

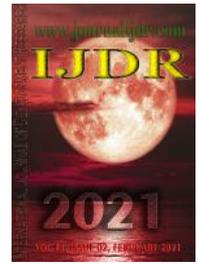


ISSN: 2230-9926

Available online at <http://www.journalijdr.com>

# IJDR

*International Journal of Development Research*  
Vol. 11, Issue, 02, pp.44875-44880, February, 2021  
<https://doi.org/10.37118/ijdr.20957.02.2021>



REVIEW ARTICLE

OPEN ACCESS

## TECHNOLOGY MANAGEMENT OF THE SEAWATER DISTILLATION SYSTEM

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### ARTICLE INFO

#### Article History:

Received 24<sup>th</sup> December, 2020  
Received in revised form  
20<sup>th</sup> December, 2020  
Accepted 14<sup>th</sup> January, 2021  
Published online 28<sup>th</sup> February, 2021

#### Key Words:

Technology management;  
Seawater; Fresh water;  
Distillation system.

### ABSTRACT

This research study assessed the Technology Management of the Seawater Distillation System to be further utilized by the residence of the Municipality of Pinamungajan in a Community Extension Initiatives. This utilized the descriptive-correlative design. Statistical Package for Social Sciences (SPSS) was used to analyze the descriptive statistical measures such as frequencies, ranges, and percentages. Regression correlation was used to test the decree of relationship between the dependent and independent variables. It was found out that the Total Dissolved Solids and Electric Conductivity Test had a highly significant relationship as to the quality of the seawater converted into fresh water. It was also found out that the most prevalent barriers and challenges of the distillation system were the cost and environment impacts of the discharges and impurities. From the data presented, it can be concluded that a need for an innovation as to seawater distillation will be of great help to augment the scarcity of fresh water especially to the coastal areas thus, the urge to conduct Community Extension Initiatives with more emphasis on demonstration of the innovated distillation system as an output of the study.

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**Citation:** Vernalee Villena Mirabel, 2021. "Technology management of the seawater distillation system", *International Journal of Development Research*, 11, (02), 44875-44880.

## INTRODUCTION

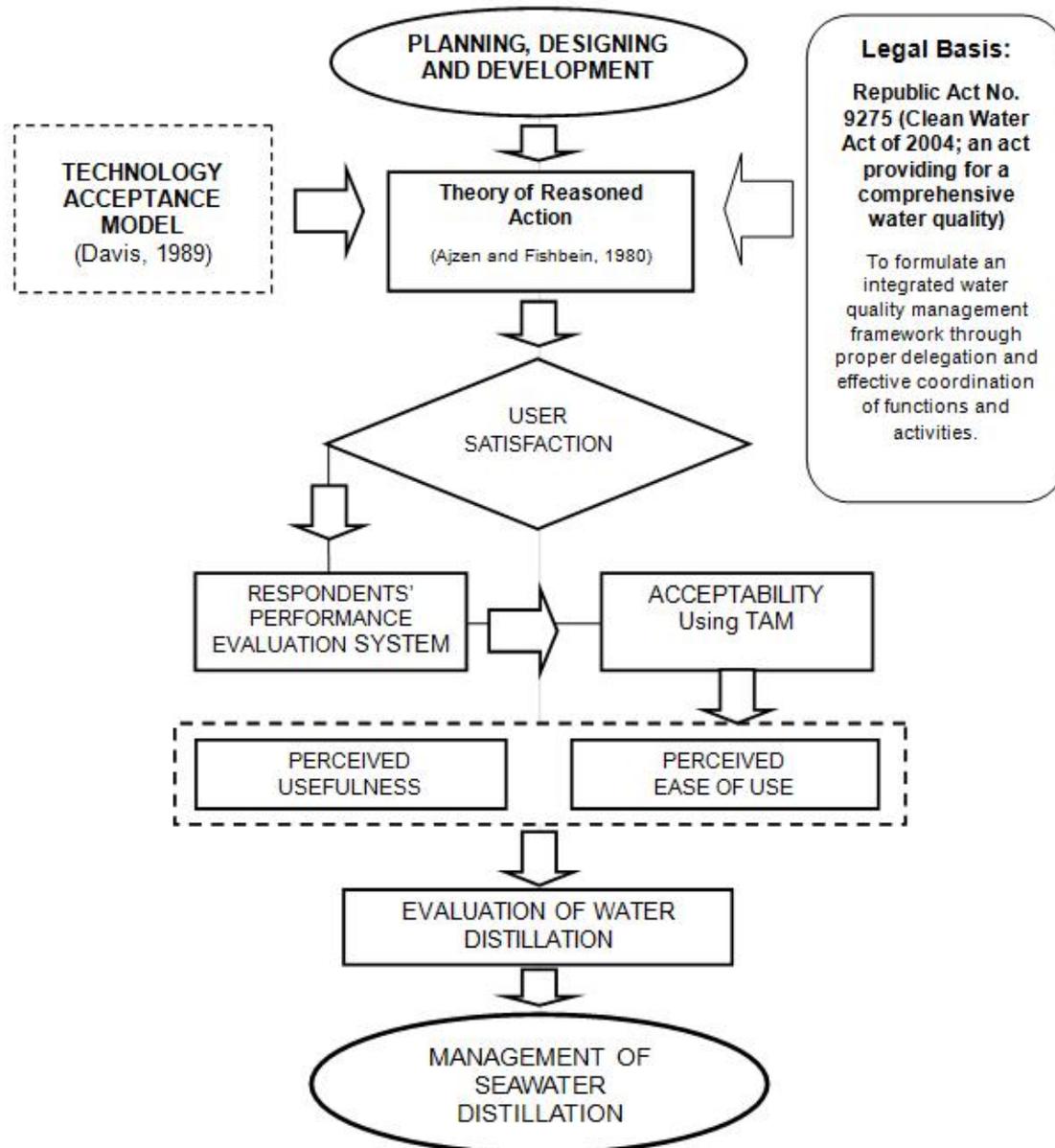
**Rationale of the Study:** Planet Earth stands out as a watery oasis with nearly all of its water found in the oceans. There is only about 2.5 percent of the water is considered freshwater—with much of it bound up in glaciers and snowpack—leaving only a small fraction to meet the world's domestic, agricultural, and environmental freshwater demands (Zander, et.al, 2008). As the population grows, the demand for the world's freshwater supplies will increase. Factors like a pleasing climate and natural resources, job growth, and rising incomes contribute to the increasing population. By 2025, about 2.7 billion people, nearly one-third of the projected population, will live in regions facing severe water scarcity (<https://www.worldwildlife.org/threats/water-scarcity>). Many prosperous and fastest-growing regions—the American Southwest, Florida, Asia, the Middle East will have inadequate freshwater supplies. The water needs of states, municipalities, industry, and citizens must be met, even as the difficulty and cost of developing new water resources increases. Distillation is that the oldest separation process and therefore the most generally used technique in qualitative analysis for characterizing materials by establishing an index of purity and for separating selected components from an entire matrix. Distillation is the foremost common and useful technique in chemistry labs, where chemists use the method to purify a compound, and also for industry, especially within the petrochemical and oil industry and in the manufacture of ethanol.

It's upon this last distillation -most famous alcoholic beverages are produced (Brennan, 2018). The reason for the wide acceptance of distillation is that, from both kinetic and thermodynamic points of view, distillation offers advantages over other existing processes for the separation of fluid mixtures because it has the potential for top mass transfer rates and better efficiency than most other available processes within the industry (Diwekar, 2000). Simple distillation, fractional distillation, and vacuum distillation are the most common conventional distillation in the Philippines that requires the boiling point of a mixture of liquids, all the volatile constituents boil. However, the quality of a constituent in the resulting vapor is based on its contribution to the total vapor pressure of the mixture. This is why compounds with higher partial pressures can be concentrated in the vapors whereas the compounds having low partial pressures can be concentrated in the liquid. Desalination has become a more popular option in regions where there's abundant supply of water that's unsuitable for use thanks to high salinity, and there are vivid opportunities for desalination plants that utilize thermal, electrical, or mechanical energy to separate the water from the salts. The choice of the desalination process depends on many factors, including salinity levels within the raw water, quantities of water needed, and therefore the sort of available energy (Davis, 2005).

**Theoretical Background:** This study is anchored on the Technology Acceptance Model (TAM) of Fred Davis (1989) which determines the user acceptance of any technology perceived usefulness and perceived ease of use factors. Perceived Usefulness is defined as the

degree to which an individual believes that using a particular system will enhance the task performance. Perceived Ease of Use is defined as the degree to which an individual believes that using a particular system is free of physical and mental effort (Davis, 1989; Davis et al., 1989; Davis, 1993). The TAM suggests that intention to simply accept the technology is determined and decided directly by attitude, perceived usefulness and perceived ease of use. Consistent with TAM individuals' intention to use technology determines the particular and on the spot use of the application and attitudes toward technology affecting the intention (Davis *et al.*, 1989; Davis and Venkatesh, 2004; Venkatesh et al., 2012). Technology Acceptance Model (TAM) is considered an influential extension of the theory of reasoned action (TRA), according to Ajzen and Fishbein (1980). The TRA is a general model which is concerned with individuals' intended behaviors. According to TRA an individual's performance is decided by the individual's attitude and subjective norms concerning the behavior in question.

channel into the electrode, while retaining the co-ions inside the electrode structure. The extended theory for MCDI which incorporates the description for the porous electrodes not only the electrostatic double layers (EDLs) formed inside the porous (carbon) particles, but also incorporates the role of the transport pathways within the electrode, i.e., the antiparticle pore space. Because in MCDI they are inhibited from leaving the electrode region, the inter particle porosity becomes available as a reservoir to store salt, therefore increasing the entire salt storage capacity of the porous electrode (P.M. Biesheuvel, 2011). A second advantage of MCDI is that in ion desorption (ion release) the voltage are often reversed. In such case the antiparticle porosity is often depleted of counterions, thereby increasing the salt uptake capacity and rate within the next cycle. During this work, the comparison of both experimental and theoretical adsorption/desorption cycles of MCDI for desorption at zero voltage also as for reversing voltage, and compare with the results for CDI (P.M. Biesheuvel, 2011).



**Figure 1. Theoretical and Conceptual Framework of the Study**

Additionally, an individual's beliefs and motivations interact with existing behavior. Membrane capacitive deionization (MCDI) is a technology for water desalination supported by applying an electrical field between two oppositely placed porous electrodes. Ions are taken from the water passing through a channel in between the electrodes and are stored inside the electrodes. Ion-exchange membranes are placed ahead of the electrodes allowing counter-ion transfer from the

To describe the EDL-structure a completely unique Donnan model is proposed valid for little pores relative to the Debye length. Capacitive mixing (CAPMIX) and capacitive deionization (CDI) are among the promising mechanism for harvesting safe, clean, renewable energy and for the energy efficient production of potable water, respectively. Both CAPMIX and CDI contain and involve water-immersed porous carbon (super capacitors) electrodes at voltages of the order of

million volts, such that counter-ionic packing is important for the electric double layer (EDL) which forms near the surfaces of these porous materials.

**Technology Acceptance Model (TAM).** Explores the prediction of acceptability (Davis, Bagozzi, & Warshaw, User acceptance of computer technology: a comparison of two theoretical models, 1989). TAM is employed to predict the acceptability of the tool as a technology, and to spot ways to enhance to make the system acceptable. (Herlocker, Konstan, Terveen, & Riedl). The researcher, in the course of the study, used this model to provide and supply solutions to questions laid out in the problem statement.

**Theory of Reasoned Action (TRA):** Suggests that an individual's intended behavior is determined by their intention to perform the behavior which intention is, in turn, a function of their attitude toward the behavior and subjective norms (Fishbein & Ajzen, 1975). The simplest and best predictor of behavior is intention or instrumentality (a belief that the behavior will cause the intended outcome). Instrumentality is determined by three things: their attitude toward the precise behavior, their subjective norms, and their perceived behavioral control. Therefore, the more favorable the attitude and the subjective norms and the greater the perceived control, the stronger the person's intention to perform the behavior (Silverman and Lim, 2016).

**User Satisfaction:** The extent to which users consider the system meets their information requirements, needs, user's comfort and acceptability (Chad Lin *et al.*, 2016).

**Respondents' Performance Evaluation:** Performance Evaluation is defined as a proper and productive procedure to measure an employee's work and results supported on their job responsibilities. It is used to gauge the amount of value and use added by an employee in terms of increased business revenue, as compared to industry standards and overall employee return on investment (ROI).

**Acceptability using TAM:** The technology acceptance model (TAM) is an information systems theory that models how users come to simply accept and use the technology (Davis, 1989)

**Perceived Usefulness (PU):** Perceived usefulness is that degree to which an individual believes that employing a particular system would enhance his or her job performance (Davis, 1989). That is, potential adopters assess the results and consequences of their adoption behaviour based on the continued desirability of usefulness derived from the innovation (Chau, 2004). In fact, data and information system adoption research suggests that a system that doesn't help people perform their jobs isn't likely to be received favourably (Nysveen *et al.* 2005b). Perceived usefulness is additional referred to as performance expectancy (Venkatesh *et al.*, 2003). On another note, perceived usefulness is also recognized as having a robust positive effect on the intention of adopters to use the innovation.

**Perceived Ease of Use (PEU):** Perceived ease of use is the degree to which an individual believes that employing a particular system would be freed from effort (Dholakia and Dholakia, 2004). Other constructs that capture the notion of perceived ease of use, are complexity, effort and energy expectancy (Rogers, 1995; Venkatesh, *et al.*, 2003). Perceived ease of use may contribute towards performance, and thus, near-term perceived usefulness and the lack of it can cause frustration, and therefore, impair adoption of innovations (Davis, 1989; Taylor and Todd, 2001; Venkatesh, 1999; Venkatesh and Davis, 2000).

**Republic Act 9275 (Clean Water Act of 2004):** An Act Providing for a Comprehensive Water Quality Management and for the Other Purposes, is a law that applies to water quality management in all water bodies. It primarily applies to the abatement and control of pollution from land-based sources and to formulate an integrated

water quality management framework through proper delegation and effective coordination of functions and activities (DENR, 2004).

## THE PROBLEM

**Statement of the Problem:** This research determines the technology management of seawater distillation system at Cebu Technological University- Pinamungajan, Cebu, during the Academic Year 2019-2020 towards viable community extension initiative.

Specifically, it seeks answers to the following:

- ) What are the prior arts related to Seawater Distillation?
- ) As perceived by the respondent-groups, to what extent is the management of seawater distillation system as regards to the following aspects:
  - o process;
  - o production cost; and
  - o safety?
- ) As rated by the experts, what is the level of efficiency of the seawater distillation system?
- ) Based on the laboratory, what is the quality of the output of the system as to:
  - 4.1 TDS (total dissolved solid); and
  - 4.2 EC (electric conductivity test).
- ) What are the challenges and barriers related to seawater distillation?
- ) Based on the findings, what community extension initiatives can be developed?

**Significance of the Study:** The main purpose of the study is to assess the Technology Management of the Seawater Distillation System that can be used to supply to the community such as Agricultural farms and the local industry. It is also considered as an alternative technology tool in the place where the study is conducted. It will benefit the Municipality of Pinamungajan, Cebu.

**The Municipality:** After the prototyping stage comes the Technology Management of the Seawater Distillation System that could be done by a group of people in the community working as a team. And this will place in the vicinity itself for the use of the next and incoming team.

**The Community:** This Technology Management of the Seawater Distillation System contributes to the community's knowledge in innovating and creating new concepts leading them to do further studies and improvements. With this, they can also arrange the competencies of producing this device for the community, constructing all parts of the project, and working as a group to arrive at the same output that could partly answer the need of providing 70 percent practical training and 30 percent theory.

**The Respondents:** With this Seawater Distillation System, the respondents will gradually meet their level of competencies tailored to their particular knowledge, skills, and attitude. Because of their participation, they can acquire the basic skills in machine operation and understanding of Fabrication Technology, an operation guide of the device, and accurate and safe manner of working habits that could answer the need of the industry which is being encompassed by this device and that the water output will benefit their community especially those nearby the coastal areas.

**The Future Researchers:** This study will help them in making doing projects. Thus, the finished product will inspire them to make a study for improvement.

## RESEARCH METHODOLOGY

**Design:** This study used the Quasi-method of research to collect facts relevant in attaining the details in planning, designing, and fabricating the Technology Management of the Seawater Distillation System. A

normative survey is the mode of acquiring data and the questionnaire serves as the main instrument. Regression correlation methods particular survey research was employed in this study. Questionnaires were given to 5 Professors/experts from the industry and 90 students from the community for evaluation. Gathered data were treated using the total weighted points and the weighted mean.

**Flow of the Study:** Figure 2 presents the flow of the study. This followed the systematic approach of input-process-output flow.

**The Input flow:** The researcher prepared a letter of request asking for permission to conduct the research study. Ocular inspection and distribution of questionnaires to the community were executed. Collection of questionnaires, weighing, and using of the numerical rating scales were also done.

**The Process flow:** Assessment of inputs through the use of questionnaires, informal interviews, observations, and statistical computations were done during the process flow.

**The Output flow:** The Technology Management of the Seawater Distillation System's community extension will be executed. After collecting and tallying the data, the researcher will collect all comments and suggestions based on the findings and recommendations on what instructional model will be applied. In the flow of the study, the researcher adopted and used the illustrated In-process-out flow to enhance the Technology Management of the Seawater Distillation System for the use of the whole community in Pinamungajan, Cebu.

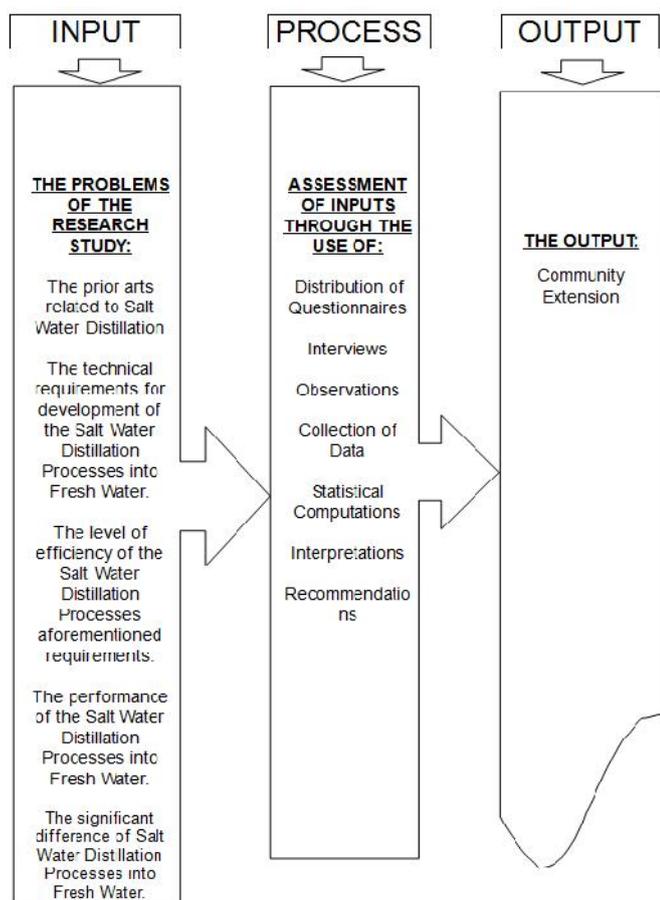


Figure 3. Flow of the Study

**Research Environment:** The Municipality of Pinamungajan is a second municipal income class municipality in the province of Cebu. According to the 2015 census, it has a population of 65,955 people and has over forty thousand registered voters based on the 2016 electoral roll. Records say that the municipality was established in 1815 when the Spanish government rules the country. The municipal

is comprised of 26 barangays namely: Anislag, Anopog, Binabag, Buhingtubig, Busay Butong, Cabiangon, Camugao, Duangan, Guimbawian, Lamac, Lut-od, Mangoto, Opao, Pandacan, Poblacion, Punod, Rizal, Sacsac, Sambagon, Sibago, Tajao, Tangub, Tanibag, Tupas, and Tutay. Pinamungajan municipality features a total land acreage of over ten thousand hectares with various features (<https://sv.wikipedia.org/wiki/Pinamungajan>). It is bordered to the north by the City of Toledo; to the west with Tanon Strait and mostly coastal along the west side. Most of the tourism, attractions, and destinations of local and foreign alike are the wide arrays of long beaches, islets, sandbars, caves, and falls; to the east is the city of Naga and the town of San Francisco; and to the south is the town of Aloguinsan. Pinamungajan has over one thousand arable land and an identical size for commercial size in terms of hectares. Industrial, disposable land, forest reservation, wildlife and national parks classification of lands also are designated. It is an agricultural area producing many farm products. The municipality is additionally present with mountainous and with steep rocky ridges.

**Review of related literature and studies:** This chapter contains discussion about other related literature and studies on saltwater refinement using distiller device perused from books, journals, electronic sources, other reference materials written by distinguished authors and unpublished dissertation whom in one way or another supported the text and substance of this study.

**Related Literature:** The availability of affordable clean water is one of the key technological, social, and economical challenges of the 21st century. Clean water is acknowledged as a basic human right by the United Nations. It is still unavailable to one out of seven people worldwide. To complicate matters, increasing groundwater extraction round the globe leads to progressive salt water ingress in wells and aquifers. As a consequence, there's an outsized interest within the development of economically attractive desalination technologies (S. Porada, et.al., 2013). For the past years, a number of desalination methods have been developed. These methods include distillation, reverse osmosis, and electrodialysis are the most commonly known and widespread technologies. However, there is a common demand to develop these technologies more energy efficient and cost effective, both for the deionization of seawater and for brackish water. Considering that there is more brackish water than freshwater in the world, it is clear that it is particularly attractive to utilize the massive brackish water resources for human consumption and residential use, agriculture, and industry (S. Porada, et.al., 2013).

**Total Dissolved Solids (TDS):** According to the World Health Organization (WHO), total dissolved solids (TDS) refers to the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The main constituents are most of the times calcium, magnesium, sodium, and potassium cations and carbonate, hydrogencarbonate, chloride, sulfate, and nitrate anions. Furthermore, TDS in water supplies comes from natural sources, sewage, urban and agricultural run-off, and industrial wastewater. There is no recent data on health effects associated with the ingestion of TDS in drinking-water appear to exist; nevertheless, associations between various health effects and hardness, rather than TDS content, have been investigated in many studies.

**Electric Conductivity Test (EC):** The electrical conductivity of the water is dependent on the water temperature. The higher the temperature means the higher the electrical conductivity would be. In every increase of 1 degree Celsius of water temperature, there is also an increase of the electrical conductivity of water by 2-3%. It is common nowadays to automatically standardize the readings of many EC meters to 25°C. Despite the fact that electrical conductivity is a good indicator of the total salinity, it does not provide any details about the ion composition in the water. There is similar electrical conductivity values that can be measured in low quality water (e.g. water rich with Sodium, Boron and Fluorides) and in high quality irrigation water (e.g. adequately fertilized water with appropriate nutrient concentrations and ratios (physics.stackexchange.com, 2018)). It is a fact that the electrical conductivity is a measure to the

capacity of water to conduct electrical current. This is directly related to the concentration of salts dissolved in water, and to the Total Dissolved Solids (TDS) (www.fondriest.com., 2014).

**Capacitive Deionization (CDI):** A robust, energy efficient, and cost effective technology for desalination of water known as Capacitive Deionization (CDI) has emerged over the years with a low or moderate salt content. The energy efficiency of CDI for water with a salt concentration below approximately 10 g/L is due to the fact that the salt ions are separated from the water mixture. Instead, other methods extract the majority of the water from the salt solution (S. Porada, et al, 2013). In addition, energy release during electrode regeneration (ion release, or electrode discharge) can be utilized to charge a neighbouring cell operating in the ion electro sorption step, and in this way energy recovery is possible.

**Presentation data, Analysis and interpretation:** This chapter determines the acceptability of the technology management of the seawater distillation system at the Cebu Technological University-Pinamungajan Extension Campus, Pinamungajan, Cebu during the School Year 2019-2020. The results from the questionnaires answered by the respondent-groups in this research study are very precise and accurate. The results of the Technology Management of the Seawater Distillation System survey identified by the respondent-groups in Pinamungajan Cebu, Philippines are also discussed. The information is collected by means of questionnaires completed by both respondent-groups: students, community, and experts from small-scale industries with a total of 95 respondents.

- J Part one (1) gives the profile of the respondents as to gender, age, and highest educational attainment.
- J Part two (2) describes the prior arts related to the seawater distillation process that is further elaborated.
- J Part three (3) discusses the extent of the technology management of the seawater distillation system in terms of process, production cost, and safety.
- J Part four (4) reveals the level of efficiency of the seawater distillation system.
- J Part five (5) describes the quality of the output of the system as to the total dissolved solids (TDS) and electric conductivity test (EC).

## SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of the study, findings on empirical data, the conclusions of the analyzed data, and the recommendations propounded from the findings.

### SUMMARY

This study was conducted to assess the technology management of the seawater distillation system at Cebu Technological University-Pinamungajan Extension Campus, Cebu during the Academic Year 2019-2020 towards viable community extension initiatives. Specifically, this study sought out the profiles of the respondents such as age, gender, and educational attainment. Assessed in the study are the extent of the management of the seawater distillation system; the

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quality of the Conductivity Test (EC); challenges and barriers related to seawater distillation; and the formulation of the community extension initiatives to be developed. A normative survey mode of acquiring data and the questionnaire serves as the main instrument. Data were collected from the 95 respondents wherein questionnaires were given to 5 experts from the industry and 90 from the students for evaluation. Appropriate statistical measures were used to analyze the data using the totals, means, weighted mean, frequencies, and percentile, and regression correlation methods particular survey research was deployed in this study. The study was presented in narrative, descriptive and tabular forms. This study further developed an output. The title of the said plan is the "Community Extension

Initiatives on Seawater Distillation at the Municipality of Pinamungajan, Cebu" which is based on the findings, conclusions, and recommendations.

### FINDINGS

The result showed that the subject of the study was determined by the purposive sampling method as a requirement for the intended study. Specifically, the results of planning, designing, fabricating, and the technology management of the seawater distillation system. The result of the questionnaires answered by the respondent-groups in this research study was very precise and accurate. The result of the technology management of the seawater distillation system survey identified by the respondent-groups in Pinamungajan Cebu, Philippines was also being discussed. The information was collected by means of questionnaires completed by both respondent-groups: students and professor/instructors/experts from small-scale industries with a total of 95 respondents.

The findings revealed that the profile of the respondents in the data showed male respondents with 62.71 percent and female respondents representing 50 percent whose age ranged from 15-19 years old represented the majority. Male respondents' ages ranged from 20-24 years old or 27.12 percent and female respondents with 25 percent are also seeming. The rest were distributed to the different age brackets. The findings on the educational attainment reveals that eighty-seven (87) or 91.58 percent of the majority respondents were High School Graduates indicating that they are currently in their second to third year in college by the time the study was conducted. Results also revealed that four (4) or 4.21 percent are postgraduate respondents as these are those indicating the number of the instructors/ professors. The extent of the technology management of the seawater distillation system on a 4-point continuum using one as the lowest rate or not acceptable and four as the highest or Highly Acceptable was used. As to the dependent variables of the study, the following results were revealed:

<b>Process</b>	-	<b>Moderately Acceptable</b>
<b>Production Cost</b>	-	<b>Moderately Acceptable</b>
<b>Safety</b>	-	<b>Acceptable</b>

The extent of the technology management of the seawater distillation system has a Moderately Acceptable result with a mean of 96.46 percent mean on a four-point scale.

## CONCLUSIONS

Based on the findings and after a careful analysis and interpretation of the research study, it is concluded that the Technology Management of Seawater Distillation System meets the required standards and is a precise aid in the community to address the water scarcity. The following conclusions are also deemed warranted:

1. The majority of the respondents with the age bracket from 15-19 though still young are immensely in admiration of their course and in fact when faced with certain innovation seemed to act as savvy which placed the researcher in great awe and somehow pressure. These rookie innovators display enthusiasm, dynamism, and excitement.
2. The prior arts related to seawater distillation are in particular successful in different states showing that it is a feasible water resource free from the variations in rainfall. A call to embrace the seawater distillation lies in the decision of the government especially here in the Philippines to somehow augment the supplies and put a solution to the water scarcity.
3. The Moderately Acceptable result on the extent of the technology management of the seawater distillation system is the result of the successful demonstration recognized by the respondents accepting the fact that the innovation's process is well prepared, the cost is practical and the safety is properly conveyed in the entire demonstration.

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