Influencers of Adoption of Mine Water Treatment Technologies in Taita Taveta County, Kenya – A Case of Aquamines Ltd

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Abstract

Although mine water could be useful, Aquamines Limited has pumped it out and discharged it. This study sought to establish the factors that have prevented the company from adopting mine water treatment technologies. A personal interview was used to collect cross-sectional data. The questions asked focused on knowledge, demand and institutions as influencers of adoption. It found out that the miner is not aware of such technologies and has not put any effort into seeking information about them. This study recommends the creation of awareness of the need to conduct mine water baseline surveys and acting on the results.

Keywords: Influencers of Adoption, Mine Water, Treatment Technologies

Introduction

Water is necessary for the survival of the human race (Oki & Kanae, 2006). Human beings discharge water waste into the environment after utilising water for consumption and execution of socioeconomic activities (Scott, Daly, Hejazi, Kyle, Liu, McJeon, & Voisin, 2016). Scott et al. (2016) further advance that climate change will negatively affect the predictability of water supply. It is therefore paramount for man to properly harness water and seek alternative founts for the same. Kandiah, Binder and Berglund (2017) posit that reuse of water might be a substitute source of water that is sustainable. According to the Resolution adopted by the General Assembly of United Nations in 2015, Goal Six of the Sustainable Development Goals seeks to ensure availability and sustainable management of water and sanitation for all. It further underscores the need for international cooperation to encourage water efficiency and support for treatment technologies in developing countries.

Mine water could be advantageous or disadvantageous to the stakeholders of the areas where it is encountered during excavation. With the advent of mine water treatment technologies, it is natural to expect that all water found in mines is used to profit the mining company, community and the environment amongst others. While this may be the norm for Western and some African countries like South Africa, it is not the same for Kenya. Since 1974, Aquamines Limited, which mines Ruby and Tourmaline gemstones, has pumped out the water that it encountered underground and discharged it for fear that it is contaminated and that there isn't a way of treating it. Thus, the question that begs is whether companies such as these are aware of existing mine water treatment technologies.

There exist several water treatment technologies. Adams, Anderson, Bless, Butler, Conway, Dailey & Hanley, 2014) categorised these technologies into two; passive and active technologies. Examples of passive ones are Anoxic Limestone Drains, Aluminator, Constructed Wetlands, Biochemical Reactors, Successive Alkalinity Producing Systems (SAPS) and Phytotechnologies. The active ones include Fluidized Bed Reactor, Reverse Osmosis, Zero Valent Iron, Rotating Cylinder Treatment Systems, Ferrihydrite Adsorption, Electrocoagulation, Biological Reduction and Ceramic Microfiltration.

Literature Review

There are varied models of explaining the spread of a particular technology, key among them is the Diffusion of Innovations theory by Rogers (1962). Rogers defines diffusion as the process by which an innovation is

communicated through certain channels over time among the members of a social system. He also defined an innovation as an idea or practice that is seen as new by an individual or other unit of interest. Rogers (2010) postulates that members of a social system perceive the following characteristics of an innovation as having an effect on the rate of its adoption. The first one is relative advantage, which means that the innovation is technically superior to the technology it supersedes; the second is compatibility with existing values, skills, and work practices of potential adopters; third is complexity and refers to the extent to which the innovation is relatively difficult to understand and use; fourth is trialability and denotes the ability of the innovation to be experimented with on a trial basis without undue effort and expense; the last is observability, which is the capability of the benefits of the innovation to be seen and communicated to others.

The rate at which technology is adopted varies from one country to another. It is also different between organizations in the same country. This rate is influenced by a myriad of factors. The drivers of adoption of technology can be classified into three broad categories: knowledge, institutions and policies, and demand (Comin & Mestieri, 2014).

Knowledge may mean the formal know-how embodied in people (Nelson & Phelps, 1966). There's a correlation between formal schooling and embracement of technology (Riddell & Song, 2012). Figuring out the kind of technology required to increase efficiency or effectiveness requires the person to be aware of the existence of such technologies (Comin & Hobijn, 2007). To this extent therefore, technology adoption is determined by the knowledge possessed by its subjects.

Beyond the knowledge held by individuals, there is organizational and sector knowledge which could positively influence the adoption technology by an organization through learning (Comin & Mestieri, 2014). They (Comin & Mestieri, 2014) further argue that similar organizations at close proximity may influence an organization into adopting the technology they are using. For instance, an organization may seek technological advice from those that have prior experience in the use of the technology in question. Organizations will tend to copy technology from neighbors especially when it is successful (Conley & Udry, 2010). In the same vein, the adoption potential of an organization could be affected by the technological experience of organizations that it has contact with even if they are geographically dispersed (Comin & Mestieri, 2014).

There's a positive relationship between the technology used and the one that follows. In other words, adoption history influences future adoptions (Comin & Hobijn, 2004). Comin et al. (2010) showed that the technology currently in use in an organization has an effect on subsequent technology through factors like culture and institutions. The findings of their study suggest that the highly likely influencer of persistence in technology is the learning of sector-specific technological knowledge. This type of knowledge is an outcome of adopting and using new technologies.

The incentive of an agent to incur the costs of using new technology may be affected by political institutions (Comin & Mestieri, 2014). It is argued by Olson (1982) that the rents of producers that have invested heavily on human or physical assets in older technologies could be eliminated by new technologies, hence resistance. Acemoglu and Robinson (2000) underscore this resistance to new technology by emphasizing that the political and economic power of some elites may be reduced by the adoption of new technologies. The other way institutions affect the adoption of technology, is because they affect the policies implemented by government.

The adoption of technology is also affected by the level of demand for the products it produces. The higher the demand, the higher the rate of adoption and vice versa. Higher demand allows the adopters to recoup their investment (Comin & Mestieri, 2014). Research and development expenditures move in the same direction with output at business cycle frequencies (Comin & Gertler, 2006). The relationship between the variables discussed above and technology adoption may be conceptualized as shown in figure 1.1 on the next page:

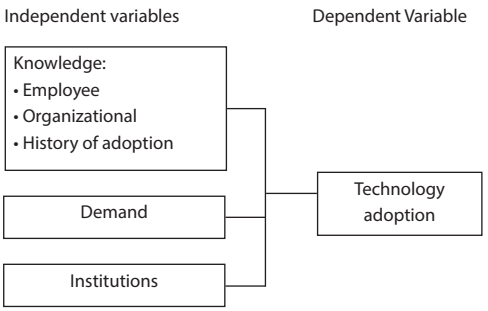

***Figure 1.1** Conceptual Framework*

This study conceptualizes the independent variables as knowledge, institutions and demand. The dependent variable is technology adoption. Of all the studies reviewed, none was found to have been conducted in the area of factors affecting the adoption of mine water treatment technologies. The studies that are close to this are 'Adoption of biogas technology as an alternative energy source in Gakawa' by Ikonya (2018) and 'A systematic review of literature of the factors that affect sustained adoption of safe water, hygiene and sanitation technologies' by Hulland, Martin, Dreibelbis, Valliant, and Winch (2015). Ostensibly thus, there is a knowledge gap in this space. The coastal region of Kenya, specifically Kasigau in Taita Taveta County is known for the challenge of encountering water while mining. This study, therefore, sought to answer the question, 'What are the influencers of adoption of mine water treatment technologies in Taita Taveta County, Kenya?'

The general objective of the study was to establish the influencers of adoption of mine water treatment technologies in Taita Taveta County, Kenya. The accompanying specific objectives were:

a) To determine the influence of knowledge on the adoption of mine water technologies in Taita Taveta County
b) To determine the influence of demand on the adoption of mine water technologies in Taita Taveta County
c) To determine the influence of institutions on the adoption of mine water technologies in Taita Taveta County

Methods

Research design has been defined by Cooper and Schindler (2006) as a blueprint for accomplishing research objectives. It is a plan for collecting, measuring and analyzing data. A research design cements the research project together (Trochim & Donnelly, 2005). It is the stratagem of the inquiry conceived to find solutions to research questions or problems (Kumar, 2011). A case study approach was adopted to guide this study.

A case study design denotes approach of investigating one or a few units (Gomm, Hammersley & Foster, 2000). The unit of study for this case was Aquamines Limited. This company mines Ruby and Tourmaline gemstones. It has always used petrol-driven generators to pump out the water that it encountered underground to allow excavations to proceed. A personal interview was used to establish what influences adoption of mine water treatment technologies. The questions asked focused on the role of human capital, adoption history, geographic interactions and institutions on the adoption of these technologies. This data was collected from the manager of the company. The researcher did also visit the mining site and observed the dewatering process. Further, secondary data relating to mine water regulations was obtained from the Mining Act 2016, of Kenya.

Findings and Recommendations

The study established that mine water is the main challenge to the mining activities of this company. Pumping out the water is considered a costly exercise in addition to the fact that the water is not utilized in any way save for consumption by wild animals and trees. The mining company does not have records of the chemical composition of the water. Mine-water treatment technologies have not been adopted at all and the interviewee is not aware that such technologies exist. No effort has been put into seeking information because of the fear of not being able to afford the technologies. The desire for use of mine water treatment technologies is present, but is not backed up

by ability to purchase the same. The fear of loss of economic rent by institutions does not apply in this case because no technologies are in use at the moment. The Mining Act 2016 of Kenya does not seem to have captured the interest of mine water treatment.

This study recommends the creation of awareness of the need to conduct water baseline surveys and acting on the results. Awareness is also required in the areas of the value of mine water and available mine water treatment technologies. There is also need for the government to include in the law matters of establishing the chemical composition of water found during excavation and management of the same. Stakeholders of the mine influenced water could also explore the use GIS-based environmental assessment to develop a robust water management plan. This kind of analysis was used to identify all probable springs of acid waters, circulation of pollutants and areas most threatened by the abandoned Kizel basin in Russia (Maksimovich, Pyankov & Khayrulina, 2017).

Conclusion

If a solution to this mine water problem is not found, the government will continue to lose would-be revenues, mining duration is unduly long and lots of man-hours are lost removing mine water. The output of this paper is important because it has brought to the fore the drivers of adoption of the technologies in Taita Taveta County, and by extension remote areas in Africa. The information shared will be invaluable to the crafting of strategies that will see mine water being put into better use.

Besides producing noteworthy results, this study was subject to some limitations which in turn provide avenues for further research. To begin with, the factors included in the conceptual model is not exhaustive. Elements like characteristics of government leaders could provide further insights into this area. Other limitations include the use of a case study design, relying on self-reported data mainly from the angle of the manager and restricting context to Taita Taveta County. Future enquiries could strive to address these limitations by using a survey research design and the establishment of the chemical composition of the water as well as varying the geographical context. This will augment the validity and generalizability of future research findings on influencers of adoption of mine water treatment technologies.

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