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Comparing Health Risks Arising from Insufficient Sanitation in Rural, Peri-Urban and Urban Regions of Vijayawada City, Andhra Pradesh.

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KEYWORDS

sanitation, economics cost of sanitation, cost-benefit analysis, India

ABSTRACT:

Sanitation is a significant study across all the countries in the world. The COVID-19 pandemic clearly explains the importance of sanitation in human life. Around 23 lakhs of people globally do not have basic sanitation facilities. India accounts for 25 percent of people lacking basic sanitation facilities. The present study focused on finding and comparing the economic cost of sanitation in the rural, peri-urban and urban areas of Vijayawada city with the help of the economic regression method using 12 variables and a total 600 sample population. The study has found high variation in health risks. The three regression models were analyzed to understand variable relationships. The rural (Model 1) had a moderate correlation and explanatory power, with a significant predictor. The peri-urban (Model 2) exhibited high correlation, substantial explanatory power, exceptional overall statistical significance and a significant predictor. The Urban (Model 3), with a strong correlation and good explanatory power, balanced simplicity and strength, features a considerable predictor and moderate overall statistical significance.

1. INTRODUCTION

Sanitation is a very sensitive study across all the countries in the world. The COVID-19 pandemic clearly explains importance of sanitation in the human life. Currently, the most popular buzzword is sanitation problems in developed and developing countries. For safeguarding vulnerable sections of the world, the most addressable problem is inadequate sanitation that including poor drinking water, inadequate health facilities, inappropriate drainage systems and low-quality hygiene. Poor sanitation facilities create many socio-economic development problems across all the countries including India and Andhra Pradesh (Snehalatha and Anitha, 2012). Hence, sanitation is a fundamental right for humans. It will improve human health, dignity, clean environment and healthy population. Low sanitation facilities in our daily life's are clutched with diseases and create havoc (Khan et al., 2017). Around 23 lakhs of people globally do not have basic sanitation facilities, 892 million people do open defecation, In its India accounts for 25 percent of people lacking basic sanitation facilities, 2.3 billion people and 45 percent of people practicing open defecation among 892 million people (World Health Organization and JMP, 2017). The diarrheal caused by poor water, sanitation and hygiene (WASH) accounts for 8, 41,000 deaths per year worldwide, of which 3, 35,000 were in India and 44 percent (Prüss et al., 2014). The inadequate sanitation costs in India were estimated to equal $ 54 billion or 6.4 % of GDP in 2006 (The World Bank, 2011).

Cleanliness and good sanitation in schools is a matter of high importance. All schools in the country should have separate toilets for girls said by Narendra Modi. Sanitation is the more humblest of the civic virtues and it is easy to underestimate its significance by Ram Nath Kovind. Poor sanitation has discouraged the development of tourism in our country by Hulton. In

Journal of Chemical Health Risks

www.jchr.org

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June 2012, the Minister of Rural Development stated that India is the world's most giant open-air toilet by Jairam Ramesh. I think toilets are more important than temples. It is also remarked that Pakistan, Bangladesh and Afghanistan have better sanitation records than India (Pathak, 2015). Many eminent Indian scholars quoted about sanitation, namely Mahatma Gandhi, who stated that sanitation is more important than independence. His dream was total sanitation for all. Sanitation and cleanness are the most important for physical well-being and healthy environment. Pranab Mukherjee said sanitation is more important than political independence and A. P. J. Abdul Kalam said, "Sanitation is a Noble 2 Mission for the Nation" (Speech-2006, Vigyan Bhawan, Delhi). All these quotes show the importance of sanitation for the economic development.

By definition. "Sanitation system perform the following: collect and isolate human waste, it safely transmit this waste and then treat it before reusing it or letting it out in the environment" (Carr and Strauss, 2001). There have been no drastic changes in the situation even after more than 75 years of achieving freedom. The study by WHO calculated that in 200l, for every US $ 1 invested in sanitation gets a return of US $ 5.50 by lowering the cost of maintaining health productivity and reducing premature deaths (Hutton et al., 2012). The Census data 2011 states that 49.8 percent of the total population in India defecates in the open (Nath and Sengupta, 2016). Many research studies also concluded that poor sanitation causes diarrhea, trachoma, schistosomiasis, stunting, environmental enteropathy, soil-transmitted helminth infection, less nutritional status and low cognitive development (Prüss et al., 2014).

Indian Prime Minister Narendra Modi launched the SBM – Clean India Mission (Swachh Bharat Mission) on October 2, 2014. The main objective of this program is toilets for all, including rural and urban areas. It includes complete school toilet coverage, improved public toilet conditions, removed legacy waste, improved visual cleanliness and open defecation free (ODF) by October 2019. Before SBM launched the Total Sanitation Campaign and Nirmal Bharat Abhiyan left the 59 percent of rural and 12 percent of urban people did not have proper toilets. The SBM has improved sanitation conditions in India. Particularly quantified are reuse value, impact on water and tourism values. Few are not quantified and some diseases could not be assessed due to lack of India-wide data, such as Hepatitis A, Hepatitis E and soil-transmitted helminths. These all are noted and observed in a few studies by the Government of India reports (Hutton et al., 2020). The implantation of Clean India has crossed a few milestones, but now the SBM's primary focus is maximizing sanitation facilities and reducing the sanitation disparities between rural and urban areas (The Union Budget of India 2022-23 and Chakraborty, 2022).

The Andhra Pradesh state government has introduced many steps to improve sanitation conditions in rural and urban areas. The Panchayat Raj institutions have significantly strengthened rural sanitation and The Municipalities also helped urban sanitation (Reddy et al., 2010). The Andhra Pradesh government has also given importance to sanitation development by initiating and implementing many schemes. However, the cause of concern is that certain districts in the state are still lagging in achieving the desired results. Some of the cities in Andhra Pradesh namely Tirupathi, Nellore, Vijayawada and Visakhapatnam have pathetic sanitation conditions.

2. OBJECTIVES OF THE STUDY

- To find out the economic cost of sanitation in the rural, peri-urban and urban areas of Vijayawada city
- To compare the economic cost of sanitation between areas in Vijayawada city.

3. LITERATURE REVIEW

The literature review is the most important step for research. The present study has reviewed the relevant literature before undertaking the research study. This study has gone through a comprehensive series of documents, reports and journals available on the internet and in libraries to develop a deeper into the subject and search for related studies and references. The database was searched with paired keywords like sanitation, health, the economic cost of sanitation, and the economic impact of WASH. The topic investigated here is at the intersection of several areas. The three main core areas of the study are

- Urban, peri-urban and rural sanitation

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- Water and health sanitation facilities
- Time and money loss.

The literature search favored any documents linked to the study's research problem. Literature was collected from both offline and online sources.

The online sources of seven metabases were used mainly to collect the first set of documentation: Science Direct, JSTOR, Pubmed, Sagepub, Springer, Elsevier, and EPW. Complementary searches were also done through Google Scholar. The keywords used in combinations in the cited metabases were urban, poverty, slum, water, sanitation, women, location, distance, time, economic loss, health, availability, accessibility and resettlement colony. The offline sources of books and journals were mainly collected from the University Department Library, Acharya Nagarjuna University, Guntur. The complementary offline searches were also done through other institutional libraries like the University of Hyderabad, The Centre for Economic and Social Studies (CESS), the Andhra University, the Andhra Loyola College, The Madras School of Economics, and The Tata Institute of Social Sciences. The review focuses only on the central core: urban slums, health, economic loss, water, sanitation, time and space, as literature on other areas of interest is scarce. It was then necessary to go beyond the central topic and explore the three keywords above. The interconnection between the issues reviewed sets of literature or information is represented below.

3. RESEARCH METHODOLOGY

The traditional method of evaluating the economic impact of human disease occurrences has typically concentrated on specific direct costs related to healthcare, along with limited indirect losses like missed wages and informal health expenses such as patient transportation. Health metrics, including the number of deaths or Disability-Adjusted Life Years, can effectively measure the burdens imposed by diseases. The economic consequences of disease events, both direct and indirect, are shaped by factors such as awareness and prevention practices that reduce risks, as well as the aftermath of losses, such as prolonged unemployment, permanent closure of markets or farms, persistent stigmas linked to specific animal products, and the effects of lost childhood education or parental support

In this study Cost of illness approach is followed for accessing economic impact. The cost-of-illness approach (COI) recapitulates the economic burden of disease by adding up all direct and indirect costs caused by the disease over a specified period. The direct costs include personal treatment costs (e.g., inpatient and outpatient treatment) and nonmedical care costs (e.g., transportation and others). The indirect costs include the loss of income of individuals afflicted with the disease and the cost of care providing,

4. SAMPLE POPULATION

The provided table bewllo outlines the proposed sample population distribution across different urban, peri-urban and rural areas, along with scores for four criteria labeled A1, A2, B1, and B2. Each area is assigned an equal score of 50 for each criterion, resulting in a consistent total of 200 for every category. The cumulative scores across the criteria and areas are then calculated, presenting an overall total of 600 for the proposed sample population. The bellow table likely serves as a structured framework for allocating and assessing sample sizes within distinct geographic regions, ensuring uniformity and balance in the representation of the population across the specified criteria..

Table 1: Sample Population Distribution

AREAS	A1	A2	B1	B2	TOTAL
URBAN	50	50	50	50	200
PERI-URBAN	50	50	50	50	200
RURAL	50	50	50	50	200
TOTAL	150	150	150	150	600

Journal of Chemical Health Risks

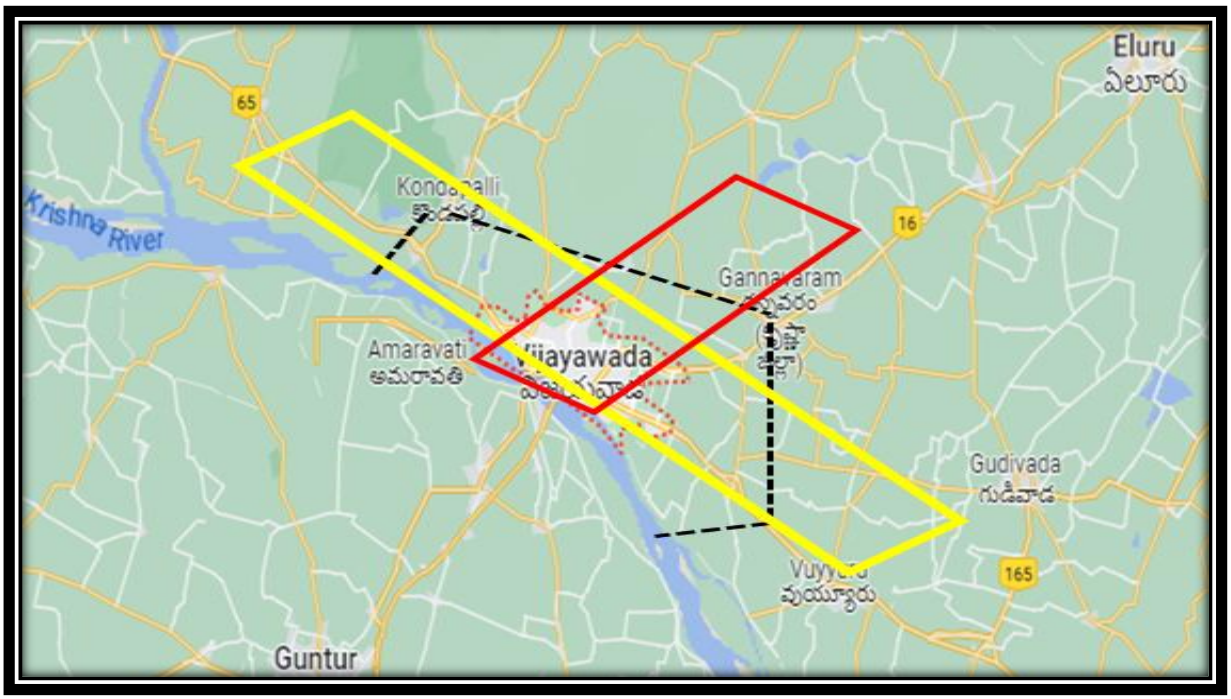
www.jchr.org

JCHR (2023) 13(6), 2892-2900 | ISSN:2251-6727

5. THE STUDY AREA

The bellow maps shows the rural, peri-urban and urban classification. Yellow Box -> A Transact, Red Box -> B Transact, Green Dot Line-> Urban Ring Road, Black Dot Line -> Peri Urban Area Limits provided this information by the Vijayawada Municipal Corporation.

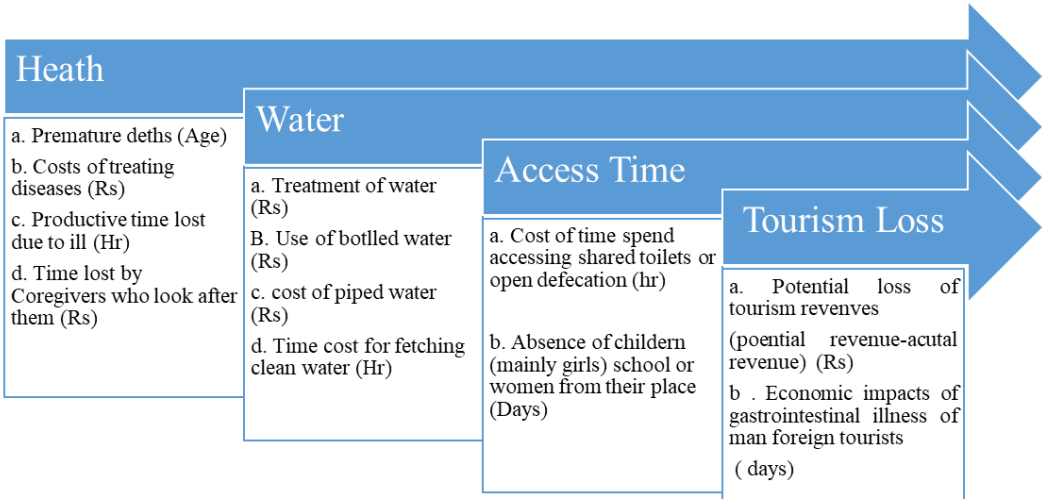
The Vijayawada City Area Identification Boundaries



Source: Vijayawada Municipal Corporation

6. ECONOMIC COST OF SANITATION VARIABLE

The evaluation of economic cost of sanitation includes following variables form Health, Water, Access Time, Tourism



Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 2892-2900 | ISSN:2251-6727

7. DATA ANALYSIS

The data analysis was done with the help of economic regression analysis with the following average data collected variable information.

Table 2 - Economic Cost of Sanitation Rural Regression Analysis (Model 1)

Regression Statistics	
Multiple R	0.8201936
R Square	0.6727175
Adjusted R Square	0.6399893
Standard Error	3401.7733
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	237859642	237859642	20.554647	0.001085
Residual	10	115720615	11572062		
Total	11	353580258			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1105.3865	1208.2479	0.9148673	0.381792	-1586.76	3797.531	-1586.76	3797.531
X Variable 1	2.6691777	0.5887386	4.5337233	0.0010851	1.357386	3.980969	1.357386	3.980969

The regression analysis provides valuable insights into the relationship between the variables under consideration. The multiple R value of 0.82 indicates a strong positive correlation between the independent and dependent variables, suggesting a robust connection. The R Square value of 0.67 signifies that approximately 67% of the variability in the dependent variable is explained by the independent variable included in the model. This reflects a substantial level of predictability, demonstrating the model's ability to capture and account for a significant portion of the observed variability.

The Adjusted R Square, at 0.64, adjusts the R Square for the number of predictors in the model, providing a slightly more conservative estimate of the model's goodness of fit. The standard error of 3401.77 represents the average distance between the observed values and the values predicted by the model, giving an indication of the accuracy of the model's predictions.

The ANOVA table further supports the overall effectiveness of the regression model. The F-statistic of 20.55, with a low p-value of 0.0011, indicates that the regression model is statistically significant. This implies that the variation in the dependent variable is not likely due to random chance, reinforcing the reliability of the model.

The Examining the coefficients, the intercept's p-value of 0.38 suggests that it is not statistically significant, implying that when the independent variable is zero, the expected value of the dependent variable is not significantly different from zero. On the other hand, X Variable 1 demonstrates statistical significance, with a coefficient of 2.67 and a low p-value of 0.0011. This suggests that the change in X Variable 1 is associated with a significant and positive change in the dependent variable, making it a key predictor in the model. The confidence intervals

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 2892-2900 | ISSN:2251-6727

provide a range within which we can reasonably expect the true values of the coefficients to lie.

In summary, the regression analysis suggests that the model is a valuable tool for understanding and predicting the dependent variable. The strong correlation, significant F-statistic and individual coefficients contribute to the overall reliability and interpretability of the model.

Table 3 - Economic Cost of Sanitation Peri-Urban Regression Analysis (Model 2)

Regression Statistics	
Multiple R	0.942465
R Square	0.888241
Adjusted R Square	0.877065
Standard Error	1987.859
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	314064408.8	314064408.8	79.47809	4.50602E-06
Residual	10	39515848.88	3951584.888		
Total	11	353580257.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-88.753	755.8403197	-0.117422901	0.90885	-1772.870146	1595.364	-1772.87	1595.364
X Variable 1	2.790109	0.312966219	8.915048364	4.51E-06	2.092776787	3.487441	2.092777	3.487441

The regression statistics provided reveal valuable insights into the relationship between the variables in question. The multiple R value of 0.94 indicates a very high positive correlation between the independent and dependent variables, suggesting a strong and robust connection. The R Square value of 0.89 is particularly noteworthy, indicating that a substantial 89% of the variability in the dependent variable is explained by the independent variable included in the model. This high R Square value suggests a powerful explanatory capability, demonstrating the effectiveness of the model in capturing and accounting for the observed variability.

The Adjusted R Square, at 0.88, adjusts the R Square for the number of predictors in the model, providing a slightly more conservative estimate of the model's goodness of fit. The standard error of 1987.86 represents the average distance between the observed values and the values predicted by the model, indicating a relatively low level of error in the predictions.

Journal of Chemical Health Risks
www.jchr.org
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Moving on to the ANOVA table, the high F-statistic of 79.48 with an extremely low p-value of 4.51e-06 reinforces the statistical significance of the regression model. This suggests that the observed relationship between the variables is highly unlikely to be a result of random chance, emphasizing the reliability and robustness of the model.

Analyzing the coefficients, the intercept's p-value of 0.91 indicates that it is not statistically significant, suggesting that when the independent variable is zero, the expected value of the dependent variable is not significantly different from zero. In contrast, X Variable 1 demonstrates strong statistical significance, with a coefficient of 2.79 and a very low p-value of 4.51e-06. This implies that a unit increase in X Variable 1 is associated with a substantial and positive change in the dependent variable.

In summary, the regression analysis indicates a highly effective model with a strong correlation and a remarkable explanatory power. The significant F-statistic and individual coefficients contribute to the overall reliability and interpretability of the model, emphasizing its ability to capture and explain the observed variations in the dependent variable.

Table 4 - Economic Cost of Sanitation Urban Regression Analysis (Model 3)

Regression Statistics	
Multiple R	0.884994
R Square	0.783215
Adjusted R Square	0.761537
Standard Error	2768.589
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	276929431.7	276929431.7	36.1287	0.00013
Residual	10	76650825.93	7665082.593		
Total	11	353580257.7			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1508.761	924.0746857	1.632726363	0.133576	-550.206	3567.728	-550.206	3567.728
X Variable 1	1.823064	0.303302318	6.010715022	0.00013	1.147264	2.498863	1.147264	2.498863

The presented regression statistics provide valuable insights into the relationship between the variables in question. The multiple R value of 0.88 indicates a strong positive correlation between the independent and dependent variables, signifying a robust connection. The R Square value of 0.78 is noteworthy, revealing that approximately 78% of the variability in the dependent variable is explained by the independent variable included in the model. This suggests a substantial level of predictability, showcasing the model's effectiveness in capturing and accounting for the observed variability.

The Adjusted R Square, standing at 0.76, adjusts the R Square for the number of predictors in the model. This adjustment provides a slightly more conservative estimate of the model's goodness of fit, considering the complexity introduced by the predictors. The standard error of 2768.59 represents the average distance between observed and predicted values, indicating a moderate level of error in the predictions.

Moving on to the ANOVA table, the model's

Journal of Chemical Health Risks

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JCHR (2023) 13(6), 2892-2900 | ISSN:2251-6727

overall statistical significance is supported by the F-statistic of 36.13, coupled with an impressively low p-value of 0.00013. This suggests that the observed relationship between the variables is highly unlikely to be a result of random chance, underlining the reliability and strength of the model.

Analyzing the coefficients, the intercept's p-value of 0.13 indicates that it is not statistically significant, implying that its impact on the dependent variable is not decisively different from zero. However, X Variable 1 stands out with a significant coefficient of 1.82 and a very low p-value of 0.00013. This implies that a one-unit increase in X Variable 1 is associated with a substantial and positive change in the dependent variable.

In summary, the regression analysis suggests an effective model with a strong correlation and a notable explanatory power. The significant F-statistic and individual coefficients, particularly for X Variable 1, contribute to the overall reliability and interpretability of the model, indicating its ability to capture and explain the observed variations in the dependent variable.

8. CONCLUSION

In summary, three regression models were analyzed, each providing insights into the relationship between variables. Model 1: Moderate correlation (Multiple R = 0.82) and explanatory power (R Square = 0.67), with a significant predictor (X Variable 1) but a less pronounced overall statistical significance. Model 2: High correlation (Multiple R = 0.94) and substantial explanatory power (R Square = 0.89). This model demonstrates exceptional overall statistical significance, supported by a low p-value and a significant predictor (X Variable 1). Model 3: Strong correlation (Multiple R = 0.88) and good explanatory power (R Square = 0.78). It strikes a balance between simplicity and explanatory strength, with a significant predictor (X Variable 1) and moderate overall statistical significance. The above one clearly explained the variations in the economic cost of sanitation rural to urban areas in Vijayawada city.

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