Water treatment process using conventional and advanced methods: A comparative study of Malaysia and selected countries

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Abstract. Water treatment is the process of removing all those substances, whether biological, chemical, or physical, that are potentially harmful to the water supply for human and domestic use. This treatment helps to produce water that is safe, palatable, clear, colorless, and odorless. The basic steps of water treatment include coagulation, precipitation, filtration, and disinfection. Water treatment before supplying water to consumers is essential to improve water quality to create a sustainable life. Water treatment can eliminate potential or certain harmful substances in the water to prevent the consumption of contaminated water sources that can cause potential health problems. Therefore, it is important to establish a water treatment facility with sufficient capacity to remove pollutants according to standards before being supplied to consumers. In this study, the focus of the discussion is on the use of river water as a source of water for consumers in Japan, Australia, Canada, and Malaysia after a water treatment process. This paper reviews the recent progresses of water treatment process using both conventional and advanced methods. A brief discussion on the water quality index of each country’s rivers is presented. Several potential applications of Industrial Revolution 4.0 technology in the water treatment process are discussed. Adoption of the industrial revolution of technology in water treatment may provide many benefits to this field and excavate more potential improvement. This paper will deliver a scientific and technical overview and useful information to scientists, engineers, and stakeholders who work in this field.

Keywords: Water Treatment; River; Water Quality; Conventional Treatment; IR4.0 Technology

Track Name: Land, Water, Forests and Food Security

1. Introduction

Water scarcity and demand in clean water sources globally has influenced all parts of human existence which creates the biggest impacts on least developed nations and rural communities. The United
Nations’ Sustainable Development Goal 6 (SDG 6) aims to ensure the accessibility and management of water and sanitation for all, including an end to open defecation, by 2030 [1]. It is known that due to rapid advancement of industrialization will results in destruction of ecosystem and biodiversity loss. As mentioned by World Health Organization (WHO, 2017), it is expected that undersupply of water will displace 700 million people by 2030, while desertification will put the livelihood of one billion people living in 100 countries across the world at risk by 2050 [1]. To fulfil the objectives of the SDG 6, the High-Level Panel on Water has developed innovative approaches to solve global water scarcity since recent years traditional financing solutions and technologies have proven to be insufficient in addressing these challenges. Concerns in the water industry were raised by several important issues that made a setback for modern technology of water treatment process to be applied in the world. These issues are also connected to the gap research of this study for instance, climate change, capacity of building infrastructure, lack of funding, improper and insufficient training.

In water treatment process, composition of precipitation in the rivers played a major role to define whether a treatment process is efficient in producing a good quality of water [2]. Due to changing of rising sea levels, unpredictable rainfall, saltwater intrusion would likely affect the change of precipitation patterns [2]. Not to mention, natural disasters such as earthquakes, storms happening in Japan, forest deforestation in Australia, floods in Malaysia can affect infrastructure of Water Treatment Plants (WTPs) in large-scale system and small-scale system [3]. Next, lack of funding for advanced water treatment process became a major barrier among countries. This is because, interests in technological innovations in water and disinfection remain insufficient [4]. The water innovations area is yet in its beginning phase of understanding the potential outcomes that 4IR can bring for real-life applications to help in the creation of smart and genuine organizations, networks, urban areas, and countries across the globe. Therefore, technologies should be combined and lead by development in organizations, plans of actions, and proper financing system for this to be a fruitful undertaking.

As mentioned before, lack of expertise between these countries could lead to a stagnant progress for advancement of water treatment process. In Malaysia, WTPs and wastewater business are in desperate need of a set up institutional program to train a huge number of staffs [5]. It was understood that the water industry (especially WTPs) is denied of formal conventional knowledge-based training for two decades since the privatization of Institut Kerja Raya Malaysia (IKRAM) in 1996 which paused many training programs in the water sector at central level [5]. Without formal centralized training institutions like IKRAM, the staffs will be dependent on in-house training which can limit newer expertise and adaptions towards technology.

Further into this paper, Water Quality Index (WQIs) of every country will be discussed as the quality of water, is an important aspect of water management system way before the age of 4IR [6]. Contaminations in the water such as pathogens, harmful chemicals can affect the overall properties of water system [7]. Every country has its own WQIs to ensure clean water consumption to avoid any acute and chronic health effects. However, sampling and testing of water source used to be done manually which is time consuming and absence of staffs attending can lead to incorrect data of WQIs. Hence, modification technological advances will be identified under the aspects of the Fourth Industrial Revolution (4IR) between Malaysia, Canada, Japan, and Australia.

In this fourth technological wave in industry, cyber physical systems can interact with one another using artificial intelligence (AI), Big Data, Drones, and the Internet of Things (IoT), etc. The 4IR mentioned, provide a progressive method of organization, production and distribution based on digital transformation and authorization that can erase limits between physical object [8]. In hindsight, the implementation of 4IR in water treatment process can contribute a lot to economic growth, employment, and sustainable development in governance of a nation. In this paper, the scope chosen for the source of water in every country is from river. Since 98 % of water came from river in Malaysia whilst it is 92 % for Canada [9]. In terms of common industry with Malaysia such as transportation, travel, and fisheries 78 % summed up the water source from river in Australia [10]. On the other hand, 11 major rivers in Japan have become the nation source of water (88 %) [25].
2. Water Treatment Process: Conventional vs Non-Conventional

There are two types of water treatment, namely conventional water treatment and unconventional water treatment. Conventional water treatment uses a combination of physical, chemical, and biological processes and operations. Preliminary, main, secondary, and tertiary and/or advanced water treatment are all words that are used to describe various levels of treatment in order of increasing treatment level. Non-conventional method water treatment is simpler than the conventional method of water treatment [11-12]. Non-conventional technologies have lower environmental impacts and reduce contaminant loads at lower costs than conventional treatments. Compared to the conventional method, the non-conventional method uses more advance equipment and technology [12-13]. The use of technology depends on the quality of the water source. Non-conventional will be used if and only the conventional water treatment is no longer feasible due to factors such as extreme water contamination. Figure 1 below shows the flow of processes that involve in typical conventional water treatment.

![Diagram of typical conventional water treatment](image)

Figure 1. The typical conventional water treatment [11-13]

Before water is distributed to an urban community, it is treated to ensure safety and pleasant to drink. Of the great variety of water treatment processes, those mentioned later are by far the most applied [11-14]. Steps of water treatment:

a. Coagulation, Flocculation and Sedimentation

While many particles will gradually settle out from water over time, a process called sedimentation, some will not. To cause slow or non-settling particles to settle out more readily, a soluble chemical or mixture of chemicals is added to the water. Such chemicals are called coagulants and the process is called coagulation [11]. Coagulants react with the particles in the water, forming larger particles called flocs, which settle rapidly and can be removed as sludge [11-12]. Flocs can also be effectively removed by passing the water through a filter, either directly or after sedimentation. The process is controlled so that the coagulant chemicals are removed along with the contaminant [11].

b. Filtration

One of the oldest and simplest processes used to treat water is to pass it through a bed of fine particles, typically sand [12-13]. Sand filtration will usually remove fine suspended solids and some other particles such as larger microorganisms. Sand filtration is even more efficient when the water being treated passes through the sand filter very slowly, although this requires large areas of land, not normally available in cities [12]. Filtration techniques have changed with the development of modern
plastics. The result is a new range of filter materials and methods to treat water for urban and industrial purposes [12].

c. Disinfection
While coagulation, flocculation on and filtration can remove quite a large amount of organic material and larger microorganisms from raw water, there are some important pathogens that are not eliminated during these treatments [13]. Disinfection kills harmful microorganisms that may be present in the water supply and prevents them from regrowing in the distribution systems. Without disinfection, waterborne diseases become an increased threat. Chlorine is the most widely used disinfectant for drinking water [12-13]. It is cheap, easy to use, effective at low dose levels against a wide range of infectious microorganisms and has a long history of safe use around the world [13].

2.1 Water Treatment Process in Malaysia
As previously mentioned, there are two types of WTP. Malaysia used both water treatment methods although the majority of water treatment plant still used conventional water treatment process for surface water [14-15]. For instance, water treatment process flow at Sungai Dua Water Treatment Plant (WTP) in which includes three types of water treatment technologies, mainly Sedimentation, Dissolved Air Floatation (DAF) and Lamella Clarifier [14]. There is a total of 5 treatment plants at Sungai Dua WTP. The plants consist of 2 sedimentation plants, 1 DAF Plant and 2 Lamella Clarifier Plants. The processes of water treatment are as Figure 2. In Malaysia, the only non-conventional WTP used is membrane technology. It is said there are only 3 WTP that use this technology in Malaysia [15-17]. The first plant with membrane technology in Malaysia using ultra-filtration process started operation in 2006 in Bukit Panchor, Pulau Pinang and then 2 other plants were built and started operation early 2008 in Selangor [15].

![Figure 2. Water treatment processes of Sungai Dua WTP. [14-15]](image-url)

In February 2013, the industrial-scale UF membrane drinking water treatment plant that located at Wakaf Bunut WTP, Kelantan was commissioned [16]. With a typical pore size of 0.02 m, ultrafiltration (UF) is a good barrier for bacteria and viruses and this method can be applied to the production of potable water [17]. Figure 3 shows the ultrafiltration method (UF) uses membrane modules as filtration media relative to conventional sand-using plant. A water treatment that uses ultrafiltration technology usually goes through simpler phases than conventional ones. Among the benefits of using UF technology is that it can generate high-quality clean water, lower operating costs, an easily upgradable system, and a compact system that reduces space.
2.2 Water Treatment Process in Canada

In 2016, regional and municipal governments in Canada had owned over 1,200 Water Treatment Plants (WTP) [18]. With recent years, the number has increased to 4% as industrial and water treatment construction projects have been active in Canada to fulfill the United Nations’ Sustainable Development Goal 6 (SDG 6) [18]. For instance, the North End Sewage Treatment Plant (NEWPCC) Upgrade Project that is still in the schematic design phase and estimated to be completed in 2028 with $1.8 billion in total costs [18].

The raw water will flow from rivers in Canada to the Water Treatment Plant (WTP) across the country. Then, it is pumped to the WTP through the reservoirs and undergoes several steps of treatment to produce high-quality water. WTPs in Canada has added Ozonation and Ultraviolet (UV) Light in their water treatment process [18]. Liquid ozone is added to kill bacteria, and sodium bisulphite is added to remove excess ozone. On the other hand, disinfection of water will be done by exposing water to the UV light [18].

2.3 Water Treatment Process in Japan

In Japan, advanced water treatment only focused on ozone treatment and biological activated carbon treatment. For the ozone treatment process, minute bubbles are diffused slowly through the jade-tinted water by the tube at the bottom of the tank [19]. Ozone is a strong oxidizing agent that has the ability of disinfection of harmful microorganism. The bubbles will attach at the surface of microorganism and react with it. Thus, it can eliminate potential health risk without chemical means, so the water does not have unpleasant odors, nor does it taste of bold or disinfectant. Ozone purification process lasts 20 minutes and fine bubbles increase the efficiency to ensure more ozone dissolve in the water [19]. The process than entering the second stage of advanced water treatment by flowing the water into a filtration pond containing different grades of biological activated carbon. Organic matter and decomposition of microorganism propagated in activated carbon. The microporous carbon supports microorganisms that break down impurities and other by-products of ozone treatment. Active carbon is very effective at purifying water but need to replenish once every four years due to the reason bed gradually loses the ability to absorb organic material [19].

2.4 Water Treatment Process in Australia

In many pieces of Australia, surface water put away in repositories is the fundamental hotspot for civil water supply, making water supply helpless against dry spells; just a lot more modest offer comes from groundwater [20]. Non-traditional water sources, for example, seawater desalination, assume an
expanding job in Australia’s water supply, with one desalination plant appointed to supply Perth and others being implicit Sydney, the Gold Coast, Melbourne, Adelaide, and another is intended to be worked at Port Augusta [20]. The utilization of recycled water- the non-consumable reuse of treated wastewater for water system of green spaces, fairways, farming yields or modern uses — is normal and expanding in Australia [20]. Among the 20 biggest water utilities in Australia, the biggest volume of reused water provided was by SA Water in Adelaide (25,047 ML or 29.6 % of sewage gathered), while the most minimal volume of reused water was by ACTEW in Canberra (2,104 ML or 7.4 % of sewage collected) [20].

WTPs in Australia has adopt Biological Activated Carbon Treatment (BAC) that is the biologically enhanced active carbon process which many water treatment industries considering using it for their utilities [21]. GAC (granular activated carbon) has long been used to remove dissolved organics from drinking water [21].

3. Comparison of Water Treatment Process

Generally, there are two different types of Water Treatment Process (WTP) that are conventional WTP and non-conventional WTP. The Table 1. will show the comparison of the conventional and non-conventional WTP between the countries. Coagulation, flocculation, sedimentation, and filtration are the most basic and commonly used conventional method in WTP. Hence, all the countries in the Table 1 using these methods in WTP. In Malaysia WTP use pulsatube clarifier and Actiflo’ technology. Pulsatube clarifier technology is the technology that combining the process of flocculation and clarification in one area whereas Actifllo’ technology is the compact water clarification process in which raw water is flocculated with microsand and polymer in a draft tube reactor [22]. All countries except Japan use chlorination method to kill microorganisms in the water. Only Canada uses biological activated carbon as a medium for filtration while Malaysia, Japan and Australia used sand for filtration in conventional WTP. In Japan, membrane filtration technology is being used in the sedimentation method [19].

The only non-conventional WTP in Malaysia is membrane technology in the ultrafiltration (UF) system. Canada adopts ozonation technology and Ultraviolet (UV) light for their non-conventional WTP [18]. Ozonation is being used to kill bacteria by liquid ozone and Ultraviolet (UV) light are used during disinfection of water. Japan and Australia use biological activated carbon treatment to clarify water. To disinfect water, Japan uses ozone treatment process. The minute bubbles slowly disperse through the jade-tinted water through the tube at the bottom of the tank. This method makes the water does not have any unpleasant odor of disinfection. The advancement of technology might bring more aid, especially for Malaysia to counter any water disruption because the majority of water disruption Malaysia are caused by heavily polluted surface water supply.

| Country     | Conventional WTP                                                                 | Non- Conventional WTP                      |
|-------------|----------------------------------------------------------------------------------|-------------------------------------------|
| Malaysia    | Coagulation; Flocculation; Sedimentation; Filtration; Chlorination; Dissolved AirFloatation (DAF); Pulsatube Clarifier Actiflo’ Technology | Membrane Technology in Ultrafiltration (UF) system |
| Canada      | Coagulation and Flocculation; DAF; Filtration; Chlorination; Fluorination        | Ozonation Ultraviolet (UV) Light          |
| Japan       | Sedimentation (Membrane filtration technology); Sand Filtration                  | Ozone treatment; Biological activated carbon treatment |
| Australia   | Coagulation; Flocculation; Sedimentation; Filtration Disinfection                | Biological activated carbon treatment     |
3.1 Concept of Water Quality Index (WQI): WQI in Malaysia
In 1985, a study entitled “Development of Water Quality Criteria and Standards for Malaysia” was dispensed by the Malaysian government which aimed to develop standards for monitoring river water quality for domestic water use, fisheries and aquatic breeding, livestock drinking, recreation, and agricultural use [23]. The National Water Quality Standards (NWQS) are defined by six classes for river water classification supported the descending order of water quality. Table 2 below shows range of values of various water quality parameters for various classes of river waters [23].

Table 2. The classification and uses of river water quality in Malaysia. Source : Jabatan Alam Sekitar (2019) [23].

| Class  | Uses |
|--------|------|
| Class I | Conservation of natural environment Water Supply I - Practically not treatment necessary  
Fishery I - Very sensitive aquatic species |
| Class IIA | Water Supply II - Conventional treatment |
| Class IIB | Fishery II - Sensitive aquatic species, Recreational use body contact |
| Class III | Water Supply - III Extensive treatment required  
Fishery III - Common of economic value and tolerant species; livestock drinking |
| Class IV | Irrigation |
| Class V | None of the above |

The Water Quality Index (WQI) has been practiced for about 30 years. The WQI formula uses six parameters to see river water quality that is biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), ammonia-nitrogen (AN), and pH [23]. The WQI formula developed by Department of Environment Malaysia (DOE) is the idea for water quality assessment regarding pollution load and river water classification under the National Water Quality Standards (NWQS) [23].

In 2019, river water quality was assessed based on 8118 samples taken from 1353 manual monitoring stations covering 672 rivers in Malaysia [23]. Out of 672 rivers monitored, 408 (61%) showed clean water quality, 205 (30%) were slightly polluted and 59 (9%) were polluted. Tabulated data in Jabatan Alam Sekitar report shows the average water quality that were monitored at Sungai Selangor in 11 stations including its parameters [23].

Based on the report From Jabatan Alam Sekitar Malaysia, 4 rivers are sampled for WQIs (Sungai Klang, Sungai Selangor, Sungai Pahang, Sungai Melaka), covering 64 stations. For Sungai Klang (13 stations) and Sungai Selangor (10 stations) are classified as Class III and Class II whereas Sungai Pahang (27 stations) and Sungai Melaka (14 stations) are Class II and Class III, respectively [23].

3.2 WQI in Canada
The Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI) has been established since 2001, and itself act as a valuable tool for water resources management [24]. The CCME WQI model consists of three measures of variances from selected water quality objectives (Scope; Frequency; Amplitude). These three objectives will be combined to produce a value between 0 to 100 that represents the overall water quality. The water quality is categorized in five grades (excellent, good, fair, marginal, poor) [24]. With the scores from WQI, these rivers are classified into classes that are: Excellent as A; Good as B; Fair as C; Marginal as D; Poor as E. The water quality data are taken from 30 river sites across the province of Ontario, Canada for 5 years (2002-2008) [24]. Within that period, CCME WQI uses 7 or 10 parameters (ammonia, chloride, nitrate, phosphate, chromium, nickel, zinc, harness, pH, temperature), to be taken for sampling at these 30 river sites. It is
apparent from the data tabulated, in terms of station years; almost 65% (93v out of 144) fall in the same category that ranges from Class A and B [24].

3.3 WQI in Japan
Japan’s rivers and lakes have moderately low levels of organic compounds and agricultural chemicals [25]. This phenomenon occurs only around rivers or streams, not in rural areas. Parameters for Japan WQI are pH, COD, NO₂, NO₃, Cl, E. coli, APE, and BPA [25]. In 2008, water samples from Hokkaido (15 Points), shown pH values ranged from 6.45 to 8.27, indicating alkaline properties due to the Hokkaido area's position as a reliable supplier of grain and livestock in Japan [25]. As a result, the rural water quality index is better than the urban water quality index. Furthermore, it was discovered that certain endocrine disruptors, such as APE and BPA, were present in water samples (Tokyo and Hokkaido) [25]. Effects of endocrine disruptors on the development and differentiation of humans and wildlife, especially aquatic wildlife. This suggests that environmental toxins, such as endocrine disrupting chemicals, should be re-examined as disrupting factors in differentiation and growth [25].

3.4 WQI in Australia
Water Quality Index (WQI) communicates the general water nature of a specific source at a specific time utilizing a 'solitary worth’ in view of chosen water quality factors [26]. The WQI consolidates nine boundaries including temperature, disintegrated oxygen, pH, phosphate, nitrate, all out broke down solids, natural oxygen interest (Body) and fecal coliform [26]. The list is determined from Q and weight factor W, where Q demonstrates the degree of water quality comparative with any single boundary and the weight factor speaks to the general significance of the single boundary to the general water quality [26]. The generally water quality positioning measures falls under five classifications which are extremely terrible when WQI is < 25, awful when WQI is 26-50, moderate when WQI is 51-70, acceptable when WQI is 71-90 and excellent when in the scope of 91-100 [26]. The WQI for the port water quality during both high and low tides were reported as good except for Port Botany and Eden as stated as following [26]. The average value of WQI for Port Jackson (79.07), Port Botany (72.79), Port Kembia (76.78), Port Newcast (75.15), Port Yamba (77.67), and Port Eden (67.42) accordingly in the tabulated data [26].

4. Fourth Industrial Revolution (4IR) in Water Treatment

4.1 Malaysia: IoT (Internet of Things) and Drones
Air Selangor applied a smart river monitoring system (SRMS) that uses unmanned aerial vehicles (UAVs) or drones and low power wide area (LPWA) communication technology [27]. Thus, it also has an Intelligent Command Centre that provides real-time views of the water supply network using supervisory control and data acquisition (Scada) systems and remote sensor [27]. According to Mazlan Abbas, co-founder and CEO of IoT service provider Favoriot Sdn Bhd, installation of IoT sensors along the river and at intersection of major drains aid the law enforcement agencies to take prompt action once the sensors discover irregularities [27]. The sensor is connected to a central system that reflected real-time data in visual form. This sensor can inspect the river water quality and odor. Sensor may install at a specific are such as middle of riverbanks to monitor the condition of rover water before entering reservoirs. Such sensors have been installed at Sungai Klang [27]. According to The Star (2020), the total of RM2 million has been allocated by Selangor state government for 4 units military-grade high technology (DJI Matrice 300) drones to observe rivers in Selangor and guard against pollution of water resources in November 2020 [28]. The drones used for monitoring Klang River Basin, Selangor River and Sungai Langat [28]. Drones can catch image of the water samples and identify area of pollution including in remote area. Additionally, drones may provide supervision for illegal suspicious activities at night to prevent individuals pollute the water [28].

4.2. Canada: IoT (Internet of Things); Blockchains; Drones and remote sensing
A company in Canada called Aridea Solutions is performing a pilot project to help predict harmful water levels in water treatment facilities [29]. They invent the system called Plug and Sense Platform and collaborate with telecommunication firm. This system consists of sensor to measure water depth and chemistry composition elements [29]. The data collected is sent by 4G internet to communicate directly to Aridea’s Terralytics Portal cloud platform. The project showed how the IoT can work efficiently and benefit water management while assuring cost reduction and removal of human error in the workflow when using automation [29].

Lake Winnipeg Foundation (LWF) through an RBC foundation grant launched Lake Winnipeg DataStream to collect data of water from lake Winnipeg [30]. All the sharing of data is through blockchains technology [30]. DataStream which leveraging the blockchains technology provides a higher level of security and transparency for managing water data in Canada. Everyone can check and know the latest authentic datasets over time. Blockchains technology have make authentication for LWF who constantly observe and protect the water of lake Winnipeg [30].

Toronto water is using drones to help conduct inspections in areas with difficult accessibility [31]. The fleet of aerial autonomous craft used is more advanced, with several drone units on hand named DJI Phantom 4, the Inspire 1 Pro, and the Mavic Air [31]. These drones will fly over major Toronto’s waterway, such as Don River to inspect if there are any pipe blockages. With drones, the city water division has been able to discover decayed infrastructure [31]. Moreover, submarine drone is also used in the fleet (DeepTrecker DTG2) to be piloted into Toronto’s larger pipes. This way, the need to hire a scuba diver can be avoided as inspection of pipe integrity can be made virtually instead [31].

4.3 Japan: IoT (Internet of Things) and Big data
The entire water distribution system in Japan, is control and monitored by online water network analysis to analyze its distributing pressure [32]. This would provide a real-time monitoring for the pump discharged pressure, valves openings based on historical setting. The system can prevent any losses in distributing the water by keeping up to date to piping network if there are any changes occur [32].

Besides IoT, Japan also is using Big Data for low emission sewage treatment control system [32]. This control system can reduce the release amount of any greenhouse gases by performing online calculation of a linear model of the water treatment process. Soft-sensor technology is the main components in this control system [32]. It has two function: to remove chemical oxygen demand and calculate volume of nitrous oxide gas. Monitoring and operating terminal would receive any measurement from soft sensor and giving a command based on operational setting through model prediction control module. The operational setting serves as an output to the distribution system to modify any changes [32].

4.4 Australia: IoT (Internet of Things) and Big data
Australia uses internet of things artificial intelligence to cut down the electricity usage and its accompanied cost in the water treatment plants [33]. A company, Melbourne water is trying to coordinates pump movement depending on the amount of treated water required on a given day in water treatment plant on a custom-developed platform [33]. Python, the platform determines optimal pump calibrations and sends them directly to the pump system without human intervention during its operation [33]. This program able to utilize historical data to determine the most energy efficient combinations of pumps and the associated speeds to run them at, to achieve the necessary flow rate and applies them in real time [33].

Australia using technology big data to collected and analyze discrete data on water resources in its country [34]. Australia uses big data to access water river quality by identified nutrient exceedances in accessed basin area. They used technology to identify and solve the problems of salinity and turbidity which was a major water quality issue for assessed basins in Australia [34]. Australia able to differentiate the significant gaps in water quality monitoring preclude a comprehensive assessment of all of Australia’s river systems. Through big data technology, Australia able to collate and interpreted
data for about 14,000 reaches across the more intensively used catchments. They examine the aquatic biota index using macro-invertebrates and a river environment index to acquire a balanced river ecosystem and usage of clean river water to other sectors [34].

5. Malaysia: Towards 4.0 IR Technology in Water Treatment

The summary of Fourth Industrial Revolution (4 IR) in Water Treatment can be shown in Table 3. As mentioned earlier that in Malaysia, water technology is still in its early stages and support. Aid from the government and NGOs would really start all possibilities towards technological innovations. Firstly, by providing courses related to Smart Water Technology in tertiary education to increase labor skills at the plants. Next, business related to water technology need to practice in creating strong ecosystem. This is because lack of supportive working environment can discourage adoption of new technology. In addition, key to the success of a project is getting a strong leadership from the beginning. Transformation leaders who involve primarily in every strategic planning and progress can ensure continuous supports from managements and staffs.

| Country   | 4.0 IR Technology | | | |
|-----------|-------------------|---|---|---|
|           | Block chain       | IoT | Drones | VR | Big Data |
| Malaysia  | ✔                 | ✔  | | | |
| Canada    | ✔                 | ✔  | ✔      | | |
| Japan     | ✔                 | ✔  | | | |
| Australia | ✔                 | | ✔      | | |

6. Conclusion

Every country has its own water method for advanced treatment but with same conventional treatment. Adoption of industrial revolution of technology in water treatment may provide many benefits to this field and excavate more potential improvement using cutting edge technology. Malaysia though has poorer water quality index due to limited on budget to kick start the major improvement projects compared to other three countries; which had successful using and showed improvement on water quality delivered. Malaysia has big potential to successfully implemented the technology in water treatment plant because they had set about to research and development in improving water treatment method by not limited to government’s effort also by private company. In the nutshell, alternative ways that may bring Malaysia to the path taken by Canada, Japan and Australia are providing a strong ecosystem to support technology, promoting Smart Water Technology courses in tertiary education, and implementing strong leadership in management and administration.

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