AN ECONOMIC ANALYSIS OF PACKAGED DRINKING WATER IN TAMIL NADU WITH SPECIAL REFERENCE TO CHENNAI CITY

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ABSTRACT: *Water is an important resource available for humans and fresh water is much more important given its limited availability and erratic distribution over space and time. Water is a renewable and finite resource available globally to the tune of 200,000 $km^{3.}$ The human population, on the other hand, has been continuously growing, which means that there is less water per head to satisfy the need for living a healthy life. Global water resources may be summarized as 97 per cent, or $1350x10^6km^{3,}$ in ice-caps and glaciers (enough to raise the sea level appreciably if it is melted). The balance of 1 per cent is made up of groundwater ($7x10^6$ km^3), saline and freshwater lakes ($0.26x10^6$ km^3), soil moisture ($0.15x10^6$ km^3), plus negligible amounts in rivers and biological systems.*
Water supply and sanitation is a State subject in India and State/Urban Local Bodies (ULBs) are vested with constitutional right for planning, designing, implementing, operation and maintenance of water and sanitation projects. The Union Ministry provides technical assistance to States/ULBs in project formulation. National Water Policies provide guidelines on priority of allocation, methods of management, resource management and institutional issues, emerging approaches and trends. The National Water Policy, 2002, assigned overriding priority to drinking water in planning and operation of water resources. Hence it is ideal to study the supply of drinking water and water rights of the people in the global scenario, national scenario, state level of Tamil Nadu and particularly the study area of Chennai.

Key Words: *Water, Packaged Drinking Water, Effective Management and Safe Drinking Water.*

Introduction:

Water is an important resource available for humans and fresh water is much more important given its limited availability and erratic distribution over space and time. Water is a renewable and finite resource available globally to the tune of 200,000 $km^{3.}$ The human population, on the other hand, has been continuously growing, which means that there is less water per head to satisfy the need for living a healthy life. Global water resources may be summarized as 97 per cent, or $1350x10^6km^{3,}$ in ice-caps and glaciers (enough to raise the sea level appreciably if it is melted). The balance of 1 per cent is made up of groundwater ($7x10^6$ km^3), saline and freshwater lakes ($0.26x10^6$ km^3), soil moisture ($0.15x10^6$ km^3), plus negligible amounts in rivers and biological systems. Movements of water from one state or location to another occur continuously. Annual evaporation is $516x10^6$ km^3 per year, 86 percent of it from the ocean. Precipitation of this moisture also falls largely on the seas (80 per cent). From these estimates it is clear that only a small proportion of the world's water is likely to be available. From India's point of view, the availability of fresh water per capita has come down from about 5,177 cubic meter per head in 1951 to 1,820 cubic meter per head in 2001 and it is expected to go down further to 1,140 by 2050 AD. The total water availability in India is 2,301 billion cubic meters (bcm), of which surface water accounts for 1,869 billion cubic meters and ground water accounts for 432 billion cubic meters. However, only 690 billion cubic meters of surface water can be utilized through storage structures and ground water can be utilized only to the extent of its annual recharge[1].

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[1] Briscoe. J and Malik R.P.S, "Hand Book of Water Resources in India, Development, Management and Strategies" Oxford University Press, New Delhi, 2007, Pp- 47-67.

2002, assigned overriding priority to drinking water in planning and operation of water resources. Hence it is ideal to study the supply of drinking water and water rights of the people in the global scenario, national scenario, state level of Tamil Nadu and particularly the study area of Chennai.

Water – Chennai Scenario

Chennai (formerly known as Madras) is heavily dependent on rain fed water sources for its drinking water supply. Often there are conflicts, and at times co-ordination with neighboring states, especially with Andhra Pradesh and Karnataka. There were years when Chennai received water from Krishna River (in Andhra Pradesh) through rail tankers to meet at least the partial demand for drinking water supply of the local people. Forced by the ever increasing population and the quest for drinking water, many private companies entered into the business of drinking water provision. Many sources have been identified over the years, there were scandals associated with the supply, there were multiple service providers supported by a party in regime, there were conflicts within the city in terms of distribution, among the states making it one of the unique cities in India along with Delhi, where the source of water itself raises a series of controversies. The Water for Chennai city is supplied by the Chennai Metro Water Supply and Sewerage Board (CMWSSB) through its surface and ground water sources. Water from the higher reservoirs flow into the lower ones, ultimately collected water distributed to the city from the Red hills reservoir which is located near the city. The Chennai Metro Water Supply and Sewerage Board (CMWSSB) formed in 1978 is supposed to supply water to the entire region. But presently it supplies water to the Chennai city and 6 Municipalities in the region. The rest of the region depends on its own surface and ground water reserves and the supply by TWAD Board.

The chosen area for the research is Chennai City. This city is the fourth largest metropolitan and the 5th most populous city in India. The rate of urbanization in this city has been quite fast and the district of Chennai holds the credit of being hundred per cent urbanized. With natural and artificial infrastructure facilities, rapid industrialization, increasing density of population and many financial institutions, Chennai is considered the Detroit of South Asia and has been booming of late. Accordingly, demand for water that is qualitative packaged drinking water is also vibrantly changing. Hence the principal investigator tries to probe into packaged drinking water availability to India's position and further narrowing down to Tamil Nadu ending with the micro study of Chennai City. The study area within Chennai is north, central and south zones which have been selected for the economic analysis of drinking water consumption. Therefore, this study attempts to find out whether the available drinking water from the water board is sufficient and the emergence of packaged drinking water in Chennai City. It tries to throw light on the drinking water shortages, drinking water availability, safety, distribution and packaged drinking water consumption in the study area. For selection of samples, the multi stage stratified random sampling technique has been adopted. Multi stage stratified sampling has been deliberately used in place of popular methods such as multi-stage stratified random sampling technique. The researcher also reviewed article on United States study (Zhihua Hu, Lois Wright Morton and Robert L. Mahler)[2] which dealt with more than 5000 samples in their packaged drinking water study.

Reviews

Srivastava Ajai (2009)[3] stated that ponds and other water bodies have come under pressure in recent years due to a sharp increase in urbanization and encroachment of land. At some places where there were ponds and wells, big residential and commercial complexes have been erected. Garbage is being dumped in other dried up water bodies. Historically important as a source of water for local people, these ponds and water bodies are on the verge of extinction due to diminishing ground water level. He stated that the government and local people have been the main reason for the present state of affairs. He also stated that the solution to Varanasi's water problems is not too difficult or farfetched. It only requires redevelopment and conservation of the water bodies that the city already has, capturing rainfall run-off and directing it to this water bodies and recharging the ground water in this process. This could help bridge the gap between demand and supply of drinking water in the city.

[2] Zhihua Hu, Lois Wright Morton and Robert L. Mahler, "Bottled Water: United States Consumers and Their Perceptions of Water Quality" International Journal of Environmental Research and Public Health, Vol. 8, Pp-565-578

[3] Srivastava Ajai, "Management of Water Bodies for Ground Water Recharging", Yojana, Vol.53, November, 2009, Pp-51 & 52.

Paramasivan and Karthravan (2010)[4] expressed their views that water has become the biggest problem of the 21st century. Global consumption of fresh water increased six fold from 1900 to 1995, at a rate greater than twice the rate of population growth. If the present trend continued, two out of every three people on earth will have to live in water stressed condition by the year 2025. They stated about 25 per cent of the world's population does not have access to safe drinking water, and 40 per cent does not have sufficient water for adequate living and hygiene. More than 2.2 million people die each year from diseases related to contaminated drinking water and poor living conditions, faced with water scarcity. The per capita availability of fresh water in the country has dropped from an acceptable 5,180 cubic meters in 1951 to 1,820 cubic meters in 2001. It will further drop to 1,340 by 2025 and 1,140 cubic meters by 2050. They concluded that the major threats to India's water resources are population explosion, industrial farming, water exploitation by multinational corporations and water privatization.

Priya (2010)[5] explained the arena of rural drinking water in India from the late 1990s has seen a number of changes. The major change in the rural drinking water arena in recent times is the shift from "supply-driven" approach to a "demand-driven" approach. At the central level, the government of India introduced such reforms in rural drinking water in 67 pilot districts covering 26 states in 1999. All countries are constantly focusing to stabilize and sustain their availability of drinking water for the near future.

Objectives and Hypothesis of the Study

To analyze the factors influencing the packaged drinking water in Chennai city. There is no significant relationship between economic determinants and attitude towards the willingness to purchase packaged drinking water.

Methodology

The present study is empirical, based on both primary and secondary sources of data. The framework of the analysis has been constructed from the data collected through primary surveys by interview schedules and field visits in Chennai city. Regarding application of statistical tools, the calculation of averages, percentages, correlation analysis and ARIMA Model can be used.

Analysis

PACKAGED DRINKING WATER

Table.1 Market for Mineral Water in India in the year 2011

Area/Side	Percentage of demand for mineral water
North	25
East	10
West	40
South	25

Source: www.mofpi.nic.in

Table 1 explains the market for mineral water in India in the year 2011. The Western part of the country demands 40 percent of the mineral water in the market. The percent demands of the Northern and Southern parts of India were only 25 percent. The Eastern part of the country demands only a meagre 10 per cent out of the total market. The water sales figures quoted by the South India Packaged Drinking Water Manufacturers Association are stunning. The next table explains the sales and revenue aspects of packaged drinking water in Chennai city.

Table.2 Sales and Revenue aspects of Packaged Drinking Water in Chennai City

Type of packaging	Price per unit	No of units sale per day	Total daily valued of sale (Rs)
250 ml Polythene sachet	Rs.2	5 million	10.0 million
One liter bottle	Rs.10 to 15	75,000	0.75 to 1.125 million
12 litre cans	Rs.20 to 25	100,000	2.0 to 2.5 million
25 liters bubble top containers	Rs.25 to 40	25,000	0.625 to 1.0 million

[4] Paramasivan. G and Karthravan. D, "Effects of Globalization on Water Resources in India", Kurukshetra, Vol. 58, No.10, May 2010, Pp-14-17.

[5] Sangameswaran Priya, "Rural Drinking Water Reforms in Maharashtra: The Role of Neoliberalism" Economic and Political Weekly, Vol.XLV No.4, January 23, 2010, Pp-62-69

Water tankers carrying 10,000 to 12,000 litres	Rs. 600 to 1000*	10,000	6.0 to 10.0 million

Note: * The price variation is due to factors such as water quality, distance transported and season (summer or monsoon months)
Source: South India Packaged Drinking Water Manufacturers Association, 2010.

Table 2 shows the sales and revenue aspects of packaged drinking water quoted by the South India Packaged Drinking Water Manufacturers Association. Every day nearly 5 million units of polythene drinking water sachets, each of 250ml and costing Rs. 2, were sold in the market. From this, 10 million rupees were generated as income. One litre bottles, each costing Rs. 10 to 15, were sold. 75,000 bottles were sold through which 0.75 to 1.125 million rupees were generated as income. 12 litre cans, each for Rs.20 to 25, were sold per day, and 1lakh cans might have been sold. Through this Rs.2.0 to 2.5 million rupees were generated every day. 25 litre bubble top containers were sold for Rs.25 to 40. The everyday sales of 25,000 might have been sold through which Rs.0.625 to Rs.1.0 million incomes could have been generated. Water tankers carrying 10,000 to 12,000 litres were sold, each for Rs. 600 to 1000. Per day sales may have been 10,000 through which Rs. 6.0 to Rs. 10.0 million could have been generated as revenue. This would be enough money for 2.82 million to 3.92 million people to buy 500 grams of rice a day each (at Rs. 10 per kilo of rice) for a whole year (515,000 to 716,000 tons of rice in a year).

There are approximately 180 brands in the unorganized sector which constitute nearly 19% of the total market. Per capita consumption of bottled water in India is very less, approximately half a litre per year, therefore there is a huge potential to exploit this sector for high future growth. The following table explains the demand of mineral water in the past.

Table.3 Demand of Mineral Water in the Past

Year	Million Cases
1990-91	2
1991-92	2.6
1992-93	3.5
1993-94	4.7
1994-95	6.5
1995-96	8.5
1996-97	11.5
1997-98	15.5
1998-99	20
1999-00	26
2000-01	33
2001-02	44.5
2002-03	55.6
2003-04	68.15
2004-05	82
2005-06	97
2006-07	112.85
2007-08	129.55
2008-09	146.8
2009-10	164.45
2014-15	265

Source: www.mofpi.nic.in

The packaged drinking water industry in India is growing at a very rapid pace. Leading players in the market are Parle Bisleri, Parle Agro, Coca Cola, Pepsi, Kothari Beverages, Mohan Meakin, Mysore Breweries, United Breweries, NDOB, Mt.Everest, Golden, Hello, Dadi Group, SM Foods, and Group Denone. The phenomenal increase in demand for bottled water from just 2.0 million cases in 1990-91 to 68.15 million cases in 2003-04 is primarily based on the concern and need for safe drinking water. In the year 2009-10, the demand for mineral water is shown at 164.45 million cases. The predicted value of future demand for mineral water in the year 2014-15 is 265 million cases. Demand for mineral water is high in the southern part of the country. Hence the following table shows the projected rate of water requirements in Chennai in the future.

Table.4 Projected Estimate of Water Requirement (CMA)

Description	2011	2016	2021	2026
Population (in lakhs)	88	100 (88)*	112 (78.57)	126 (69.84)
Water requirement in MLD for the resident population				
Scenario I @ 150 lpcd	1165	1284 (90.73)	1431 (81.41)	1606 (72.54)
Scenario II@120 lpcd	938	1035 (90.6)	1154 (81.28)	1296 (72.38)
Scenario III@100 lpcd	762	838 (90.93)	933 (81.67)	1046 (72.85)

Source: Draft Master Plan –II for CMA, IEA 92nd Annual Conference 27-29, Dec-2009.
Note: * Values in the parenthesis percentage value calculated by the principal investigator.

The table.4 shows the projected estimate of water requirement for Chennai metropolitan area. Population of Chennai city in 2011 was 88 lakhs, in 2016 it is projected to be 100 lakhs, by 2021the population will be 112 lakhs and the projection for 2026 is 126 lakhs. Along with the projected increase in population, the water requirement has also increased for the residents of Chennai. It is shown in the table in Scenario I, Scenario II and Scenario III. The entire three scenarios show water requirement will be at the rate of approximately above 90 percent in 2016 for 88 percent of population, for 2021 the water requirement will be above 81.41 per cent for 78.57 per cent of population, for 2026 it will decrease to 72.54 per cent for 69.84 per cent of population. The overall projection shows, in future, the population as well as water requirement for the residents of Chennai city will decrease. The next section is analyzing the secondary data with statistical model of ARIMA.

An Autoregressive Integrated Moving Average (ARIMA) Process:

The use of ARIMA model is not on constructing single-equation or simultaneous equation models but on analyzing the probabilistic or stochastic properties of economic time series on their own under the philosophy, "let the data speak for themselves". Unlike the regression models in which Y_t is explained by k regressor X_1, X_2, …X_k, the BJ-type time series models allow Y_t to be explained by past or lagged values of Y itself and stochastic error terms. For this reason, ARIMA models are called 'atheoretic'. The researcher emphasis in this study is on univariate ARIMA model (pertaining to a single time series, that is the demand for drinking water in the study area through the decades) though the analysis can be extended to multivariate ARIMA models. To sum up, the mean and variance for a weakly stationary time series are constant and its covariance is time-invariant. But many economic time series are non stationary, that is, they are integrated. If a time series is integrated of order 1 (i.e., it is I (1)), its first differences are I (0), that is, stationary. Similarly, if a time series is I (2), its second difference is I (0). In general, if a time series is I(d), after differencing it "d" times we obtain an I (0) series.

Therefore, if the researcher has to difference a time series "d" times to make it stationary and then apply the ARMA (p, q) model to it, the original time series is ARIMA (p, d, q), that is, it is an auto regressive integrated moving average time series, where p denotes the number of autoregressive terms, d the number of times the series has to be differenced before it becomes stationary, and q the number of moving average terms. Given the values of p, d and q, one can tell what process is being modelled.

Table.5 ARIMA Model- Descriptive Statistics

Fit Statistic	ARIMA (1,2,0)	ARIMA (1,2,1)	ARIMA (1,2,2)	ARIMA (1,2,3)	ARIMA (1,2,4)
	Mean	Mean	Mean	Mean	Mean
Stationary R-squared	.132	.473	.481	.505	.554
R-squared	.455	.669	.674	.689	.719
RMSE	125.003	99.223	100.314	99.888	96.838
MAPE	41.533	30.819	32.143	31.602	29.987
MaxAPE	167.767	138.620	139.241	133.779	138.168
MAE	92.447	68.126	68.868	66.928	65.037

MaxAE	246.456	240.467	239.676	236.473	257.698
Normalized BIC	9.883	9.535	9.670	9.775	9.826

Model	Ljung-Box Q(18)			
	Statistics	DF	Sig.	Number of Outliers
Drinking water supply-Model_1	11.322	16	.789	0

Normalized Bayesian Information Criterion: A general measure of the overall fit of a model that attempts to account for model complexity, it is a score based upon the mean square error and includes a penalty for the number of parameters in the model and the length of the series. The penalty removes the advantage of models with more parameters, making the statistics easy to compare across different models for the same series.

It is seen in the above table that the BIC value is lower for the model ARIMA (1, 2, 1). We can say that the overall best models are ARIMA (1, 2, 1) because BIC value is 9.535 which is lower compared to all other models.

HYPOTHESES TESTING:

Table.6 - Economic Variables

Number of observations = 4000
LR Chi^2 (14) = 3977.23
Probability>Chi^2 = 0.0000
Log likelihood =-771.15813 Pseudo R^2 = 0.7206

Demand for packaged drinking water	Co-efficient	Z	P>IzI	$\delta y/\delta x$
Monthly Income of the respondents	0.0000237	1.69	0.091**	0.00000553
Additional income of the household	0.66363	0.51	0.613	0.0154651
No. of the dependents in the household	-2.505014	-17.05	0.000*	-0.5846298
Total monthly household expenditure of the respondent	-0.0000277	-1.17	0.243	-0.00000647
Has there been an increase in the expenditure on purchase of drinking water alone	-0.0002629	-1.80	0.071**	-0.0000614
Has there been increase in the monthly budget due to purchase of drinking water	-0.3352896	-2.48	0.013*	-0.0785008
Type of residence the respondent lives in(whether owner/tenant)	0.1215246	0.94	0.348	0.0283589
DEMAND FACTORS				
Hygienic & safe packaged drinking water	6.700417	14.71	0.000*	0.71387
Availability of packaged drinking water	9.573599	17.92	0.000*	0.9257523
Affordability of packaged drinking water utility	1.577316	8.17	0.000*	0.366004
SUPPLY FACTORS				
Dissatisfaction in the supply of surface water	1.562991	8.80	0.000*	0.9257523
Dissatisfaction in the supply of metro water	1.571198	7.68	0.000*	0.3590484
Utility level derived from other electrical devices	-10.9921	-20.47	0.000*	-0.9877649
Willingness to pay for water	0.1421563	1.09	0.278	0.0330863
Constant	6.131641	15.24	0.000	

Note: * Statistical significance at 1% level ; ** Statistical significance at 10% level.

H_0: There is no significant relationship between economic determinants and attitude towards the willingness to purchase packaged drinking water.

Result: In table 6, of the various economic variables, number of dependents, the utility level derived from electric devices and an increase in the monthly expenditure due to purchase of packaged drinking water show statistical significance at 1 per cent but with negative coefficients. The significance of these variables with co-efficient moving on the opposite direction portrays the attitude of the people on spending on potable water. However, one set of attitudinal variables are off-set by another set of behavioural variables when it comes to good health, backed by affordability and availability of packaged drinking water with statistical significance at 1 per cent level. Giving further boost is the statistically high significance at 1 percent levels of the supply factors, that is, the dissatisfaction or the reduction in the utility derived from the water supplied through various other sources. Though at 10 per cent significance level, monthly income of the respondents also gives a positive co-efficient, followed by an increase in the monthly expenses incurred on packaged water, which is used for various purposes/reasons (additive utility coming into force), however, with a negative co-efficient. In other words, higher the expenses incurred on the purchase of packaged water, lower is the marginal propensity to expend and vice versa. This is further emphasized by the role of "affordability" factor - more the affordability higher the demand for packaged drinking water and vice versa. When packaged water becomes costlier, it pinches the "real income" of the consumer. The dependent variable is explained by 72 percent by the set of economic variables. This is quite significant for this study. The probability > chi^2 value is highly significant at 1 per cent. Therefore, the null hypothesis stand is rejected and the alternate hypothesis that there is a relationship between the dependent variable and economic variables is accepted.

Conclusion

Water is essential to human health and life. Access to safe water supplies and affordability are central concerns of public health and health of individual consumers. In this study the researcher found that perceptions of ground water quality and local water supply safety are associated with decisions to purchase bottled water vis-à-vis the use of public water systems for drinking water. When local water is not considered safe or of high quality consumers are more likely to use bottled water as a primary water source. Furthermore, negative perceptions of safety increase the likelihood of consumers frequently purchasing bottled water regardless of whether their primary source of drinking water is a small water system or large municipal water supply system.

Two key implications of this research findings are that (1) public health officials and community leaders need to work to assure that public municipal drinking water supplies are safe; in addition, they should find effective ways to communicate to local residents the safety of their water supply; and (2) environmental leaders and activists need to campaign about the long lasting impacts of plastic water bottles. Further the public must be engaged in understanding the relationship of water quality to the capacity of local water systems to maintain safety and good taste standards. Consumer distrust of their groundwater quality should be leveraged to create community action to address legitimate concerns.

References

1. Khurana Indira and SenRomit, "Drinking water quality in rural India: Issues and approaches" Background Paper, 2003.
2. Sridharan. N "Institutional and Consumer Contestations over Water: Case of Chennai Metro Area", 12th EADI General Conference Global Governance for Sustainable Development the need for policy coherence and new partnerships, Geneva 24-28 June 2008, Pp-1-26.
3. TikuSeid, LegesseWorku, EndaleHailu and FarisKebede (2003), "Factors affecting Drinking Water Quality from source to home in Tehuledereworeda, Northeast Ethiopia", Ethiop Journal of Health Science, Vol. No. 13(2); Pp 95-106.
4. Srivastava Ajai, "Management of Water Bodies for Ground Water Recharging", Yojana, Vol.53, November, 2009, Pp-51 & 52.
5. Paramasivan. G and Karthravan. D, "Effects of Globalization on Water Resources in India", Kurukshetra, Vol. 58, No.10, May 2010, Pp-14-17.
6. Kumar Sanjay, "Ground Water Information System", Kurukshetra, Vol.58, No.10, May 2010, Pp-32, 33.
7. Iyer. R. Ramaswamy, "National Water Policy: An Alternative Draft for Consideration", Economic and Political weekly supplement, Vol. XLVI, Nos 26&27, June 25, 2011, Pp-201-214.
8. Saxena and Mishra "Water Scarcity – The Biggest Crisis of All, 2010, Pp-1267-1280.

9. Shankar P.S. Vijay et.al,"India's Groundwater Challenge and the Way Forward", Economic and Political Weekly, Vol.XLVI, No.2, January, 2011, Pp-37-45.
10. Misra Smita and Goldar Bishwanath, "Likely impact of Reforming Water Supply and Sewerage Services in Delhi", Economic and Political Weekly, October 11, 2008, Pp-57-66
11. Nanoti Madan and Vaidya Shweta, "Present and Futuristic Assessment of Water Quality Standards in India", Safe Water for Community Health" The National Academy of Sciences, Allahabad, 2009, Pp 76-84.
12. Kamatchiammal. S, et.al, "Surveillance of Water Quality in Chennai" Safe Water for Community Health" The National Academy of Sciences, Allahabad, 2009, Pp-151-158.
13. Ntengwe, F.W. "The impact of consumer awareness of water sector issues on willingness to pay and cost recovery in Zambia", Physics and Chemistry of the Earth, Vol. No. 29 (15-18), Pp 1301-1308.
14. Cho, Y., Easter, K.W., McCann, L.M.J., Homans, F. "Are rural residents willing to pay enough to improve drinking water quality? Journal of the American Water Resources Association, Vol. 41 (3), 2005, Pp-729-740.