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**A CASE STUDY ON RANHILL WATER SERVICES
AND SYARIKAT AIR NEGERI SEMBILAN IN COMBATING
THE NON-REVENUE WATER PROBLEM IN JOHOR
AND NEGERI SEMBILAN**

**¹Bee Chuan Sia, ²Angelina Anne Fernandez, ³Shyue Chuan
Chong, ⁴Mohammad Falahat & ⁵Bik Kai Sia**

Faculty of Accountancy and Management,
Universiti Tunku Abdul Rahman, Malaysia

¹*Corresponding author: siabc@utar.edu.my*

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ABSTRACT

Up to date, Non-Revenue Water (NRW) is still a problem in many states. This study is focused on the states of Negeri Sembilan and Johor. A team of Malaysian lecturers from Faculty of Accountancy and Management, Universiti Tunku Abdul Rahman (UTAR), under the Malaysian governmental grant (TRGS 2016-1) are researching how to combat the NRW problem in the states of Negeri Sembilan and Johor. Data were collected through field research and focus group interviews from both Ranhill Water Services Sdn Bhd (Ranhill) and Syarikat Air Negeri Sembilan Sdn Bhd (SAINS). This study also looked into the laws and several legal cases involving non-revenue

in Malaysia. Our research questions are what is non-revenue water, what are the institutions governing non-revenue water in Malaysia, what are the legislations and cases of non-revenue water in Malaysia and how do we overcome non-revenue water in Malaysia based on findings from Johor and Negeri Sembilan. From the research have found that the main contributors to NRW in Johor are a leakage in their pipe system and also reservoir overflow. They are now utilizing loggers to detect leakage. It was highlighted that amongst the challenges to combat NRW are the acknowledgement and awareness on the client-side and educating the client on the true situation of the pipe conditions and how to manage the NRW problem. As for SAINS, awareness is the same issue faced by SAINS just like Ranhill in which 80.0% are still more focused towards water supply rather than NRW.

Keywords: Awareness, Leakage, Non-Revenue Water, Water Resources, Water Sustainability.

INTRODUCTION

The management of water in Malaysia is administered by the various water authorities to ensure its sustainability. Malaysia is sanctified with an abundance of water resources; nonetheless, factors such as climate change, population explosion, industrialization, rapid urbanization, tourism and other developments are impairing Malaysia's water resources. The water authorities in various states in Malaysia has adopted various equipment and used science and technology to combat the problem the best they can. Nonetheless, up to date, non-revenue water (NRW) is still a problem in many states. This study is focused on the states of Negeri Sembilan and Johor.

According to an article penned by Lai and Chan (2015) has identified that water issues such as water pollution, destruction of water catchment, water wastage, high NRW, low tariffs and lack of public awareness for water conservation has seriously been a factor which has contributed to the decline in our countries water resources. Malaysia's NRW issues are also indirectly caused by several factors and amongst them are bursting of pipes, leakages, inaccurate meter readings, water theft as well as the failure to report leakages soonest possible. Some of these factors can be attributed to non-public awareness. According to Farley and Liemberger (2005) if there is a high rate NRW it means

poor water management. According to News Strait Times, in their article Tapping into Malaysia's Water Future, it is stated in the UN Water Development Report 2015 that there will be a 55.0% increase in water demand by 2030, but the resources can only meet 60.0% of the world's water needs. According to Loo Took Gee, the advisor to the Minister of Energy, Green Technology and Water (KeTTHA), Malaysia, stated that there needs to be a mindset that water supply cannot be infinite as it is not the reality. The regulators of Malaysia, on the other hand, has estimated that a whopping 13 billion worth of investment in water distribution systems is needed to achieve its NRW target of 25.0% by 2020 (Anwar, 2016).

According to the National Audit Department of Malaysia (2014), the problem of NRW losses has brought about the attention of Members of Parliament and State Legislative Assembly and also drawn the attention of the mass media. NRW if not properly governed can be highly detrimental to both the government, the consumers and also hurts the economy. Thus, the roles and responsibilities of auditors in the management and control of NRW are very important to ensure that the responsible parties are made accountable. An interview conducted by the Edge Financial Daily, National Water Services Commission also known as SPAN, its Executive Director of the water regulatory department Marzuki Mohammad, said the regulator conducted a study last year and found that the country needs over Ringgit Malaysia (RM) 13 billion worth of works to shave the NRW rate and this figure includes replacement and installation of water pipes and meters. Malaysia's NRW was documented at 35.6% in 2014 which happens to a tad lower by 1.0% than the previous years according to SPAN. According to Malaysia Water Industry Guide 2016, the national NRW rate for 2015 was at 35.5% or 5,743 million liters per day (MLD) and some states were having even higher rates of more than 50.0% such as Pahang (52.8%), Perlis (56.3%) and Sabah (55.1%). If we compare our NRW with developing countries, it is between 5.0% and 10.0% namely in Singapore and Denmark. It is submitted by the authors Yazid et al. (2017), in their article Economic and Efficiency Indicators in NRW Performance that higher NRW rates indicate management inefficiency thus, in turn, leaving an effect to the financial sustainability of a country since government funds are funding water utilities. There needs to be a more efficient mechanism for Malaysia's National NRW Action Plan to be effective and able to achieve the 2020 NRW nationwide target level that is set at 25.0%.

From the research, it was highlighted that amongst the challenges to combat non-revenue water (NRW) are the acknowledgement and awareness on the client-side and educating the client on the true situation of the pipe conditions and how to manage the NRW problem. The root cause of the leakage of a pipe has to be identified. The material and quality of the pipe used is essential. When a pipe is installed in a housing area, the quality of the pipe cannot be substandard. Awareness is the same issue faced by Syarikat Air Negeri Sembilan Sdn Bhd (SAINS) just like Ranhill Water Services Sdn Bhd (Ranhill). Even though there are few NRW campaigns and events launched, the response is still considered weak. Awareness on NRW is so crucial to educate and spread awareness of NRW at least 2-3 times in a year. When embarking on new technology, both Ranhill and SAINS want to use more technology to reduce workforce and also to ensure material quality and good workmanship on the pipes. As such, both Ranhill and SAINS requires their staff to attend proper training to enhance their performance in utilizing the new technologies. The cost of replacing the pipes is also an issue due to budget constraint.

Our research questions from this study are namely:

1. What is Non-Revenue Water?
2. What are the institutions governing non-revenue water in Malaysia?
3. What are the legislations and cases of non-revenue water in Malaysia?
4. How do we overcome non-revenue water in Malaysia based on findings from Johor and Negeri Sembilan?

DEFINITION AND CAUSES OF NON-REVENUE WATER IN MALAYSIA

Based on Kingdom et al. (2016) Non- Revenue Water is water that is pumped and not accounted for. According to Lai et al. (2017) Non-Revenue Water can be recognised as the loss of water that it caused by real losses, commercial losses and unbilled authorized consumption. Non-revenue water (NRW) is water produced without generating revenue to water utilities. According to Lambert and Hirner (2000) it comprises the volume of water lost physically such as pipe leakage and overflow of the reservoir, water lost commercially via water theft and unrecorded water consumption, and other forms of unbilled water consumption or loss. According to Mahmoudi et al. (2012) there is

ineffective governance and regulation that has led to inefficient water management, and his article highlighted deterioration in the quality of water creates socio-economic problems to consumers (households and industries). The NRW are issues affecting water utilities in the developing world because it will seriously affect the financial viability of water utilities through lost revenues and increased operational costs. According to Kingdom et al. (2006) a high NRW level means a poorly run water utility due to lack of governance, autonomy, accountability, and technical and managerial skills necessary to provide reliable service to their population.

Ranhill Water Services Sdn Bhd (Ranhill), the non-revenue water (NRW) specialist defines NRW as water produced by treatment plants which are not billed to customers. According to Farley (2008), water loss occurs in all distribution systems, only the volume of loss varies. NRW is divided into three main categories namely physical, commercial losses and unbilled authorized consumption. Physical losses as defined by Ranhill is water losses that happen in all distribution networks even new ones. Physical losses are sometimes known as real losses or leakage and this includes the total volume of water losses minus commercial losses. The three main components of physical losses include leakage from transmission and distribution mains, leakage and overflows from the utility's reservoir and storage tanks, leakage on service connections up to the customer's meter. On the other hand, commercial losses are known as apparent losses which include water that is consumed but not paid for by the user and the water has gone through the meters but is not recorded accurately. Commercial losses are divided into customer meter inaccuracy, unauthorized consumption, meter reading errors and data handling and accounting errors. The third cause is unbilled authorized consumption which includes water used by the utility for operational purposes, water used for firefighting, and water provided for free to certain consumer groups.

INSTITUTIONS FRAMEWORK OF NON REVENUE WATER IN MALAYSIA AND LAWS GOVERNING NON REVENUE WATER IN MALAYSIA

Malaysia has taken our water services seriously by introducing the Water Services Industry Act 2006 and has followed through with the establishment of the National Water Services Commission (SPAN) in

the year 2008. At a national scale, the SPAN regulates non-revenue water (NRW) works and monitors the performance done by the operators. SPAN regulates NRW since January 2008, and auditing is carried out by SPAN to monitor progress and performance. It happens to be one of the key performance index (KPI) imposed on all water distribution operators. All operators are required to submit NRW quarterly report to SPAN NRW performance are being monitored at the quarterly regulatory meeting with each operator. From SPAN's point of view amongst the weakness, they have identified are that there are insufficient funds on NRW management and work as the total of old and weak pipes are still high, no program or control planning on NRW holistically, insufficient competent workers, no program or control planning on active leakage control, weak asset management, non-systematic implementation and maintenance work on water supply system, no policy on meter replacement in view of the meter usage age, weakness in using information technology system, lacking data collection and record, failure of contractor on implementing NRW work, technology transfer and knowledge and in NRW management are still less and not being given proper attention, negative attitude and impression of some parties who have the impression that water is something not valuable due to lower water price and water loss is not the top priority due to vast water resources.

The Minister of Energy, Green Technology and Water (KeTTHA), Malaysia is involved in producing the policy regarding the NRW management and in managing the fund allocation for NRW work. Pengurusan Aset Air Berhad (PAAB) and Jabatan Bekalan Air (JBA) is involved in the funding of the NRW works. The consultants engaged for NRW are involved in the planning, designing and supervising of the NRW work and the contractors are instruments to implement the works. The Water operators conduct the maintenance of water supply system, implement the NRW work and take over and continue NRW works from the contractors and the consumers play the role to report the activity that contributes to NRW namely the leakage, water theft and burst in any pipes.

According to the Audit Guidelines on Non-Revenue Water (2011), the laws governing Non- revenue Water are namely Suruhanjaya Perkhidmatan Air Negara Act 2006 [Act 654], Water Services Industry Act 2006 [Act 655], Occupational Safety and Health Act 1994 [Act 514], Street, Drainage and Building Act 1974 (Act 133), Ministry of Housing

and Local Government, Malaysia, State Water Supply Enactments namely the Selangor State Water Supply Order, Revised 1997, Kedah Darul Aman State Water Supply Enactment (First Revision), Perak Water Board Enactment No 12 of 1988, Selangor State Water Supply Order, Revised 1997, Negeri Sembilan State Water Supply Enactment (NBB Chapter 203), Negeri Sembilan Water Supply Rules 1981, Melaka State Water Supply Enactment 2002, Johor State Water Supply Enactment 1993, Pahang Water Resources Enactment 2007, Terengganu State Water Supply Enactment 1998, Sabah Water Supply Enactment 2003, Sarawak Water Ordinance 1994, Sarawak Water Supply Regulations 1995, Kelantan Water Supply Enactment 1995, Kelantan Water Supply Rules, Technical Guidelines and Instructions (Road) 2002 and the Public Works Department The Water Services Industry Act 2006 (WSIA) which happens to be applicable only in the states of Peninsular Malaysia and Federal Territory of Labuan, while Sabah and Sarawak fall under the water legislation and their respective state regulatory bodies. Under the Water Services Industry Act 2006 section 2 “consumer” means— (a) a person who is supplied with water by a water distribution licensee or provided with sewerage services by a licensee providing sewerage services; or (b) a person who has made a request to a water distribution licensee for a supply of water or to a licensee providing sewerage services for a provision of sewerage services; “occupier” means— (a) a person in occupation or control of premises; and (b) in relation to premises where different parts of the premises are occupied by different persons, the respective persons in occupation or control of each part of the premises. Under Section 3(1) The Federal Government shall have executive authority with respect to all matters relating to water supply systems and water supply services throughout Peninsular Malaysia and the Federal Territories of Putrajaya and Labuan. Under section 33 of The Water Services Industry Act 2006, a servicing licensee providing water supply services or sewerage services has a general duty to— (a) deal reasonably with consumers; and (b) adequately address consumer complaints. Security, integrity and safety of the water supply system and sewerage system. As for section 34 reiterates that it shall be the duty of every licensee to maintain at all times the security, integrity and safety of its water supply system and sewerage system and all other assets in relation to the systems. Duty of facilities licensee in respect of water supply system and sewerage system is contained in section 35 whereby it shall be the duty of every facilities licensee to construct, refurbish, improve, upgrade, maintain and repair its water

supply system and sewerage system and all other assets in relation to the systems such that the facilities licensee is and continues to be able to meet its obligations under this Act and its subsidiary legislation.

As for the developing and maintaining water supply system under section 36 (1) it shall be the duty of every service licensee providing water supply services to maintain an efficient and economical water supply system. Section 36 (2) states that a water distribution licensee shall ensure that all arrangements have been made— (a) for providing water supply to premises within its water supply distribution area and for making such supply available to persons who demand them; and (b) for maintaining, improving and extending the water supply system in relation to the distribution of water, such that the water distribution licensee is and continues to be able to meet its obligations under this Act. Section 36 (3) states that a water distribution licensee must maintain a public water supply system shall be up to the end of the communication pipe, and the cost of repairing, replacing and maintaining the communication pipe shall be borne by the water distribution licensee which is reiterated in Section 36 (4) of the Water Services Industries Act 2006. The most relevant section to non- revenue water is section 123 which is in regards to the unlawful connection of water supply whereby under section 123 (1) No person other than a licensee shall make any connection to a public main or service water pipe. (2) Where a service water pipe to any premises has been unlawfully connected to a public main or another service water pipe serving other premises, it shall be presumed until the contrary is proved that the unlawful connection was made by the owner or the occupier of the first-mentioned premises. (3) A person who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment for a term not exceeding one year or to both.

In the case of *Syarikat Bekalan Air Selangor Sdn Bhd v Liew Lai Yin* (2010), the plaintiff namely Syarikat Bekalan Air Selangor claimed the defendant Liew Lai Yin and it was based on the tort of conversion. The plaintiff claimed that the defendant had without its authority or permission stolen water treated by the plaintiff to property belonging to the defendant namely at Lot 806, Kg Baru Salak South, Kuala Lumpur. According to the investigating officer, he discovered that a water hydrant had been removed and in its place and there was a

4-inch pipe which had been utilized to connect water from the mains to Lot 806. The investigating officer testified that when he arrived at Lot 806, he met the owner of the premises, a person by the name of Mr Liew Lai Yin. Liew was said to have told the investigating that since the pipes broke in 2003 and despite numerous complaints, the pipes had not been repaired, he then resorted to unlawfully connecting the pipes in the manner described. The water from the said connection was then piped into a nearby pool. The defendant nonetheless contended that the plaintiff's claim ought to be dismissed as there was failure to call Liew as witness or explain his absence, the photographs were taken at the material time and tendered at trial were of no probative value as they did not show any coherent evidence of any relevant fact, and the plaintiff failed to show that the water that was said to be wrongfully connected had indeed been channelled to the defendant's property. The court decided that the plaintiffs could claim with costs as the defendant would be liable regardless whether he knew, or had reason to know, or could not by the reason of the exercise of reasonable care have known of the 'neighbour's interest in the goods'. Strict liability was applied in this case. The plaintiff had to prove that the defendant dealt with the plaintiff's water, in a manner inconsistent with the plaintiff's rights, and that there is an intention on the part of the defendant to deny the plaintiff's right. Defendant's knowledge was immaterial. It was decided in these cases that there was clear evidence of the tort and the defendant's wrongdoing. The defendant had also utilized the water over a period of time including keeping the water in the pool identified. There was no innocence on the defendant as it displayed deliberate wrongful acts in direct theft of water on the part of the defendant.

In the case of *Syarikat Air Negeri Sembilan Sdn Bhd lwn One Visa Sdn Bhd* (2017), the respondent happens to be a proprietor of a few lots of land in Pekan Ulu Temiang, Seremban, Negeri Sembilan meanwhile the appellant was the company for supplying water to the premises in Negeri Sembilan. The legal issue, in this case, is when the respondent discovered that the appellant was supplying water to squatters without authorisation from the respondent. As such, the respondent commenced legal action because the appellant was a trespasser and was liable to pay damages to the respondent. The appellant brought a defence that it was a statutory right to supply water to occupants of the said lands under the corporatisation agreement and the Water Services Industry Act 2006. It was found in this case that there are provisions

in the Corporatisation Agreement and the Water Services Industry Act 2006 which reiterates the obligation of the appellant in supplying water to individuals or occupiers of premises; nonetheless notice has to be communicated to the appellant by the rightful owner of the land. The occupiers or squatters of the said lands have no legal or equitable right to occupy the same and are therefore occupying the said lands as civil wrongdoers or squatters and in doing so are trespassers at law on the said lands without any rights of occupation. The court has concluded that the word occupier in s 37 of the Water Industry Act 2006 does not include illegal occupiers. The appellant was aware as early as 3 July 2014 about the status of the occupants; nonetheless the appellant continued supplying water to the occupiers. Therefore, the date which the appellant is liable as trespassers would be from 3 July 2014 until the appellant discontinued the water supply to the occupiers and removal of whatever structures which were constructed or emplaced after that date (3 July 2014) on the said lands until its removal. The court decided that damages are to be calculated from that date.

METHODOLOGY

This research focuses on the non-revenue water (NRW) problem in both states of Johor and Negeri Sembilan. This research aim is to study the problems faced by both Ranhill Water Services Sdn Bhd (Ranhill) and Syarikat Air Negeri Sembilan Sdn Bhd (SAINS). According to Ghauri and Gronhaug (2005), research methods are rules and procedures and are seen as tools or ways of proceeding to combat a problem. For this research, a qualitative approach is used as a research design for data collection. Semi-structured and in-depth interviews were the primary method. This study has conducted interviews with both officials from Ranhill and SAINS that are involved in the management of NRW. This study interviewed three management staff from Ranhill and six staff from SAINS consisting of an NRW manager, a district manager, two engineers and two supervisors. From this interview, researchers gain information on reasons for NRW, measures taken by the companies to combat NRW. Meanwhile, secondary data were obtained from company records, archives, media, websites and others. The secondary data for this research were also obtained from journals written by scholars on the related fields. This literature helps further assist this research in obtaining basic knowledge on the research background.

RESULTS AND DISCUSSION

From the discussion and interview conducted in Ranhill Water Services Sdn Bhd (Ranhill) it was identified that the main causes of non-revenue water (NRW) are physical, commercial and unauthorized consumption. The main contributors to NRW in Johor are a leakage in their pipe system and also reservoir overflow. Most of the leaks are hidden and that is not visible to the public. The contractors detect these leakages. The average cases per month for Johor are about 10,000 cases. Ranhill has a SAJ Ranhill Info Center and a hotline number for the public to call and inform on the leakages. Ranhill manages the hotline and the Center deals with issues on water supply, low pressure and water leaks. For active leakage control team, Ranhill has approximately 65 teams. Each team consist of three persons namely a technician and two system supervisors. When the NRW programme started in Johor in April 2005, the level of NRW was at 37.0% and today the level of NRW in Johor is approximately 25.0%. Ranhill is now utilizing loggers to detect leakage. It was highlighted that amongst the challenges to combat NRW are the acknowledgement and awareness on the client-side and educating the client on the true situation of the pipe conditions and how to manage the NRW problem. The root cause of the leakage of a pipe has to be identified. Material and the quality of the pipe used are essential. When a pipe is installed in a housing area, the quality of the pipe installed cannot be substandard. The workload of each team member managing NRW in Ranhill is inserted in a tablet and the tablet has a password and username in order for them to access the Aquasmart system. The team have to reach the target and does a step test. The teams are trained hands-on and every two years the teams are sent for training to familiarize themselves with the system. There is a target for each team and they will be appraised accordingly and upon not reaching the target the supervisor is answerable. Every job that the team captures is documented in a picture and in unique cases, the teams are required to take videos. There is also an evaluation conducted on the contractors in which there is a key performance index (KPI) set for them. At the end of every contract, the contractors are expected to achieve 85.0% of their KPI. Less than 50.0% performance of the KPI, the contractor's contract will be terminated. Ranhill uses the Aquasmart system in the year 2010. Ranhill is hopeful that with the presence of big data technology, it will assist them better in managing leakage and repairing records. Ranhill is utilizing technology and loggers to

monitor NRW. The turnover time to fix an NRW repair is within 18 hours. If a subcontractor does not repair within 18 hours, then the subcontractor will be penalized.

From the interview with Syarikat Air Negeri Sembilan Sdn Bhd (SAINS), most of them agreed that physical loss due to reservoir or storage tank overflow issues were amongst the reasons for NRW and there are challenges to detect system pipe leakages and bursts as it cannot be detected by merely looking at it. Physical loss ranks number one as the leading cause of NRW in Malaysia. SAINS stated commercial losses would be the second one. SAINS also stated the geographical location of the pipe is also an issue. Additional to that, the cost of replacing ageing pipes are very costly. Commercial losses are the second reason for NRW and commercial losses are harder to detect due to meter inaccuracy reading. They have agreed that unbilled authorized consumption will be ranked as the 3rd cause of NRW in Negeri Sembilan. Over the last year, data collection and recording of leakages were conducted monthly. SAINS has now installed Pressure Relief Valves (PRV) in the water system to control the water pressure but because the water pipes are already ageing, they need to be careful by balancing the perfect amount of water pressure for sufficient water supply and yet at the same time do not burst the ageing pipe. In 2016, water pipe leakage, flow and pumping issues were fully controlled by the SAINS headquarters (HQ). As for staffing, there are around 30 staff in 2016, but in 2017, the staff was redistributed to different districts. The team is called “team active leakage”. As for now, SAINS HQ has three teams in which the NRW issue are attended by six fitters, two technicians and two engineers. SAINS all agreed that the HQ team would only go down on the field when their expertise is needed. If the district person in charge cannot handle the situation, they will request help from HQ. In every district, SAINS has allocated two staff in managing the NRW issues and there will be a manager or supervisor in that district to supervise them. The manager has other roles to in charge as well and NRW will be one of his tasks. For district, water supply is the main concern while NRW is the second. Raising public awareness is the same issue faced by SAINS just like Ranhill in which 80.0% are still focused towards water supply rather than NRW. Although there are few NRW campaigns and events launched, the response is weak. Awareness on NRW is as crucial as people from HQ should be sent to the district to educate and spread and create awareness of NRW in two to three years times in a year. Staff from the district may need some

time to attend NRW on-field training or courses which are provided by the HQ in order for them to understand the actual and right situation to handle and settle challenges in a proper way. The team for active leakage in every district will be in charge of handling NRW issues in their district. They will go and detect leakages which are not reported by the consumers and can be found by the reading of the water meters. Usually, the leaks are detected by customer's complaints and the team for active leakage from that district. There is a call centre for the customer to make a complaint if there is any water-related issue in their residential area. The call centre is responsible for arranging the team to solve that particular issue in a certain amount of time given. SAINS has decode these waters related issues and it is to be solved in the given amount of time to fulfil the KPI for every district in which they need to target at least 90.0% in their KPI monthly, water pipe leaking, water pipe replacement, etc. Just like Ranhill, the team for active leakage in SAINS will detect some water pipe leakages which are harder to detect by using a sounding stick, noise logger, ground microphone and leak noise correlator. SAINS often uses these four technologies due to cost-effectiveness. The sounding stick is the technology that is considered more effective if compared to leak noise correlator as it is easy to use and require little skill to use it. The age of pipe is determined by using GIS's system of existing data to understand the quality of the pipe. They can detect the reservoir by looking at it visually and knowing through the alarm sensor alert system if there is an overflowing issue happening. There should be more labour force to be allocated from the process of repairing to replacing the pipe. Therefore, each staff can focus on their own task more which can leads to others to focusing solely on achieving their KPI. The districts can decide whether to outsource or not but the list of contractors will be filtered by HQ first in term of quality checking before listing them in the mentioned list. Amongst the challenges of combating NRW faced by SAINS are the operation team will focus on increasing water supply by increasing water pressure, while the NRW site will be focusing on the KPI which has been set by the National Water Services Commission (SPAN). They have mentioned that there are lots of consumer's complaints stating that there are many illegal connections made by the contractors through the construction site and factories. As for unbilled authorised consumption, it mainly involves the fire brigade will using water for firefighting events and flushing situation. They have also mentioned that NRW awareness knowledge should be educated to the young generation to combat NRW in the future.

CONCLUSION

According to Tengku Azzlan et al. (2016) entitled Sustainable Water Management for Water Supply Efficiency: A case study at Syarikat Air Melaka Berhad the author referred to an article written by Farley (2008), in which Farley has come up with leakage management policies.

According to Farley (2008), pressure management is one fundamental component of a well-organised leakage management strategy. And according to his article, the most cost-effective schemes are the ones that cover a large area and which has an impact on average pressures. He submits that pressure management is best undertaken together with district metering or when establishing supply zones. These study also goes on to submit that the reduction in pressure and good pressure management will ensure more stable pressures thus resulting in less strain on the pipe network and less chance of fatigue damage at joints.

Amongst the suggestion by the Tengku Azzlan et al. (2016), it was suggested by the authors that Malaysia should apply for technology and knowledge transfer. These study has directed us to Singapore who has recorded only 5.0% of non-revenue water (NRW) followed by Denmark and Netherlands with 6.0% and Japan with 7.0% according to World Bank (2007). It was suggested by the Tengku Azzlan et al. (2016), that technology and knowledge transfer can improve NRW. By transferring technology from other countries, it will help Malaysia improve and manage our technology for better management practices.

From this research could not agree more with the importance of public awareness and this also been raised by the Tengku Azzlan et al. (2016), this study agrees on the importance of public awareness and education in conserving our water and making it a priority to report immediately if there is a leakage found. Raising awareness amongst the public through campaigns and distributing free pamphlets at schools, workplaces is important to ensure successful implementation of water conservation programmes and activities. Without public awareness, the problem with NRW will not be solved and be an ongoing nightmare for our country. Public awareness can be raised by the involvement of the NGO's and media to raise concern on issues surrounding the NRW problem and how the public can play a part to reduce it. There should include a holistic NRW management by

setting up a uniform definition of NRW to be adopted by the water supply industry in Malaysia and there should be an understanding and explanation on term holistic in NRW to avoid confusion and misrepresentation. There should be an implementation of efforts to reduce NRW holistically through methods and best practices guidelines namely NRW reduction strategy and there should be a mandate of usage of indicators Infrastructure Leakage Index (ILI) and the promotion of a more appropriate indicator and Economic Network Efficiency (ENE) as adopted at the international levels in the future. The management should have a concept of preventive rather than reactive. This is to ensure that all contractors licensed by National Water Services Commission (SPAN) are competent, to ensure that all products used meet the standard and quality approved by SPAN, also to ensure design and supervision by consultant meet standard specification and engineering practice and finally to regulate handing over of water supply system by consultant or contractor to meet the specification. There should be human capacity building in managing NRW in which there should be more trained personnel to handle the NRW problem. This is important in terms of producing effective, well trained and competent staff in managing NRW continuously through forms of internal training and to develop a competency scheme with regards to the Water Services Industry Act (Section 49) by making them attend training conducted by training agencies such as SPAN and finally to also establish leak management guidelines which can be used as the best practice by the water operators. It is also suggested that there should be improvement and research development and innovation in managing NRW. This can be done by the implementation of managing NRW pilot project as a showcase to determine the effectiveness of NRW activity which can be used as a great form of reference and to report the NRW performance in various states to draw a comparison on NRW activities nationwide. Amongst the roles that should be played by operators are they should also play their part by carrying out investigations to detect and disconnect illegal connections, they should offer incentives and rewards to informers of illegal users, and they should establish amnesty programmes to attract back illegal consumers, and also conduct regular report checks on large customers and construction sites and also ensure to conduct spot checks and auditing of meter readings and rotation of meter readers (every six months), they can also play their part by identifying and replacing old and worn out consumer meters with new ones and conduct prompt updating of customer databases, etc.

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