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Smart Water Technology Adoption: A Case Study in a Water Supply Company

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Abstract

Purpose: The study aims to explore the key factors that influence smart water technology adoption.

Design/methodology/approach: This study utilised a case study approach to gain an in-depth understanding of stakeholders' perceptions towards smart water technology adoption within the selected water supply company. The researchers interviewed 15 key stakeholders in the company to collect primary data for the study. The stakeholders included top management, the management team, and engineers involved in the decision-making process and implementation of smart water technology. The interviews were semi-structured, allowing flexibility in exploring the stakeholders' perspectives on smart water technology adoption. The use of a case study approach allowed the researchers to analyze the complex interactions and contextual factors that influenced the adoption of smart water technology in the company.

Findings: The study found that management support, water tariffs, knowledge management, and system complexity are key factors in smart water technology adoption in a water supply company, but their interests, attitudes, and influence vary. The company needs a Smart Water leader to support adoption, especially in water-scarce states, but low tariffs and financial constraints can slow adoption. Integration of existing and new systems remains a challenge. An extensive pool of experts is needed for knowledge sharing and learning from mistakes. Technical and maintenance support is essential for continuous improvement and expansion. However, a lack of formalized approach to measurement and reward technology knowledge sharing among staff and management, as well as retiring staff's lack of motivation to keep up with fast-changing technology, contribute to challenges in adopting smart water technology. The study used Innovation Diffusion Theory (IDT) to guide the direction of the study and develop interview questions.

Research limitations/implications: This study only involved a single water supply company in Malaysia. Future research might consider all of the 12 water companies in Malaysia to extend the findings.
Originality/value: This study provided insights into the main factors influencing smart water technology adoption in water utility companies by developing the proposition for future research.

Keywords: Water supply, Smart Water technology, Support, Challenges, Industry 4.0
Classification: Case study

1. INTRODUCTION

Traditionally, the water industry has been slow to embrace change because water has been treated as an undervalued resource. While many industries have already transformed their processes to adopt Industry 4.0 technologies, the water industry is still in its infancy. The objective of the study is to explore the critical factors that impact the adoption of smart water technology in a renowned water utility company located in the Northern region of Malaysia, in order to increase customer services, overcome the limited water resources issues, and manage the water cycle holistically. Thus, water utilities have to utilise innovative and creative water solutions and technologies to gather and analyse the data efficiently and coherently (Vacca, 2020), so as to optimise the efficiency of operational processes and administrative works.

The smart water technologies adopted in water supply companies, such as smart water systems and smart metering, are significant in optimising the performance of water supply to the stakeholders. Nonetheless, the unpredictability of implementation and execution work has caused postponement and huge costs, partly because smart water technology inherits challenges such as rapidly and unpredictably changing schedules, short execution spans, and work complexities. Moreover, lack of a standardised way of capturing tacit knowledge among the staff has been considered as one of other complex factors which further constrain smart water adoption in achieving identified objectives. One of them is the lack of a formalised approach for capturing tacit knowledge among the staff, lack of motivation to keep up with ever-changing technology in the industry, and no proper measurement developed for knowledge contribution in water supply companies. Because of the resistant of new changes and exposure in an industry considered important and traditional and at the same time facing financial constraint, the making smart of water supply infrastructure is generally slow and outdated. Unlike water, other utilities sector such as gas and telecommunications are moving fast. (Cassidy et al., 2021) and financial constraints. However, by looking at it positively, we can see that there is a chance to improve and grow the sector. Risk can be avoided and mitigated if the water sector can learn from other utilities.

With reference to the literature review conducted, quite a number of research papers focus on Industry 4.0 and the application to the water supply industry. However, there are limited studies that focus on the process and factors in adopting Industry 4.0 technologies. In particular, there is a lack of understanding of the elements that influence the application of smart water technology by water supply companies. Thus, this paper looks at the opportunities to fill in the gap of research by helping the Malaysia water industry to understand the factors that assist in smart water technology adoption. By accruing insights through interviews, this study aims to improve

successful technology adoption rates and get an in-depth understanding regarding the implementation process involved.

Hence, the main purpose of this research is to explore the key factors that affect smart water technology adoption. In Malaysia, water supply company had not been the subject of an academic research. This gap in extant knowledge has created the chance to explore the strategies, identify challenges, and utilisation of smart water technology in the water supply sector. Results from this research will contribute to the current knowledge in technology adoption, as the study is the first of its kind in the water supply industry. The strategic use of specific knowledge available in a company is critical to ensuring the good outcome of smart water technology adoption.

2. LITERATURE REVIEW

2.1 Industry 4.0 and Adoption

Ghobakloo (2018) highlighted that Industry 4.0 principles include the ability of exchange and make use of data, capable to optimise in virtual infrastructure, decentralized systems, ability to run in real-time, orientation for service, and modular production. Then, we can see the potential improvement for organizations as it focus on process, product, and the business model (Tortorella and Fettermann, 2017). For example, the Internet of Things (IoT) can be used to connect smart and decentralized value chain networks (Kerin and Pham, 2019). Real time monitoring can be achieved by retrieving data from the systems that are integrated (Ben-Daya et al., 2019). The connection between the physical and spatial worlds are enhance by the new technologies and also provide chances for the company to improve its efficiency and production capacity (Büchi et al., 2020).

2.2 Smart Water Technology Application in Water Supply Sector

To supply big data needed for water management and to monitor performance in water sector, it is important to develop a centralised global water information monitoring system (Willian & Daniel, 2015). The data and information provided should be from a wide-angle, i.e. from local, national and up to global levels. The required information includes monitoring data, public reports, local- and national plans, and suitable technology availability. Timely, real-time, and comprehensive data in easy and accessible formats will ease decision making process and allow people to innovate and create new insights. The example of applications including smart water system in leakage management, smart water network (hydraulic model) to do simulation for water supply (pressures, flows and levels) and smart metering to ease the management of water demand.

2.3 Knowledge Management in Water Supply Industry

As water utilities also run it business according to general business principal, basic meaning and approaches of knowledge management (KM) also utilise by water utilities. Knowledge in organization including knowledge identifying, capturing, storing, using and sharing (Bennet & Bennet, 2011). Water utilities have significant underground and structural assets, of which they do

not have enough knowledge. Price (2001) pointed out that the situation is alarming now as providing good services to the customers out there strongly depends on the optimise utilisation and well maintenance works of all water infrastructure and asset. Compare to intangible tacit knowledge, explicit knowledge is rather more easy to manage in an organisation. This intangible knowledge should be viewed as an organisation's most valuable asset as by capturing and sharing tacit knowledge, we then only can achieve sustainability (Lubit, 2001).

2.4 Theoretical Orientation

Several theories were reviewed and considered for this study. The Technology Acceptance Model (TAM) introduced by Davis in 1986. It is one of the most popular models to explain user acceptance behavior. This model is grounded in social psychology theory in general and the Theory of Reasoned Action (TRA) in particular (Fishbein & Azjen, 1975). TRA asserts that beliefs influence attitudes, which lead to intentions and therefore generate behavior. Subsequently, Davis (1986, 1989) introduced the constructs in the original TAM as follows: perceived usefulness (PU), perceived ease of use (PEOU), attitude, and behavioral intention to use. Among the ideas, PU and PEOU make up the user beliefs on technology and therefore forecast the user's behavior toward the technology, that in turn estimate their acceptance of the technology. On the other hand, Innovation Diffusion Theory (IDT) explains how individuals and organizations adopt innovations. IDT identifies the major element that affect the rate and extent of innovation adoption. In the context of smart water technology adoption, IDT can be used to explore the items that affect the speed and spread of technology adoption by water supply companies. These theories guided the study to find out the key factors affected the smart water technology adoption in the select company. They serve as a base to work out interview questions and provide the directions of the findings in the study.

3. METHODOLOGY

3.1 Overview

This study employed a case study approach to understand stakeholders' perceptions (top management, management, engineers, and staff) of smart water technology within the select water supply company. The open-ended questions were designed to examine situations in-depth, explore complex questions, and facilitate the utilisation of other information sources pertinent to the study. The research design of this study is framed by a narrative inquiry of identity and experience. Narrative inquiry is a "profoundly relational form of inquiry" (Clandinin, 2007) which allows for an observation of the participants in their natural environment, seeking their views based on their perceptions, beliefs, and experiences.

3.2 The Selected Company

The water supply company in this study is a State-owned corporation responsible for water supply services in northern peninsular Malaysia. It was corporatized in 1999 to be a responsible, result-driven, customer-oriented, accountable, and financially independent operator. In 2001, the company implemented a water-based GIS to integrate engineering and consumer data, and aerial

photography to develop a strategic network model. The GIS unit evolved and became a section under the Command Centre, which was launched in 2017. The centre is equipped with a 10-screen video wall to display key data and information generated by an online system for real-time monitoring and predictive detection of potential water supply issues. The company fulfils the selection criteria for this study.

3.3 Data Collection and Analysis

This research utilised the interview data as the primary source of evidence to obtain a detailed, rich and holistic understanding of the company participants' experiences, points of view, and their behaviour toward smart water technology adoption. An interview guide was prepared to ensure relevant questions will be derived from the research objectives, and each question would be directed towards appropriate research subjects. The interviews were conducted to ensure the study managed to capture a greater breadth of data. The key participants for interview sessions in this study included the Chief Executive Officer, Command Centre Head, Head of Facility, Head of Production, Head of Operations, Head of Planning and Development, and 2 senior technical staff involved in smart water technology projects in the select company. All the interviews were then transcribed and study by using thematic analysis.

Common subthemes were created by coding the information from the open-ended questions. The subthemes were then further analysed to identify core meanings by doing content analysis. According to Sekaran (2016), there are generally three steps involved in qualitative data analysis: data reduction, data display, and conclusions. Firstly, data reduction in qualitative data analysis refers to choosing, coding, and categorizing the data. The second step, data display that refer to data presentation. The trends and the patterns of the data can be displayed by using quotes, a map, a table or a chart. The data presentation will help the researcher and, later, the readers digest and understand the data and draw conclusions. It is found that qualitative data analysis is not a direct or linear process but rather a continuous and iterative process. As an example, data coding may help develop new ideas on how the data may be displayed in a better way as well as to draw some initial conclusions. In return, initial conclusions may determine that the raw data are coded, categorized, and displayed (Sekaran & Bougie, 2016).

To analyse the sorted data, this research adopted thematic networks published by Attride-Sterling (2001). It summarised the main themes by using web-like map. Thematic network is a tool to organise the qualitative data analysis. It helps to structure and portray the themes in a systematic way. It was found that the process of identifying themes from the interview data and the presentation of the themes by using a tool is already well established in qualitative study. As such, thematic networks analysis is not in any way a new method; its use is to summarise the main themes of the research study.

4. FINDINGS AND DISCUSSIONS

In this study, the data extracted from the interviews were further refined so that can further contribute to the empirical findings. Four clear themes showing the major factors that affected the adoption of smart water technology in a water supply company. They were identified as follows:

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4.1 Management Support

The CEO of the organizations involved in water management play a crucial role in put up the directions and strategies for the company. Different owners and industries different prioritization of organizational objectives. Therefore, it may need different type of technologies. For example in Netherlands, the water utilities owned by the government and their focus not only on water utilities to provide water supply to customers but also to ensure environmental sustainability. Because of this, many of their water utilities supply water and at the same time invest a lot in environmental conservation program where they abstract their raw water resources. This definitely affect and decide the appropriate technology used by the water utilities. On the other hand, a purely privately-owned company may prioritize more on business-oriented objectives and built up business processes that reflect on this (Smit, 2015).

"A good water supply management involves forward-planning, making the right engineering decisions, and recommending and implementing precise solutions." (CEO)

Management always supports the initiatives and projects that increase the company's efficiency and performance. However, some constraints slow down the adoption process of smart water technology.

4.2 Water Tariff/Financial Constraints

The maintenance of low water tariff is a people-friendly initiative. However, this initiative is also accompanied by a "high cost" and various negative impacts. A tariff review is the logical and rational solution to address the increasing water supply infrastructure and services cost.

"Without tariff review, we have no choice but to focus on maintaining existing systems and put aside investment on new technology at this point in time." (CEO)

"*To overcome the financial constraints, we split the project into phases to spread the cost over a few years. For example, the submarine pipeline project's building was split into land pipelines following areas and actual submarine pipelines. "(CEO)*

Unlike Malaysia, Singapore as a water-stressed country views water as a strategic commodity. Singapore stressed R&D and invested in all kind of smart water technology. PUB, Singapore's national water agency, is one of the few utilities in the world to manage and close the entire water loop, by introducing NEWater (recycled used water) and desalinated seawater to its water source portfolio to meet the nation's current and future demand. They focus on reducing carbon emissions and energy usage, and conduct data analytics for process optimization.

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4.3 Systems Complexity (Integration and Support)

The perceived complexity of the smart water system and the challenges surrounding new technology adoption also affect the smart water technology adoption. Many users find the smart meter system difficult to understand and access (Kim et al., 2014). Water and wastewater treatment facilities avoid installing smart equipment because people consider the installation, operation, and maintenance to be more complex and riskier (Blom et al., 2010). The experience that the employees possessed, and the knowledge management culture that was built from the time the organization was established, could serve as invaluable input to understand how company culture and experiences play a significant role in cultivating employees' minds in accepting new technology. Comments as below:

"The integration of existing and new systems is never easy and we need to plan carefully." (Head of Planning & Development)

"The maintenance support from the system vendors is important" (Head of Facility)

A system consists of data, hardware, software, and user. Integration is a complicated process and not all systems can be integrated and maintained across a long period of time. Often, the operator need a dedicated team to look at a system and well-trained personnel to address maintenance and handle all the components in a system. The company also needs to ensure lifelong support from the system vendor and swift rectification when system issues occur.

4.4 Knowledge Management and Sharing

Organisational knowledge is grouped into two categories: explicit, which is documented and written down in a transferable way, and implicit, which is inherent or tacitly implied in the performance of a task. Most knowledge tacitly resides within individuals and requires translation in order to make it explicit, shareable, and storable (Nonaka & Takeuchi, 2006). Knowledge creation is important in transforming tacit knowledge into explicit knowledge (Nonaka et al., 2009) or knowledge resources (Darroch, 2005). Nonaka et al. (2009) highlight that knowledge is the cumulative information that has been obtained from experience by individuals. It is also known as "justified true belief". The basis for knowledge sharing is knowledge creation (Nonaka et al., 1994) which an individual experientially creates and then transfers into a shareable method, which an organisation can utilise for their firm's benefit. In organisations, knowledge is viewed as an intangible resource that brings competitive advantages which can be utilised (Darroch, 2005). Knowledge sharing needs an appropriate environment. It need a platform that is organised and come with appropriate infrastructure. The basis of knowledge sharing also need to tackle the cultural and individual issues.

"We need a standard platform to share technical knowledge, specifically knowledge in smart water technology adoption" (Head of Command Centre)

"Sometimes, we bring back the retired staff to solve certain technical issues" (Head of Operations)

"We need training to keep ourselves up to date with fast moving technology out there" (Senior Technical Staff 2)

The company need to conduct or provide suitable training to the staff so that they understand the criticality of knowledge sharing and they can know how to use modern KM tools that supplied to them to ease their daily jobs. To share knowledge and information, the people need to be motivated by the support from management, leading by example from the top and have the opportunity to join knowledge projects (Bennet & Bennet, 2011).

Within the selected company, knowledge has been shared through many platforms. For example, the command centre captures real-time data which it displays on the dashboard to share among the technical team members. Email and WhatsApp have also been utilised to communicate issues and provide solutions and monitor progresses. However, like other traditional company, the works often carried out in a fire fighting mode thus lead to information overloaded. Often, there is no time for the staff to digest the information and make extra effort to share it effectively. This lack of time scenario leads to conditions where skills and experiences will not be documented and share out among the staff. Usually, when staff gain more experience, they naturally draw upon their tacit knowledge more fully in their daily work and practices. Later, slowly it become very difficult to draw it out from the employees' memories.

5. RECOMMENDATIONS

This study recommends the following four propositions for further study to enhance smart water technology adoption in water supply companies in line with the aforementioned discussions and arguments.

Proposition 1: Management support is positively associated with the success of smart water technology adoption in a water supply company.

Proposition 2: Water tariff increase can positively affect the adoption of smart water technology in a water supply company.

Proposition 3: Knowledge management is positively associated with the successful adoption of smart water technology in a water supply company.

Proposition 4: Systems complexity negatively affects the adoption of smart water Technology in a water supply company.

6. CONCLUSION

Overall, this study contributes to the in-depth understanding of how the smart water technology adopted in a water supply company. It is influenced by the attributes of management support, water

tariff, system complexity, and knowledge management. This study provides insights into the transformation process involved in adopting smart water technology in water utility companies. The challenges faced in the transformation of smart water technology were determined in this study, the results of which can be used to formulate strategies to deal with the difficulties faced during the transformation of smart water technology. Moving forward, future studies should consider the recommendations above to improve company performance by adopting smart water technology.

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