International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 5 May 2023, pp: 644-651 www.ijaem.net ISSN: 2395-5252

Performance Risk Assessment of Water Supply Sector of Urban Local Bodies of Gujarat

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Date of Submission: 08-05-2023 Date of Acceptance: 20-05-2023

ABSTRACT: One of India's major industrialised states is Gujarat, which is situated in the country's western region. Nagar Palikas and Maha Nagar Palikas supply water and sanitation services to the urban areas of Gujarat. In this context, evaluating the performance of the public services offered by the respective Nagar Palikas of the state is essential for raising the level of service that is offered. Water quality as well as quantity should be taken into consideration in order to suit human demands. Rapid development, industrialisation, mixed agriculture, and climate change are all threatening urban water use. Evaluation of current water activities is necessary for urban water management. Because everyone involved in the water business ultimately wants a good water infrastructure, benchmarking can be a valuable procedure. The effectiveness of ULB should be evaluated compared to other similar organisations, rather than in absolute terms. The aim of this study is to carry out first of its kind assessment of performance risk of 156 urban local bodies providing services in water sector in Gujarat. The study shall be helpful to identify and rectify the vital performance parameters for water sector and would help to frame citizen-centric policies and build sustainable cities.

KEYWORDS: Urban Local bodies, water supply sector, Performance Risk Assessment, Performance Indicators (PIs), service level benchmarks, Hazard, Survival analysis, Gujarat, Cox regression

I. INTRODUCTION

Local infrastructure plays a vital role in the overall development of an urban area. Many cities in the developing world do not cater satisfactory services to its citizens rendering reduction in productivity of these urban areas. The citizens are forced to lead a sub-standard life and are made to cope up with the inferior services offered by Urban Local Bodies (ULBs) than to contribute towards national development. The ULBs also known as Nagar Palikas/ Municipalities on one hand collect handsome taxes against the services offered by them, on the other fails in meeting the expectations of its residents.

The ULBs are entrusted to cater services as water supply, sanitation, sewerage, solid waste disposal and street lighting to its citizens. With a view to reinforce the functioning and offer greater autonomy to ULBs the 74th Amendment Act, 1992 was introduced into the Article 280 of the Constitution of India. Despite these, the rapid urbanization has spurt deficiencies in urban infrastructure and has also made the existing problems of housing needs, water supply, sanitation, sewage, solid waste disposal and urban transport even worst. Many researchers have attempted to understand the reason as to why the ULBs are not so strong in catering effective services to its citizens.

The ultimate mandate of any government is to provide to its citizens public goods and services so very essential to lead a happy life. The topic of efficient management of government has been always remained of high interest among researchers and the policymakers.

Assessing the performance of ULBs is vital in improving its functionality & would prove highly valuable as knowledge-exchange platform and in achievement of higher efficiency and effectiveness in delivery of public services [1].

Numerous researchers especially in advanced countries have evaluated the performance of ULBs for instance, in Norway by Kalseth & Rattso (1995), in Belgium by De Borger & Kerstens (1996), in United States by Grossman et al. (1999), in Australia by Worthington (2000),in Brazil by Sampaio & Stosic (2005), in Finland by Loikkanen & Susiluoto (2005),in Portugal by

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Afonso & Fernandes (2008), in United Kingdom by Revelli (2010), In Germany by Kalb (2010) and Geys et al. (2010), in Greece by Doumpos & Cohen (2014),), in Spain by Balaguer et al. (2015) & Perez-Lopez et al. (2015), in Italy by Lo Storto (2016) [2].

Vilanova et al., 2015 in their study upon reviewing many research articles on performance measurements and indicators for ULBs had applied knowledge in contextualizing the wide-ranging aspects for water sector as the authors believed that performance assessment is vital in improving the quality of service catered by ULBs and needs to be attuned to stakeholders' & technical actors' needs and capabilities [3].

In Indian context, Bajpai, 2016 [4] has identified many vital bottlenecks in efficient functioning of ULBs like absence of income sources, undue controlling in discharging mandatory functions, sub-optimal administrative systems, poor relations among elected representatives and government officials, unsatisfactory service levels etc.

In order to satisfy basic human needs not only the quantity of water but also the quality of water shall have to be given due weightage. Due to rapid urbanization, industrialization, hybrid agricultural activities & ill-effects of climate change the urban water is under threat [5]. Maintenance of urban water sector calls for assessment of the current performance of the water sector [6]. In the water service sector, effective performance comparisons can boost the effectiveness of the system as at the end of the day, all stakeholders look for a well-developed water sector. ULBs performance cannot be evaluated in absolute terms it has to be evaluated relatively [7].

The aim of this study is to carry out first of its kind assessment of performance risk of 156 urban local bodies providing services in water sector in Gujarat. The study shall be helpful to identify and rectify the vital performance parameters for water sector and would help to frame citizen-centric policies and build sustainable cities.

II. STUDY AREA

Gujarat, well-known as 'The Land of the Legends', is bordered to the north and east by Pakistan and Rajasthan, to the east by Madhya Pradesh, and to the south by Maharashtra and the Union territories of Diu, Daman, Dadra, and Nagar Haveli. Both to the west and the south-west, the state is bordered by the Arabian Sea. Table 1 shows the demography of Gujarat and Figure 1 shows various ULBs of Gujarat.

Table 1 Demography of Gujarat

Total Population in 2011(in million)	60.4
Total Urban Population in 2011(in million)	25.7
Percent urban to total state population	42.6
Rate of growth of urban population (2001-2011)	5.24
Percent of urban population below poverty line (2009)	16.75 Percent
Number of Urban Municipal Centres	164
Municipal Corporations	8
Class-A (with population 100,000 to 500,000)	18
Class-B (with population 50,001 to 100,000)	32
Class-C (with population 25,001 to 50,000)	44
Class-D (with population <25000)	63

(Source: Census of India 2011 and Dept of Urban Dev. & Housing, Gujarat 2011)

The Narmada Canal based raw and treated water is the major source of water supply in Gujarat. This constitutes 46 percent of total water used by cities and towns. Surface water (33 percent) and Ground water (21 percent) are the other sources of water used by rural and urban agglomerations. According to Census 2011, as compared to national average of 71 percent, 86 percent of the Gujarati households were using tap water.

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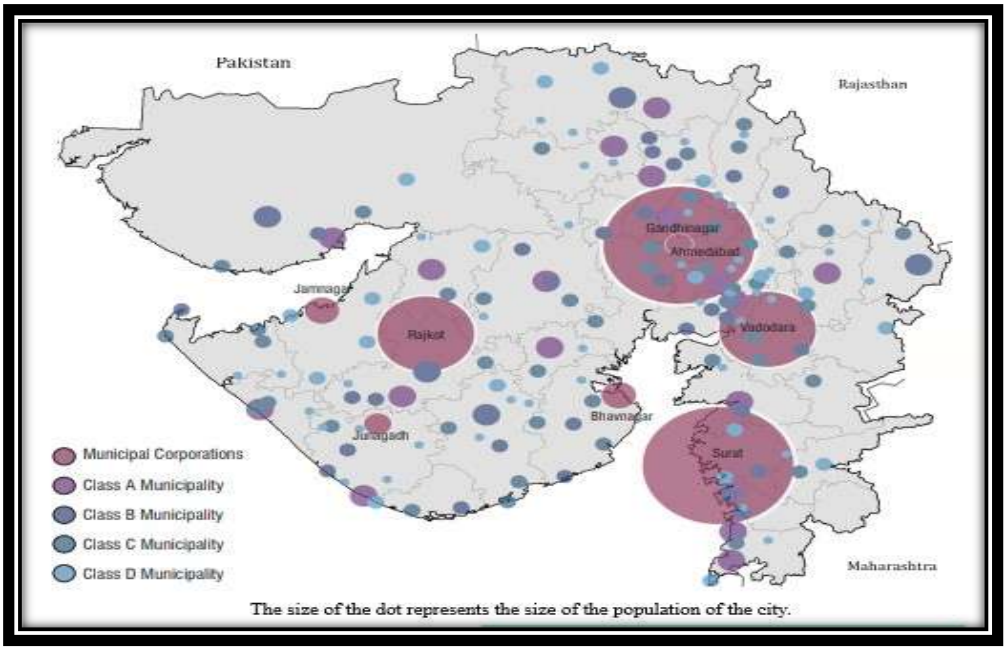

(Source: Modified from www.pas.org.in)

Figure 1classification of cities

The overview of water sector in various cities of Gujarat is shown in Table 2.

Table 2 Overview of Water Sector in Gujarat

Class of City	Coverage of Water Connections by Class of City (%)	Coverage of Water Connections by Divisions (%)	Liters Per Capita supply (lpcd)	Non-Revenue Water (%)	Coverage of Water Connections by Class of City (%)	Coverage of Water Connections by Divisions (%)	Liters Per Capita supply (lpcd)	Non-Revenue Water (%)
	2010				2019			
Municipal Corporations	87	89	117	21	96	94	146	29
Class A	63	72	79	19	72	77	105	28
Class B	72	78	83	20	78	83	101	24
Class C	68	65	73	20	77	80	93	35
Class D	68	82	73	20	83	93	111	35
State	79	69	102	24	89	89	130	27

III.DATA COLLECTION AND METHODOLOGY

This study used and analyzed the information available on Performance Assessment System (PAS) which was setup by the CEPT university (funded by the Bill and Melinda Gates Foundation) that was entrusted to monitor urban services in India. It has annual information of water sector in all urban areas of Gujarat from 2008. We assessed urban water sector in 156 Nagar palikas of Class A, Class B, Class C & Class D. The performance parameters selected for the study (Table 2) is drawn from the Government of India's 'Service Level Benchmarks (SLB) for urban water supply sector. The data collected from various ULBs were scaled on reliability. Data collected through fully automated systems for data management was assigned reliability scale 'A' and reliability scale of 'D' was assigned to data that was drawn from no records. Weighted scales of such data were used to draw values of respective parameters.

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A. Pareto analysis:

Pareto analysis is a technique used to identify and prioritize the most important factors or issues contributing to a problem or situation. Pareto analysis techniques were applied to the data of each NP to find the most significant PI of the system. From the Pareto analysis the vital parameters and trival parameters from the all performance indicators are identified. The PIs considered for the present study is presented at Table 3.

Table 3: Performance Indicators and Its Notations

SR NO.	PIs	NOTATIONS
1	**Efficiency In Redressal Of Customers' Complain**	ECC
2	**Quality Of Water Supply**	QWS
3	**Per Capita Availability Of Water**	PCA
4	**Continuity Of Water Supply**	CWS
5	**Coverage Of Water Supply Connections**	COWSC
6	**Coverage Of Water Supply Connections In Slums**	COWSS
7	**Efficiency In Collection Of Water Supply Related Charges**	ECWSC
8	**Extent Of Non Revenue Water**	ENRW
9	**Cost Recovery In Water Supply Services**	CRWS
10	**Extent Of Metering Of Water Connections**	EMWC

The sample Pareto chart for Morbi (class-A),Bardoli (class-B),Sanand (class-C),Chotila (class-D) Nagar Palikas are presented at Fig. 2 Similar charts for rest 152 NPs were also prepared and resulting vital PIs were found out.

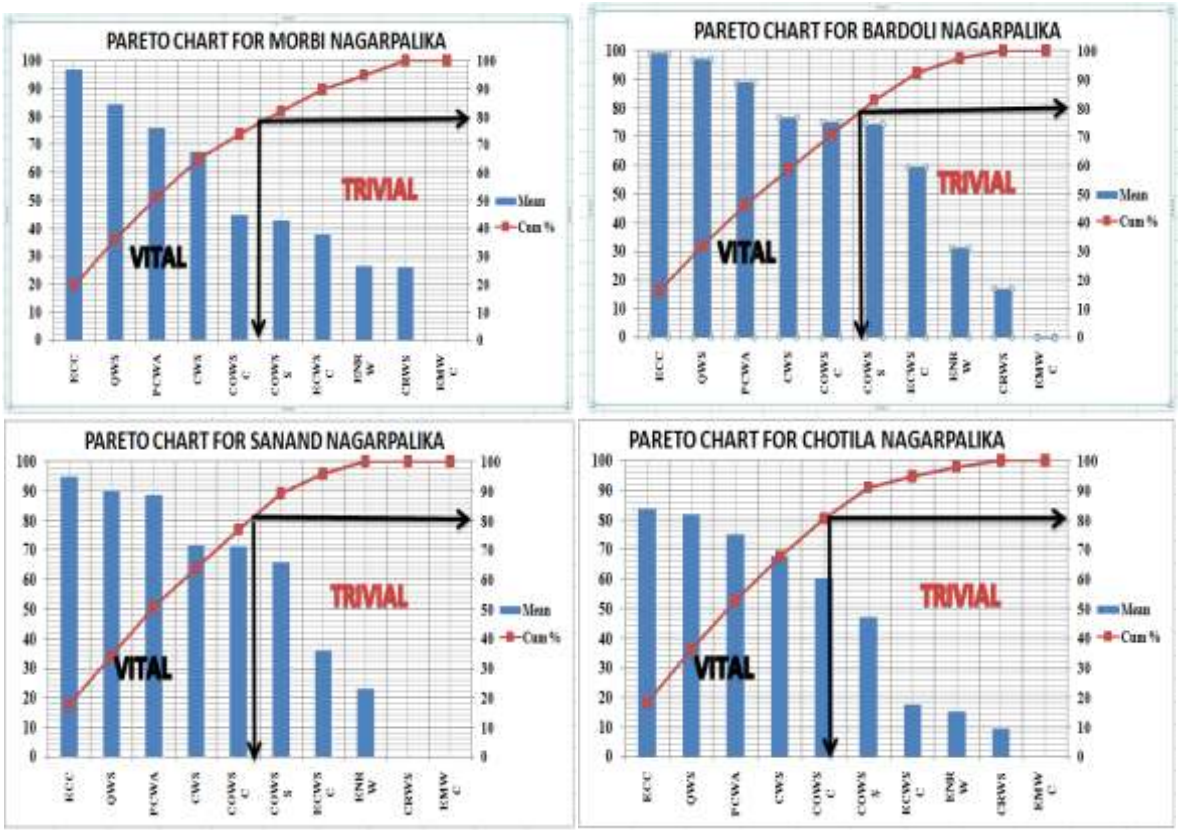

Figure 2: Pareto Charts

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After, finding the vital parameters of all NPs of Gujarat weighted analysis of the vital parameters was calculate. For the various NPs weighted analysis given below. The performance indicators and Rank of all the NPs are presented at Table no. 4.

Table 4 : Rank of PIs of all NPs

PIs	Class-A	Class-B	Class-C	Class-D
ECC	1	1	1	1
QWS	2	2	2	2
PCA	4	5	5	4
CWS	5	-	-	5
COWSC	3	3	3	3
COWSS	-	4	4	-

B. Performance score:

The PI and Rank of all the NPs are presented in Table 4. Subsequently, calculations for the performance score for hazard analysis were done. For finding the performance score the following formula was used.

Performances score = ((W1*V1) + (W2*V2) + (W3*V3) + (W4*V4) + (W5*V5))…(Eq.1)

Where,

W1: weight of first rank V1: value of the first rank PIs

W2: weight of second rank V2: value of the second rank PIs

W3: weight of third rank V3: value of the third rank PIs

W4: weight of forth rank V4: value of the forth rank PIs

W5: weight of fifth rank V5: value of the fifth rank PIs

IV.RESULTS AND DISCUSSION

After finding the performance scores for all NPs the hazard analysis of the data were calculated. In this study uses a Cox regressions model for survival and hazard analysis. Cox regressions generates a survival function that tells you probability of an event happens at a particular time t. Cox model can be viewed as a relationship between independent variables and variables, i.e. survival time from hazards. Survival analysis is a statistical method used for the data analysis where the output variable is, the time from the corresponding observed variable to the occurrence of an event. The results of the analysis indicate the following:

The survival analysis in SPSS is performed using the Cox proportional hazards model. Here is the general formula for the Cox proportional hazards model:

h(t)=h0(t)*exp(B1X1+B2X2+...+Bn*Xn)….eq(2)

Where:

- h(t) is the hazard rate at time t
- h0(t) is the baseline hazard rate
- B1, B2, ..., Bn are the regression coefficients for the predictor variables X1, X2, ..., Xn
- exp() is the exponential function.

CASS OF NP= CLASS OF NP *exp (ECC*X1+CWC*X2+COS*X3)……eq(3)

1. The change from previous step and change from previous block both report the effect of adding Class of NP to the model selected in Block 1. Since the significance value of the change is less than 0.05, you can be confident that Class of NP contributes to the model.

2. The final model includes Coverage of Water Supply (CWC), Continuity of Water Supply (COS), Efficiency in Redressal of Customers' Complain (ECC) & Class of Nagar Palika.

Table 5: Case Processing Summary

		N	Percent
Cases available in analysis	Event[a]	314	40.3%
	Censored	466	59.7%
	Total	780	100.0%
Cases dropped	Cases with missing values	0	0.0%

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	Cases with negative time	0	0.0%
	Censored cases before the earliest event in a stratum	0	0.0%
	Total	0	0.0%
Total		780	100.0%

a. Dependent Variable: ATTAINMENT TIME (IN MONTHS) FOR ACCEPTABLE PERFORMANCE

Categorical Variable Codings[a]

	Frequency	(1)	(2)	(3)
CLASS_NP[b] 1.00=NP CLASS A	110	1	0	0
2.00=NP CLASS B	150	0	1	0
3.00=NP CLASS C	236	0	0	1
4.00=NP CLASS D	284	0	0	0

a. Category variable: CLASS_NP (CLASS OF NAGARPALIKA)
b. Indicator Parameter Coding

3. To understand the effects of individual predictors, look at Exp(B), which can be interpreted as the predicted change in the hazard for a unit increase in the predictor.
4. The value of Exp(B) (table no.6) for ECC means that the Performance Acceptability hazard for an Unacceptable Performance is 1.036 times that of Acceptable Performance.

Table 6: Variables in the Equation

	B	SE	Wald	df	Sig.	Exp(B)
Step 1 ECC	.035	.009	14.897	1	.000	1.036
CWC	.034	.005	40.661	1	.000	1.035
COS	.028	.003	120.252	1	.000	1.028
CLASS_NP			65.858	3	.000	
CLASS_NP(1)	.204	.173	1.395	1	.237	1.227
CLASS_NP(2)	-1.100	.232	22.416	1	.000	.333
CLASS_NP(3)	.638	.133	22.958	1	.000	1.893

Model if Term Removed

Term Removed	Loss Chi- square	df	Sig.
Step 1 CLASS_NP	81.593	3	.000

Table 7: Covariate Means and Pattern Values

	Mean	Pattern			
		1	2	3	4
ECC	91.382	91.382	91.382	91.382	91.382
CWC	73.181	73.181	73.181	73.181	73.181
COS	57.461	57.461	57.461	57.461	57.461
CLASS_NP(1)	.141	1.000	.000	.000	.000
CLASS_NP(2)	.192	.000	1.000	.000	.000
CLASS_NP(3)	.303	.000	.000	1.000	.000

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5. The value of Exp(B) for CWC means that the Performance Acceptability hazard is increased by 100 % − (100 % × 1.035) = 3.5 % for each score a NP has catered water to the customers at the same address.The Performance Acceptability hazard for a NP that has catered water series for five performance score is reduced by 100 % − (100 % × 1.035 5) = 18.76 %.

6. The value of Exp(B) for COS means that the Performance Acceptability hazard is increased by 100 % − (100 % × 1.028) = 2.8 % for each score a NP has catered water to the customers at the same address.The Performance Acceptability hazard for a NP that has catered water series for five performance score is reduced by 100 % − (100 % × 1.028 5) = 14.80 %.

7. The regression coefficients for the first three levels of Class of NPs are relative to the reference category, which corresponds to 'Class D' Nagar Palika.

Figure 3 : Survival Analysis

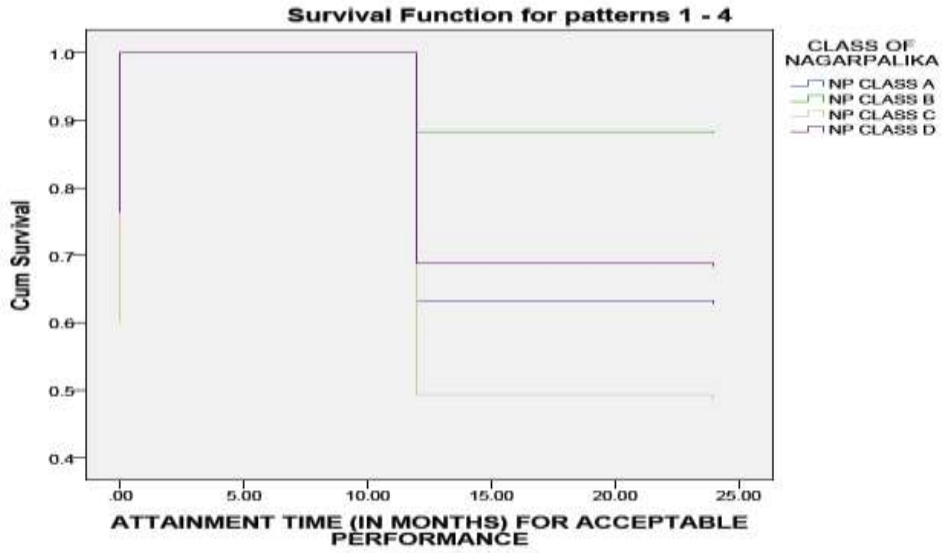
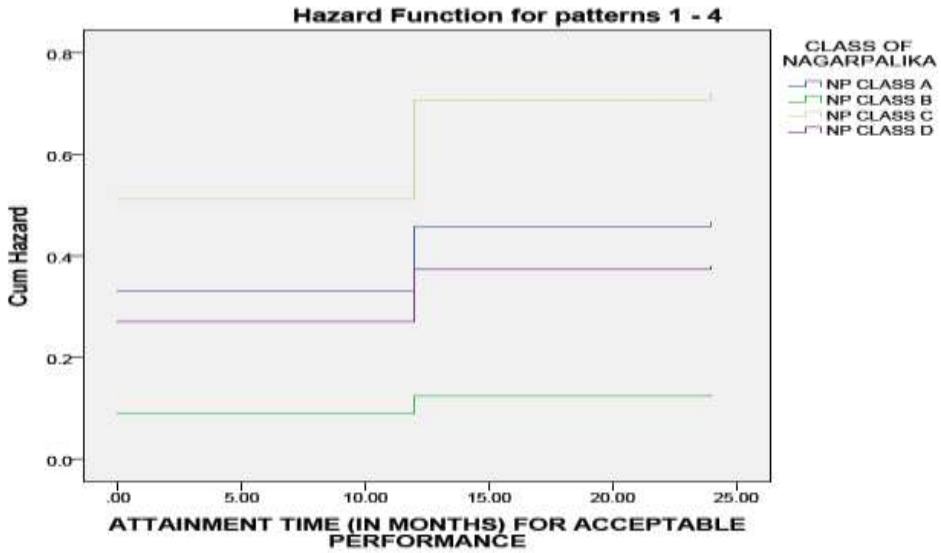


Figure 4 : Hazard Analysis



8. The regression coefficient for the first category, corresponding to 'Class A' Nagar Palika, suggests that the Performance Acceptability hazard for 'Class A' Nagar Palika is 1.227 times that of 'Class D' Nagar Palika; however, the significance value for this coefficient is greater than 0.10, so any observed difference between these Nagar Palika categories could be due to chance. By contrast, the significance values for the second and third categories,corresponding to 'Class B' Nagar Palika and 'Class C' Nagar Palika, are less than 0.05, which means they are statistically different from the 'Class D' Nagar Palika. The regression coefficients suggest that the hazard for 'Class B' Nagar Palika is 0.333 times that of 'Class D' Nagar Palika and the hazard for 'Class C' Nagar Palika is 1.893 times that of 'Class D' Nagar Palika.

V.CONCLUSION

Traditionally, there are various performance benchmarking employing numerous indicators for the assessment of the water supply sector. However, availability of limited manpower, technical, financial, and institutional arrangements hamper ULB's efforts in achieving sustainability and optimality in public service delivery. The proposed study attempts to reduce the indicators that can be used to assess the performance of the respective ULBs such that even the least resourced ULB would comply with the service delivery standards as set-out by the government authorities. The study proposes a novel method that can be employed for ascertaining hazard analysis of water sector performance of all NPs of Gujarat.

Coverage of Water Supply (CWC), Continuity of Water Supply (COS), and Efficiency in Redressal of Customers' Complain (ECC) are the three main indicators that play a pivotal role in assessing water sector performance. The data pertaining to identified three indicators are easily captured and available with all types of ULBs. The Performance Acceptability hazard for 'Class A' Nagar Palika is higher than that of Class D' Nagar Palika. The regression coefficients suggest that the hazard for 'Class B' Nagar Palika is considerable low than that of 'Class D' Nagar Palika and the hazard for 'Class C' Nagar Palika is considerably higher than that of 'Class D' Nagar Palika.

The proposed method has the potential to offer solution to perplexed prevalent problems in the ULB and would benefit not only in improving the performance in service delivery but also would help create an environment of institutional reforms within the respective ULBs. The proposed method can also be appropriately extended to cover city's sewerage network, solid waste management services and storm water drainage network.

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