, virtual reality can reduce the training time by eight months and save 28-33% of the budget.

It takes approximately one to two years for an employee to become fully productive (Training Industry Quarterly, 2012), but virtual reality training shortens that adjustment period. Employees are immersed in scenarios using simulations and they have an opportunity to practice in a safe and undisrupted environment. This helps employees retain information faster and longer. Virtual reality is a type of experiential learning where the audio, visual senses are engaged, and the simulations are cognitively designed to test the employee and keep them engaged.

Trends for learning and teaching are now moving towards more use of technology. We saw how computers and e-learning became popular and now immersive learning like AR, VR, AI are providing an even better learning experience than previous methods and modalities. The shortage of time and manpower does not allow much downtime for the employee to get 2-3 days of training. VR allows the employee to practice when they want, and where they want and as much as they want. The data analytics at the back end record the progress of the employee and thus providing tangible proof of the progress made. No one has ever earned to drive a car by studying about it. One needs to actually be in the drivers' seat to experience the true nature of that skill. Similarly, VR has the ability to bring to life the 2D images (see Figure 4) and put the employee in the simulated situation where they go through the same experience without the hazards, dangers, and safety issues.
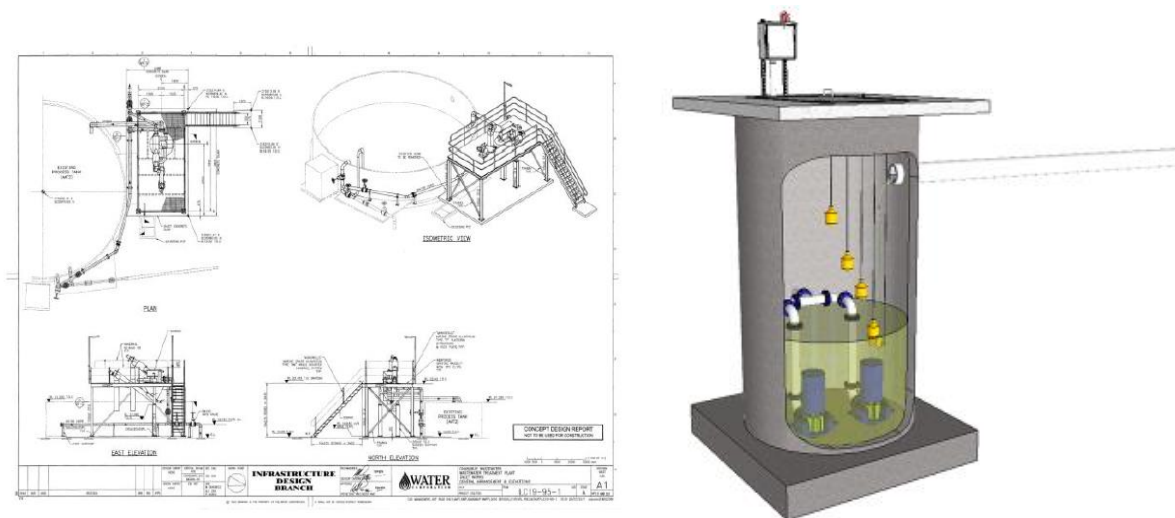

Figure 4. From 2 Dimensional to 3 Dimensional
Source: Wastewater 101. (2018). https://wastewater101.net/2018/11/collection-system-study-time-discussion-pumps-5/scada-lift-station-dorsett-technologies/

AR for Design and Engineering

Augmented Reality has found great success in the ability to being 2D designs to life in detailed 3D models. These 3D models can be viewed from all sides, internally and can be broken apart into individual pieces. This enables the learner to learn about the parts as we as how it actually works.

Visualize before Building: AR enables engineers and designers to have a visual rendering of the building, machinery, or wastewater plant, before it is built. This is done in the planning phase of the project which allows the experts to identify design flaws, safety issues, space restrictions, dimensions etc. This ensures that when the actual project is built there are little to no errors.

Figure 5. AR Repair Assistance
Source: Techsee. (2020).
https://techsee.me/blog/augmented-reality-remote-assistance/

For electrical staff working at Boeing, they calculated that the use of AR has saved the company about 25% of wiring time and lowered the error rates to nearly zero. (Upskill, 2019)

Instruction Manuals replaced by AR: AR via a mobile phone/tablet or through glasses like the HoloLens, has replaced the need for instruction manuals (see Figure 5). When the glasses are put on, or the item is viewed through the camera of a smart phone or tablet, instructions appear digitally over the actual physical item. AR is an excellent tool used by training developers to help break down complex procedures, using an audio and visual step by step process. This reduces downtime and troubleshooting as they have all the information required at their fingertips.

AR vs. VR

There has been some debate as to whether AR is better or VR. Each has their own benefits and can successfully cater to certain situation. For example, VR is an excellent tool for being fully immersed and attentive like for simulated flying. Its benefits have also been seen for soft skill learning like having difficult conversations with employees, firing them or polishing customer service skills. A virtual-reality company based in California, Talespin VR, have created a digital character "Barry", who is an employee that needs to be fired. The employee puts on the VR headset and is immersed in an office setting where they are the boss that needs to fire Barry. This is part of a workplace training tool to help management and employees deal with difficult situations. VR enables the employee to practice the needed skill without any distractions and without feeling shy or embarrassed about role playing in front of others.

Despite the numerous benefits and wow factor of virtual reality, it is still not ideal in every situation. VR is not a viable tool in the field as it doesn't allow you to see your surroundings and that's a huge safety issue. On the other hand, AR is the perfect tool for the field. When looking at an asset through the lens of a tablet or smart phone or AR glasses (Like Magic Leap & HoloLens), the user is able to clearly see their surroundings. In addition to their environment, they see markers at different parts of the asset, called anchors. If its mixed reality it blends the real with the virtual and creates a digital overlay on top of the actual. This enables the person to safely move around as well as not having to guess where the pipes or connections are. The virtual graphics help guide the way to the exact location required. Therefore, one is not better than the other, they are just more applicable in certain situations.

Leadership & Culture Issues

In a survey asking a number of utility employees on what skill and capability gap do they see going forward the top skill was critical thinking skills, then leadership skills and then last but not least, communication skills. (KPMG, 2017)

The main point of interest here is that despite a shortage of skilled labor, technical skills was not even one of the top three areas (see Figure 6). All three are the softer skills. In the age of robots and artificial intelligence it has become imperative that we keep the human factor and soft skills at the top of our priority list. Now more than ever these skills are in demand and going forth will separate the leadership position potentials from the skilled technical experts.
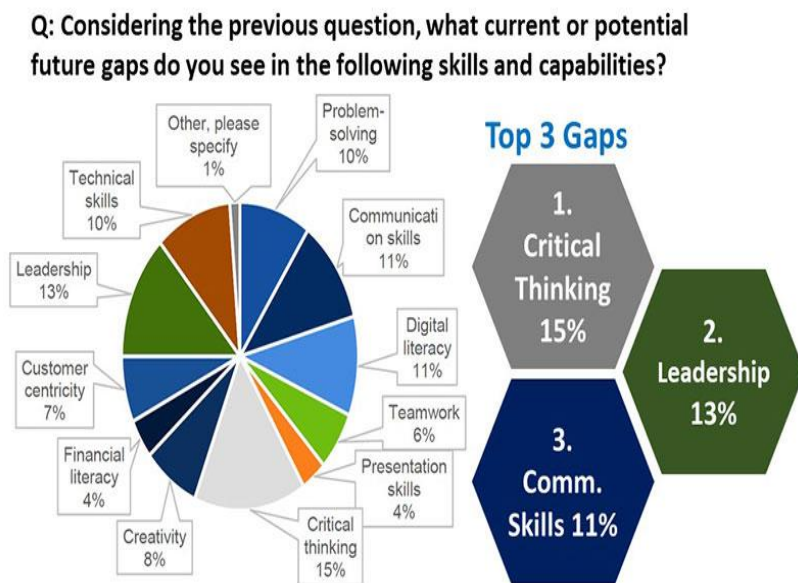

Figure 6. Top 3 Future Skills
Source: WSAA-WRF survey. (2018). http://cweawaternews.org/water-workforce-report-highlights-need-to-invest-and-to-up-skill/

VR again wins this round. Many employees do not have the proper time or opportunity to practice skills like giving and receiving feedback, giving performance reviews, having difficult conversations, firing someone etc. Consider a leadership training that is at a remote off-site location where the leaders need to aggregate for 2-14 days. This bears logistical costs like travel, hotels, food and of course the fee of these outrageously priced non effective leadership courses. During the course, the participants are provided a 30-60-minute activity, usually a role play, to practice the skill. This time is not enough for everyone in the class to be able to master the skill. In addition to that, a lot of people do not feel comfortable acting in these role plays as everyone is watching and the scenario is not realistic. VR has been an excellent medium to provide ample practice to the employee, whenever they have time and without travelling. Also, they can do it safely without anyone watching and making them feel uncomfortable along with data showing their progress after each session. It helps save time money and logistical nightmares, along with providing private practice sessions to mastery of the skill.

Success Story: Melbourne Water

Melbourne Water in Australia has successfully been using AR VR Technologies for many years now. Some of the successful uses involve the ability to identify design defects and occupational health and safety risks during project planning phase, bridge the gap between operations and maintenance technicians, visualize potential hazards quickly and also enhancing learning experiences and retention. Snakes are a big issue faced by the field workers; therefore, MW has used VR to teach staff and community on how to treat a snake bite by using their self-paced mixed reality training program. In order to give others an idea of the difficult work the water sector performs, they designed a large-scale simulator that immerses the person in a situation where they are lowered in a manhole to conduct a sewer walk. In 2017, Melbourne Water also identified an opportunity to utilize VR for a new sodium hypochlorite disinfection facility within their Winneke treatment plant.

In August 2019, Melbourne Water was acknowledged in the influential Most Innovative Companies list, published by the Australian Financial Review and Boss Magazine. (Utility Magazine, 2019). With more than 800 organizations nominated across Australia and New Zealand, making the list is no small achievement. Utility Editor, Charlotte Pordage, spoke with Michael Wandmaker (see Figure 7), Managing Director of Melbourne Water, to find out more about how innovation is permeating every aspect of the business. 'Innovation is happening in all parts of the business, but this award recognized the work between our safety, IT and asset management teams as well as our research partners at Deakin University's Virtual Reality Lab in Geelong. 'The Deakin collaboration has helped us accelerate adoption of VR technology in a number of business applications, including safety training, building design and engagement. VR has become a core business tool with real benefits in enhancing safety and efficiency in our operations and projects. As a fast adopter in our sector, Melbourne Water is also creating opportunities for others to access our training content."

Dr Bach says "Often with urban planning you have people from multiple sectors, with conflicting needs, trying to work together. The question might be how to manage risk, manage operations, or can we agree on the solution? The use of 'serious gaming' and VR technology can achieve greater immersion into the problem and allows users to 'experiment' and observe the consequences of decisions in a risk-free environment. Alternatively, we can put an individual in the shoes of someone else, so that they can better understand their position and their constraints for decision making. This is proving to be a very valuable tool."

Those that want to adopt this technology sometime face the issue of being attracted to the "wow" factor but really don't know how they can apply it in their organization. More than 50% of the organizations ready to implement AR/VR, lack the ability to identify a specific area or use case. Focusing on the "correct" specific area is imperative for the provision of long-term value. A simple way to identify a potential use case, says Peter Kjeldgaard, global alliance manager at Upskill, the GE- and Boeing-backed AR start-up, is by "focusing on operational impact." He adds: "think about the job your employees do and how small amount of digitization can help them do it better."

57% of early achievers have experienced over 10% efficiency increase (see Figure 7) with AR/VR compared to only 23% of the rest of the companies. There is no doubt that experiential learning with AR VR tools cuts the cost and learning time and increases retention.

CONCLUSION

Water is life. We all rely on access to safe and clean water for good health, a sustainable environment and economic growth. However, water utility sector customers are so used to opening faucets and having access to clean water, that they often forget the immense amount of infrastructure and manpower involved. Despite being overlooked and underappreciated, that in no way diminishes the importance of this critical infrastructure.

Most people are unaware of the fact that this is a very stable sector to build a career in. We will always need water; therefore, we will always need experienced and skilled workers who know how to manage and maintain the assets and infrastructure.
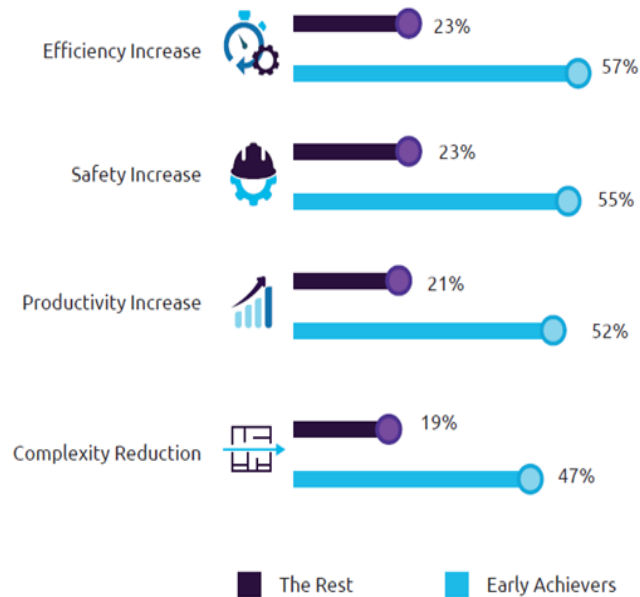

Figure 7. Success of Early Adopters
Source: Capgemini Research Institute, Augmented and Virtual Reality Survey; May-June 2018, N=603 organizations that are exploring and implementing Augmented Reality and Virtual Reality; N=134 Early Achievers

The utility sector facing a shortage of skilled labor. However, virtual, and augmented reality are readily available technologies that can be used to transform and increase the efficiency of the sector. Trainers can fully make use of the 3-dimensional modelling and simulations to bring new talent up to speed and increase the supply of skilled and well-trained workers. The silver lining is that it can be done at half the cost and with increased skill retention rates. The aspect of full immersion in virtual reality can further build resilience by helping the user prepare for daily operations as well as emergency scenarios, while being in a totally safe environment. User manuals will become a thing of the past as augmented reality can provide real time, on the job training as well as maintenance and repair assistance. The uses are as many as one can imagine.

The utilities that are at the forefront of embracing these technological advancements, are building resilience and are on the path to long term sustainability. It is very clear that the future workforce will consist of those that are flexible enough to except the change and are able to harness its power to their benefit. AR & VR are disrupting the way we do things. They are assisting in making workflows safer, more efficient, and increasing the productivity of the workforce. In the last 2 years there has been a massive boom in the industry, and this has resulted in the devices and platforms to become more cost effective and a great future investment. Knowledge capture and retention becomes more consistent and scalable and not limited to certain training locations.

These modelling and simulation technologies are making it easier to find and retain talent, as it appeals to the more tech savvy generation. It opens up career possibilities for many that had never considered this sector before.

With the above examples of successful implementation of AR and VR in various areas of the water sector and the success story of Melbourne Water, it proves that there is a strong case and urgent need for the utility sector to embrace and adopt the technological advancements, so they are able to properly plan the future skill sets needed to keep the economic activity and utility sector functioning properly.

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