A COMPARATIVE ANALYSIS ON OREGON WATER QUALITY INDEX TO ANALYSE POTABILITY OF GROUND WATER AND RO WATER IN THANDALAM

P. Poornachandrasekhar[1], Vidhya Lakshmi Sivakumar[2]

[1]Research Scholar,Department of Civil Engineering,Saveetha School of Engineering,Saveetha Institute ofMedical And Technical Sciences,Saveetha University, Chennai, Tamilnadu, India. Pincode: 602105.

[2]Department of Civil Engineering,Saveetha School of Engineering,Saveetha Institute of Medical And TechnicalSciences,Saveetha University, Chennai, Tamilnadu, India. Pincode: 602105.

Email: poornachandrasekhar17@saveetha.com[1],vidhyalakshmis.sse@saveetha.com

ABSTRACT: Aim: The aim of this study is to assess the quality of pond water and reverse osmosis water in Thandalam region through the comparison and analysis of Oregon Water Quality Index (OWQI). **Materials and methods:** Twenty numbers of samples from a local pond and potable water sources were tested and the water quality induces were derived anc compared with each other.. **Results and Discussion:** The results of the analysis are fed into a statistical software by keeping the pre-test power as 80%. On performing an independent sample t-test on the two groups considered, it is observed that there exists a significant difference between them ($p < 0.05$). OWQI was higher in pond water than that of reverse osmosis water. **Conclusion:** This study shows that the pond water is not potable when compared to reverse osmosis water. The pond water requires treatment prior to domestic use in order to improve sustainability.

KEYWORDS: Physico-chemical Parameters, Pond Water, Reverse Osmosis Water, Environmental Engineering, Oregon Water Quality Index, Novel Water Quality Index

1. INTRODUCTION

With increasing population, industrial development and expansion of urban region, i.e, urban sprawl comes increasing pollution. With increasing environmental pollution, quality of soil, water and air gets affected, and this, indirectly, has a huge impact on the country's economic growth (Rasool, Malik, and Tarique 2020). With reference to water quality, in recent days, it has become imperative to assess the quality of water in any given region due to its enormous effect on health as is evident from (Akter et al. 2016; Ji et al. 2020; Adimalla 2020; Chidambaram et al. 2015). Drinking water quality refers to water that is available for consumption by humans in acceptable form (Akter et al. 2016). Therefore water quality depends on the water physico-chemical parameters that composes the water in a given locality and to characterise water is of immense importance. Therefore, assessment of water quality index is a potential tool to monitor water quality, anthropogenic impact and ensure sustainable development of a country (Kachroud et al. 2019; Sany et al. 2019). In addition, assessment of water quality is required for the policy implementation related to water protection, and optimal usage of water to a variety of uses based on their individual needs (Kachroud et al. 2019).
In recent years, while the research done on environmental engineering is very high, there are nearly 150 articles published on this study in only two sources, google scholar and researchgate.net. Among them the most cited articles were (Hoseinzadeh et al. 2015). In rivers, water flowing results in dilution and decomposition of pollutants faster than standing water. Water quality index (WQI) is a tool to reflect the composite influence of different water quality parameters. WQI is a fast and simple manner to show water quality from the point of view of a special consumption such as human consumption etc (Sherrard, Wilson, and Sii 1994). The development of a better system for indexing water quality and its application to four water use classes are described. There are three dominant use classes: bathing, water supply, and fish spawning, and one general use class. In all of them protection of aquatic life is included. To ensure that the index score tells us something useful and does not hide important information as current indexes (or indices) tend to do, the water quality variable giving the lowest score (i.e. the minimum operator) has been employed to produce the final index score (Smith 1990). Preliminary indications are that this is a more useful aggregation method than the more commonly used additive, and multiplicative techniques. Index development has been linked to recommended water quality standards developed for New Zealand water legislation. The indexes are intended to assist in the dissemination of water quality information, particularly to lay-people (Ward, Loftis, and McBride 1991). Design

DOI: 10.9756/INT-JECSE/V14I3.730

of Water Quality Monitoring Systems Design of Water Quality Monitoring Systems presents a state-of-the-art approach to designing a water quality monitoring system that gets consistently valid results. It seeks to provide a strong scientific basis for monitoring that will enable readers to establish cost-effective environmental programs. Here the best study in my aspect is the (Hoseinzadeh et al. 2015).Our team has extensive knowledge and research experience that has translate into high quality publications(Patturaja and Pradeep 2016; Ramesh Kumar et al. 2011; Krishnan, Pandian, and Kumar S 2015; Felicita 2017b, [a] 2017; Kumar 2017; Sivamurthy and Sundari 2016; Sathivel et al. 2008; Sekar et al. 2019)

Assessment of water quality index in a pond near Thandalam village, Sriperumbudur district. Tamilnadu is not reported in literature. Analysing water quality index with the samples of water will help to identify the potable nature of the water. A number of studies on water quality have already been studied in the previous years but have not been tested in Thandalam village with particular reference to environmental engineering. The aim of this study is to check the potability of water by comparing the water quality index of two sources of water in Thandalam village, Sriperumbudur district.

2. MATERIALS AND METHODS

Water samples for this study are collected from a pond and drinking water in the locality in Thandalam village to test for water quality and a novel water quality index is used in this study. Thandalam is a village located along the NH4 in the Sriperumbudur Taluk of Kancheepuram district, Tamil Nadu. The RO water samples were taken from several households along this village. This village is of semi-urban nature with the occupation of the population being agriculture. A part of the village also undergoes transitional industrial related activities with Sriperumbudur being the industry hotspot of Chennai (Malar et al 2015). The topography is flat with an average elevation of 37 m above mean sea level. The annual average rainfall for the district is 1252 mm. The tests were conducted in the Water Quality Analysis laboratory, Saveetha School of Engineering, SIMATS, Tamil Nadu, India. The two groups of water are group A - pond water and group b - RO water. A total of 20 samples for each group, i.e., 20 samples of pond and RO water each were collected in and around Thandalam. The samples were collected (N=20) for the Group 1 (Pond Water) at regular intervals of 5 m across the pond. In addition, 20 samples (N=20) of Group 2 (RO water) were taken from different places along the village. The sample size was taken as 20 after being calculated for a pre-test power of 80% with an alpha value of 0.05 in clinical.com. The input for the sample size calculation is the mean and standard deviation of the parameters from previous established studies (Sarkar, Ghosh, and Mondal 2020).
A huge number of water quality indices viz. Weight Arithmetic Water Quality Index (WAWQI), National Sanitation Foundation Water Quality Index (NSFWQI), Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI), Oregon Water Quality Index (OWQI) etc. have been formulated by several national and international organizations. These WQI have been applied for evaluation of water quality in a particular area. Moreover, these indices are often based on the varying number and types of water quality parameters as compared with respective standards of a particular region. Water quality indices are accredited to demonstrate annual cycles, spatial and temporal variations in water quality and trends in water quality even at low concentrations in an efficient and timely manner. On the basis of reviewed literature, available indices have many variations and limitations based on the number of water quality variables used and not accepted worldwide. Hence, it needs worldwide acceptability with varying numbers of water quality variables. Various WQI determination methods have been described herein. OWQI creates a score to evaluate the general water quality of Oregon's stream and the application of this method to other geographic regions, which combines eight water quality variables into a single number. The parameters covered in this method are temperature, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), pH, ammonia and nitrate nitrogen, total phosphorus, total solids and fecal coliform (Cude 2001). The original OWQI was designed after the NSFWQI where the Delphi method was used for variable selection. It expresses water quality status and trends for the legislatively mandated water quality status assessment. The index is free from the arbitration in weighting the parameters and employs the concept of harmonic averaging. The mathematical expression of this WQI method is given by

$$\text{WQI} = \sqrt{n \div \{\sum_i^n \quad (1 \div SI)\}} \text{ --------(1)}$$

where, n = number of subindices, SI = sub index of i^{th} parameter,. Furthermore, the rating scale of this WQI has also been categorized in various classes as given in Table 1. The OWQI is calculated for both the sources of water as mentioned in Equation (1). The results of the novel water quality index as derived is displayed in Table 2 and is used as input to the statistical analysis.

Statistical Analysis

DOI: 10.9756/INT-JECSE/V14I3.730

A statistical analysis between the two groups of water is performed using SPSS version 25. An independent samples t-test was carried out with independent variables as water quality index value from pond water and RO water. No dependent variables are considered in this study.

3. RESULTS

Table 1 shows the WQI index values used as reference for assessing the quality of the water. By following the mathematical formula as given in Equation 1 for the oregon water quality index, the values of water quality index of the samples of the pond and RO water are calculated and various values are obtained for the various samples by giving these values as an input for the SPSS software for statistical analysis. The mean of the WQI of the pond water obtained was 64 representing that it is of poor quality standards and the mean of WQI of RO water obtained was 87 representing that it is of good quality standards. Figure 1 shows the graph obtained from the statistical analysis using SPSS. Table 3 shows the mean, standard deviation and standard error difference for the independent variables considered in this study, namely, pond water and RO water. No dependent variables were used in this study. Table 4 shows the results of SPSS analysis.

4. DISCUSSION

Within the limits of this study, it is observed that WQI values of pond water seemed to be lower than that of RO water in Thandalam, Sriperumbudur taluk (p-values <0.05, independent samples t-test).
This study is supported by (Rajesh, Chakravarthi, and Subashini 2018; Bora and Goswami 2017) that found samples from several water sources in and around Sriperumbudur are not potable due to WQI being on low. And also study made by (Mahmud, Sikder, and Joardar 2020) shows that the water quality standards which are low in Oregon water index chart are not potable for use and it must be purified or filtered to use for drinking and other purposes. (Mahmud, Sikder, and Joardar 2020; Mirrasooli, Ghorbani, and Molaei 2017)The most important aquatic ecosystems are freshwater rivers, which are considered as biodiversity and drinking water. In this regard, the quantitative and qualitative study of these resources is an important pillar of sustainable development. The parameters of dissolved oxygen, nitrate, nitrite and PH were measured at each turn and the data were analyzed by WQI qualitative index. (Tyagi et al. 2020) claims that the OWQI creates a score to evaluate the general water quality of Oregon's stream and the application of this method to other geographic regions, which combines eight water quality variables into a single number. The parameters covered in this method are temperature, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), pH, ammonia and nitrate nitrogen, total phosphorus, total solids and fecal coliform

The main limitation of the OWQI is that it was developed for use in Oregon waterbodies. Despite this limitation, it is used in this study, since it uses only 8 parameters for the assessment of water quality. To overcome, suitable water quality indices involving simple procedure and less parameters such as New WQI as proposed by (Said, Stevens, and Sehlke 2004) may be utilised for quick evaluation of water quality.

5. CONCLUSION

In this study, the Oregon Water Quality Index is used to assess the water quality of the two sources of water in Thandalam Village, Kanchipuram district. Eight physico-chemical parameters were tested for and the indices are derived and it is concluded that this novel water quality index used highlighted that the water quality is poor for the pond water under investigation.

DECLARATIONS:

Conflict of interests

No conflict of interests in this manuscript

Authors Contributions

Author PP was involved in data collection, data analysis, manuscript writing. Author SVL was involved in conceptualization, data validation, and critical review of the manuscript.

Acknowledgments

The authors would like to express their gratitude towards Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (Formerly known as Saveetha University) for providing the necessary infrastructure to carry out this work successfully.

Funding

We would also like to thank the following organisations for providing financial assistance to complete the study.
1. Ram Mohan Rao Farms, Andhra Pradesh
2. Saveetha University
3. Saveetha Institute of Medical and Technical Sciences
4. Saveetha School of Engineering

6. REFERENCES

[1]. Adimalla, Narsimha. 2020. “Controlling Factors and Mechanism of Groundwater Quality Variation in Semiarid Region of South India: An Approach of Water Quality Index (WQI) and Health Risk Assessment (HRA).”*Environmental Geochemistry and Health* 42 (6): 1725–52.

[2]. Akter, Tahera, Fatema Tuz Jhohura, Fahmida Akter, Tridib Roy Chowdhury, Sabuj Kanti Mistry, Digbijoy Dey, Milan Kanti Barua, Md Akramul Islam, and Mahfuzar Rahman. 2016. “Water Quality Index for Measuring Drinking Water Quality in Rural Bangladesh: A Cross-Sectional Study.” *Journal of Health, Population and Nutrition*. https://doi.org/10.1186/s41043-016-0041-5.

[3]. Bora, Minakshi, and Dulal C. Goswami. 2017. “Water Quality Assessment in Terms of Water Quality Index (WQI): Case Study of the Kolong River, Assam, India.” *Applied Water Science*. https://doi.org/10.1007/s13201-016-0451-y.

[4]. Chidambaram, S., M. Bala Krishna Prasad, M. V. Prasanna, R. Manivannan, and P. Anandhan. 2015. “Evaluation of Metal Pollution in Groundwater in the Industrialized Environs in and Around Dindigul, Tamilnadu, India.” *Water Quality, Exposure and Health*. https://doi.org/10.1007/s12403-014-0150-6.

[5]. Cude, Curtis G. 2001. “OREGON WATER QUALITY INDEX A TOOL FOR EVALUATING WATER QUALITY MANAGEMENT EFFECTIVENESS.” *Journal of the American Water Resources Association*. https://doi.org/10.1111/j.1752-1688.2001.tb05480.x.

[6]. Felicita, A. Sumathi. 2017a. “Quantification of Intrusive/retraction Force and Moment Generated during En-Masse Retraction of Maxillary Anterior Teeth Using Mini-Implants: A Conceptual Approach.” *Dental Press Journal of Orthodontics* 22 (5): 47–55.

[7]. ———. 2017b. “Orthodontic Management of a Dilacerated Central Incisor and Partially Impacted Canine with Unilateral Extraction - A Case Report.” *The Saudi Dental Journal* 29 (4): 185–93.

[8]. Hoseinzadeh, Edris, Hassan Khorsandi, Chiang Wei, and Mahdi Alipour. 2015. “Evaluation of Aydughmush River Water Quality Using the National Sanitation Foundation Water Quality Index (NSFWQI), River Pollution Index (RPI), and Forestry Water Quality Index (FWQI).”*Desalination and Water Treatment*. https://doi.org/10.1080/19443994.2014.913206.

[9]. Ji, Yujie, Jianhua Wu, Yuanhang Wang, Vetrimurugan Elumalai, and Thirumalaisamy Subramani. 2020. “Seasonal Variation of Drinking Water Quality and Human Health Risk Assessment in Hancheng City of Guanzhong Plain, China.” *Exposure and Health*. https://doi.org/10.1007/s12403-020-00357-6.

[10]. Kachroud, Moez, Fabienne Trolard, Mohamed Kefi, Sihem Jebari, and Guilhem Bourrié. 2019. “Water Quality Indices: Challenges and Application Limits in the Literature.” *Water*. https://doi.org/10.3390/w11020361.

[11]. Krishnan, Sindhuja, Saravana Pandian, and Aravind Kumar S. 2015. “Effect of Bisphosphonates on Orthodontic Tooth Movement-an Update.” *Journal of Clinical and Diagnostic Research: JCDR* 9 (4): ZE01–05.

[12]. Kumar, Santhosh. 2017. “The Emerging Role of Botulinum Toxin in the Treatment of Orofacial Disorders: Literature Update.” *Asian Journal of Pharmaceutical and Clinical Research* 10 (9): 21.

[13]. Mahmud, Asif, Shraboni Sikder, and Jagadish Chandra Joardar. 2020. “Assessment of Groundwater Quality in Khulna City of Bangladesh in Terms of Water Quality Index for Drinking Purpose.” *Applied Water Science*. https://doi.org/10.1007/s13201-020-01314-z.

[14]. Mirrasooli, Elham, Rasoul Ghorbani, and Masoud Molaei. 2017. “Water Quality Assessment in Terms of Water Quality Index (WQI): Case Study; Gorganroud River, Golestan Province, Iran.” *Open Journal of Ecology*. https://doi.org/10.4236/oje.2017.713044.

[15]. Patturaja, Kiruthika, and D. Pradeep. 2016. “Awareness of Basic Dental Procedure among General Population.” *Journal of Advanced Pharmaceutical Technology & Research* 9 (9): 1349.

[16]. Rajesh, S., Saritha Chakravarthi, and Maria Subashini. 2018. “GROUND WATER ANALYSIS IN SRIPERUMBUDUR.” *International Journal of Pure and Applied Mathematics: IJPAM* 119 (12): 8903–12.

[17]. Ramesh Kumar, K. R., K. K. Shanta Sundari, A. Venkatesan, and Shymalaa Chandrasekar. 2011. “Depth of Resin Penetration into Enamel with 3 Types of Enamel Conditioning Methods: A Confocal Microscopic Study.” *American Journal of Orthodontics and Dentofacial Orthopedics: Official*

DOI: 10.9756/INT-JECSE/V14I3.730

Publication of the American Association of Orthodontists, Its Constituent Societies, and the American Board of Orthodontics 140 (4): 479–85.

[18]. Rasool, Haroon, Mushtaq Ahmad Malik, and Md Tarique. 2020. "The Curvilinear Relationship between Environmental Pollution and Economic Growth." *International Journal of Energy Sector Management*. https://doi.org/10.1108/ijesm-04-2019-0017.

[19]. Said, Ahmend, David K. Stevens, and Gerald Sehlke. 2004. "An Innovative Index for Evaluating Water Quality in Streams." *Environmental Management* 34 (3): 406–14.

[20]. Sany, S. B. Tavakoly, S. B. Tavakoly Sany, G. Monazami, M. Rezayi, M. Tajfard, and H. Borgheipour. 2019. "Application of Water Quality Indices for Evaluating Water Quality and Anthropogenic Impact Assessment." *International Journal of Environmental Science and Technology*. https://doi.org/10.1007/s13762-018-1894-5.

[21]. Sarkar, Rituparna, Apurba Ratan Ghosh, and Naba Kumar Mondal. 2020. "Comparative Study on Physicochemical Status and Diversity of Macrophytes and Zooplanktons of Two Urban Ponds of Chandannagar, WB, India." *Applied Water Science*. https://doi.org/10.1007/s13201-020-1146-y.

[22]. Sathivel, Arumugam, Hanumantha Rao Balaji Raghavendran, Periasamy Srinivasan, and Thiruvengadam Devaki. 2008. "Anti-Peroxidative and Anti-Hyperlipidemic Nature of Ulva Lactuca Crude Polysaccharide on D-Galactosamine Induced Hepatitis in Rats." *Food and Chemical Toxicology: An International Journal Published for the British Industrial Biological Research Association* 46 (10): 3262–67.

[23]. Sekar, Durairaj, Ganesh Lakshmanan, Panagal Mani, and M. Biruntha. 2019. "Methylation-Dependent Circulating microRNA 510 in Preeclampsia Patients." *Hypertension Research: Official Journal of the Japanese Society of Hypertension* 42 (10): 1647–48.

[24]. Sherrard, Joseph H., Terence E. Wilson, and Hie-Ing Sii. 1994. *Development of a Water Quality Index Based on Fuzzy Set Theory and Intended Water Use*.

[25]. Sivamurthy, Gautham, and Shantha Sundari. 2016. "Stress Distribution Patterns at Mini-Implant Site during Retraction and Intrusion—a Three-Dimensional Finite Element Study." *Progress in Orthodontics* 17 (1): 1–11.

[26]. Smith, David G. 1990. "A Better Water Quality Indexing System for Rivers and Streams." *Water Research*. https://doi.org/10.1016/0043-1354(90)90047-a.

[27]. Tyagi, Shweta, Bhavtosh Sharma, Prashant Singh, and Rajendra Dobhal. 2020. "Water Quality Assessment in Terms of Water Quality Index." *American Journal of Water Resources*. https://doi.org/10.12691/ajwr-1-3-3.

[28]. Ward, Robert C., Jim C. Loftis, and Graham B. McBride. 1991. *Design of Water Quality Monitoring Systems*. John Wiley & Sons.

FIGURES AND TABLES

DOI: 10.9756/INT-JECSE/V14I3.730

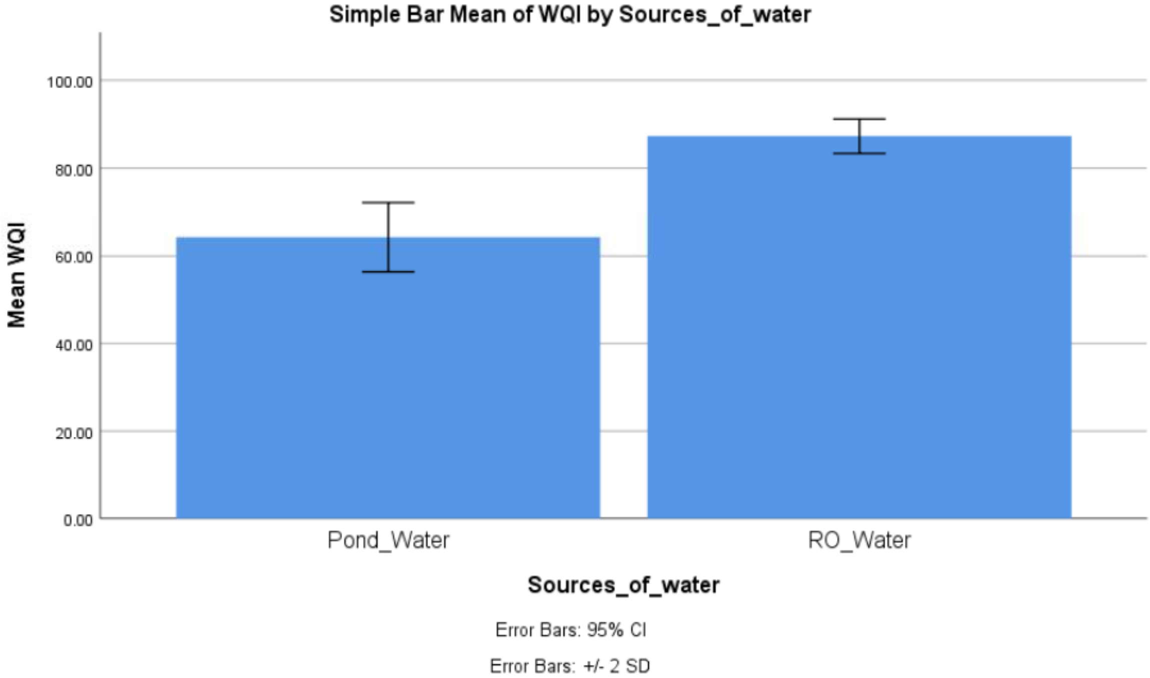

Fig. 1. A simple bar mean graph of the WQI for pond water and RO water by SPSS Version 25 with SD±2. There was a statistical significance between the pond water and the RO water ($p<0.05$, independent samples-t-test). It is observed that pond water seems to have a lower water quality index value than RO water.

DOI: 10.9756/INT-JECSE/V14I3.730

Table 1. Water Quality Rating as per Oregon Water Quality Index method

90-100	Excellent water quality
85-89	Good water quality
80-84	Fair water quality
60-79	Poor water quality
0-59	Very poor water quality

Table 2. Water quality index values obtained for two groups tested in laboratory and calculated using formula

Sl. No	**Pond Water**	**RO Water**
	WQI	**WQI**
1	55	86
2	59	88
3	66	89
4	68	90
5	70	87
6	58	83
7	64	87
8	62	89
9	61	88
10	66	84
11	62	86
12	63	87
13	64	88
14	66	86
15	67	84
16	69	88
17	64	88
18	65	89
19	66	90
20	70	89

DOI: 10.9756/INT-JECSE/V14I3.730

Table 3. Group statistics showing the mean, standard deviation and standard error mean values for the two groups considered in the study with 20 samples for each group, namely, pond water and RO water. The confidence interval is kept at 95%. It is observed that pond water is much more unsuitable for consumption than the RO water.

Group Statistics					
	Source of water	**N**	**Mean**	**Standard deviation**	**Std. error mean**
WQI	**Pond water** **RO water**	20 20	64.2500 87.3000	3.95867 1.97617	0.88519 0.44189

Table 4. The results of an independent samples-t-test run on the samples show that there is a significant difference of $p = 0.01$ between the pond water and RO in terms of WQI ($p < 0.05$).

Independent-samples-t-test									
	Levene's Test for Equality of Variances		**t-test for Equality of Means**						
								95% Confidence Interval of the Difference	
	F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
WQI Equal Variances Assumed	6.093	0.01	-23.29	38	<0.001	-23.05000	0.98935	-25.05	-21.04
Equal Variances Not Assumed			-23.29	27.916	<0.001	-23.05000	0.98935	-25.07	-21.02

DOI: 10.9756/INT-JECSE/V14I3.730