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STATISTICAL MODELING OF PUBLIC ATTITUDES TOWARDS WATER INFRASTRUCTURE RETOOLING ALTERNATIVES IN SHRINKING CITIES

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Abstract: Many US cities, such as Gary, Indiana and Detroit, Michigan, have and continue to experience substantial population decline. The footprint of the built infrastructure in these cities does not contract with urban decline, but remains relatively unchanged, consequentially resulting in underfunded and underutilized infrastructure. Right sizing the physical footprint for the current and projected population needs has the potential to stabilize or reduce the rising per capita cost of services. While unilateral infrastructure decisions may save time and money, they pose risks, such as inefficient or unsuccessful implementation or unsustainable infrastructure projects, due to public opposition. The objective of this paper is to assess the public attitude concerning water infrastructure management alternatives. In November 2013, a voluntary survey was deployed to residents of 21 medium or large US shrinking cities. Binary probit models were estimated to determine the demographic and geographic variables influencing the support (or opposition) of five water infrastructure management alternatives. The statistical models indicated that different alternatives have different probabilities of support (or opposition) in varied geographic locations. Demographic variables, such as age, employment status, and income, have a propensity towards (or against) select management alternatives. This study demonstrates a method for understanding and incorporating public opinion into the pre-planning process for potentially reducing public opposition. Potential opposition regarding infrastructure management decisions may be alleviated through participatory processes and targeting identified demographic groups for involvement in new infrastructure projects and decisions.

1 INTRODUCTION

Many US cities, such as, Cleveland, Ohio, and Buffalo, New York, have and continue to experience substantial population decline (Pallagst 2008). As the populations decline, these cities, termed shrinking cities, face a multitude of infrastructure-related challenges, including a decreasing tax base, a reduced number of customers demanding infrastructure services, and a built infrastructure footprint that remains relatively unchanged in spite of the shrinking populations. These challenges result in an excess of underutilized and underfunded infrastructure. Approximately, 75 to 80 percent of water infrastructure costs to provide service are fixed costs (Herz 2006; Hummel and Lux 2007; Schlör et al. 2009). These fixed costs must still be recovered in the presence of the urban decline and a reduced number of customers, potentially resulting in infrastructure services becoming prohibitively more expensive per capita (Rybczynski and Linneman 1999; Herz 2006; Butts and Gasteyer 2011; Beazley et al. 2011). Further straining this financial situation with regard to water service is the financial capital necessary to meet the increasingly stringent regulations set by the state and federal government (Roberson 2011).

Prior literature regarding water infrastructure in shrinking city has: (1) qualitatively discussed water infrastructure management alternatives to reduce the physical footprint for the current and projected population, such as decommissioning/razing or repurposing underutilized infrastructure components (Hoornbeek and Schwarz 2009; USEPA2014), and (2) examined the relationship between urban decline and rising per capita water/wastewater service costs (Herz 2006; Hummel and Lux 2007; Schlör et al. 2009; Butts and Gastayer 2011). To the authors' knowledge, the literature has not addressed the attitudes towards possible water infrastructure retooling alternatives in shrinking cities. Water infrastructure retooling alternatives are changes to the systems, whether physical, operational, or managerial, that may have the potential to reduce or stabilize the cost or increase the level of service of the systems. Prior work regarding public views has evaluated the perceived quality of life in areas of urban decline and perceptions towards abandonment and vacancies (Greenberg and Schneider 1996; Bright 2000; Hollander 2010; Hollander 2011). Understanding the public attitude and ensuring adequate public support may increase the success of an infrastructure project by mitigating the possibility of inefficient or unsuccessful implementation, or unsustainable alternatives arising from public opposition (Susskind and Cruikshank 1987, Global Water Partnership Technical Advisory Committee 2000, Gerasidi et al. 2009, Nancarrow et al. 2010, Faust et al. 2013). Sustainability, in the context of this paper, refers to managing and maintaining the water infrastructure system's ability to provide adequate service to the current and projected populations.

This study aims to evaluate the attitude of residents in shrinking cities towards select water infrastructure retooling alternatives. A survey was deployed to residents of shrinking cities to evaluate the public attitudes towards five water infrastructure retooling alternatives using statistical modeling: (1) investing in more infrastructure, (2) razing or decommissioning infrastructure components, (3) repurposing the existing infrastructure, (4) investing in the maintenance of the current infrastructure, and (5) doing nothing (make no changes) to the current infrastructure. Of interest to this study are the outcomes of the statistical models, which provide insight into the geographical and demographic characteristics of the public that increase the likelihood of supporting or opposing the implementation of different water infrastructure retooling alternatives. Understanding the attitudes of the public in shrinking cities (that is, which locational and demographic characteristic have an initial propensity towards certain alternatives) may help facilitate the analysis of implementable alternatives within these communities (Faust et al. 2013) that have minimal public opposition.

2 METHODOLOGY

A survey was deployed in November 2013 to the general public to capture the perceptions, attitudes, awareness, and knowledge regarding specific retooling alternatives and water sector infrastructure challenges. The attitude questions were posed as a binary question, *agree/support* or *disagree/oppose*, to avoid decision paralysis and force a stance that is often missed when questions are posed on a multi-point scale with a *neutral* or an *I do not know* option (Tversky and Shafir 1992). These attitude questions directly asked what the respondent *thinks* should be done in his or her city, and thus, may capture factors such as, the NIMBY theory ("not in my backyard"). It should be noted that the attitudes expressed in this paper represent the public views at a snapshot in time. Attitudes are dynamic, changing with external factors such as, additional information, experience, education, and outreach.

Qualtrics, a web-based survey software, was used to format and deploy the voluntary survey to residents over the age of 18 in 21 US shrinking cities (Table 1). The survey was validated via content review by 11 subject matter experts with expertise in issues inherent to shrinking cities, water sector infrastructure management, or survey analyses. Following content validation, the survey underwent IRB review at Purdue University and was pre-deployed to 25 people with limited knowledge of water sector infrastructure issues to confirm that residents could easily respond to, and understand the posed survey questions. The responses from the pre-deployment were not included in the final sample pool used for the statistical modeling.

The respondent pool consisted of residents from shrinking cities that had peak populations greater than approximately 100,000, and have experienced a decline of at least 30% of their population since the peak population (Table 1). As of the 2010 census, the combined population of the targeted cities was approximately 4.6 million (US Census Bureau 2011). A confidence level of 95% with a confidence interval of 5% was obtained with a sample size of 455 complete surveys from these 21 the shrinking cities. A minimum of 10 responses was gathered from each targeted city. Responses were sought from cities spanning multiple states to reduce the potential that responses reflect local policies, and to allow the comparison of the attitudes of residents across cities/states.

Table 1: Targeted cities comprising survey response pool

City	**Percent decline from peak population**	**Peak Population (Year)**	**2010 Population** *(US Census Bureau 2011)*
Akron, Ohio	34.5%	290,351 (1960)	199,110
Baltimore, Maryland	34.6%	949,708 (1950)	620,961
Birmingham, Alabama	37.7%	340,887 (1950)	212,237
Buffalo, New York	53.4%	580,132 (1950)	270,240
Camden, New Jersey	37.9%	124,555 (1950)	77,344
Canton, Ohio	37.6%	116,912 (1950)	73,007
Cincinnati, Ohio	41.1%	503,998 (1950)	296,943
Cleveland, Ohio	56.6%	914,808 (1950)	396,815
Dayton, Ohio	46.1%	262,332 (1960)	141,527
Detroit, Michigan	61.4%	1,849,568 (1950)	713,777
Flint, Michigan	43.4%	196,940 (1960)	84,465
Gary, Indiana	55.0%	178,320 (1960)	98,026
Niagara Falls, New York	51.0%	102,394 (1960)	52,200
Pittsburgh, Pennsylvania	54.8%	676,806 (1950)	371,102
Rochester, New York	36.7%	332,488 (1950)	121,923
Saginaw, Michigan	47.5%	98,265 (1960)	51,508
Scranton, Pennsylvania	46.9%	143,333 (1930)	67,244
St. Louis, Missouri	62.7%	856,796 (1950)	537,502
Syracuse, New York	34.2%	220,583 (1950)	75,413
Trenton, New Jersey	33.7%	128,009 (1950)	43,096
Youngstown, Ohio	60.6%	170,002 (1930)	103,020

To determine the demographic and location parameters that influenced the attitudes of the respondents towards the five infrastructure retooling alternatives, different statistical models were assessed to identify the best-fit models. Ultimately, binary probit models were used to identify the parameters influencing public attitude. The binary probit models were estimated with the standard maximum likelihood method and assumed normally distributed error terms (ε) with a mean of zero. The binary probit model:

[1] $P_i(YES) = \phi\left(\frac{\beta_{YES} X_{YESi}}{\sigma}\right)$

estimates the probability of outcome 1 for observation *i*. Phi (Φ) is the standardized cumulative normal distribution, β_1 are the estimable parameters for outcome *i*, and X_{1i} are the vectors of the observable characteristics (e.g., demographic characteristics, cities) that determine if "1" is the suggested outcome of observation *i* (Washington et al. 2011).

Marginal effects, which are the average changes in probability resulting from a one-unit change in the independent variables (or a change for zero to one for indicator variables), are used to interpret the impact of each parameter (Washington et al. 2011). The reported marginal effects presented in the tables below for each significant parameter is the average of the individual marginal effect for all observations.
For model selection, the Akaike information criterion (*AIC*) and the Bayesian information criterion (*BIC*) were used. Both criterion incorporate the same goodness- of-fit term and, with *k* equal to the number of

parameters in the model and log-likelihood function *f*(*y*|.), where $AIC = -2\ln f(y|\widehat{\beta_k}) + 2k$ and $BIC = -2\ln f(y|\widehat{\beta_k}) + k\ln n$ (Cavanaugh 2012). *AIC* is asymptotically efficient, selecting the model that minimizes the mean square error, and thus, is appropriate as a predictive criterion (identifying, via a pairwise comparison, which model most efficiently predicts the outcomes). *BIC* is consistent, identifying the model with the factors that are the most influential, and thus, is appropriate as a descriptive criterion (Cavanaugh 2012). When selecting models, the smallest *AIC* and *BIC* are indicative of the best fitted models (Schneider and Schneider 2009).

3 RESULTS

Of the survey's respondents, approximately 60% were male and approximately 50% were over the age of 50 years old. A majority of respondents had an individual annual income of less than $35,000. Descriptive statistics of the significant demographic variable in the statistical models are shown in Table 2.

Table 2: Survey sample pool demographics

CHARACTERISTIC	MIN/ MAX	AVE.	ST. DEV.
Individual Characteristic			
Gender (1 if male, otherwise 0)	0/1	0.61	0.49
Marital Status			
Single (1 if single, otherwise 0)	0/1	0.36	0.48
Divorced (1 if divorced, otherwise 0)	0/1	0.12	0.33
Separated (1 if separated, otherwise 0)	0/1	0.02	0.15
Age			
18-25 years old (1 if 18-25 years old, otherwise 0)	0/1	0.09	0.28
26-35 years old (1 if 26-35 years old, otherwise 0)	0/1	0.20	0.40
Over 50 years old (1 if over 50 years old, otherwise 0)	0/1	0.47	0.50
Respondent Approximate Income			
No Income (1 if respondent has no income, otherwise 0)	0/1	0.08	0.27
Under $19,999 (1 if respondent's income is less than $19,999, otherwise 0)	0/1	0.26	0.44
$20,000-$34,999 (1 if respondent's income is $20,000-$34,999, otherwise 0)	0/1	0.24	0.42
Employment Status			
Out of work and looking for work (1 if out of work and looking for work, otherwise 0)	0/1	0.05	0.22
Retired (1 if a retired, otherwise 0)	0/1	0.21	0.41
Primary Source of News			
Newspaper (1 if primary source of news is the newspaper, otherwise 0)	0/1	0.36	0.48
Internet (1 if primary source of news is the Internet, otherwise 0)	0/1	0.66	0.47
Television (1 if primary source of news is the television, otherwise 0)	0/1	0.75	0.43
Social media (1 if primary source of news social media, otherwise 0)	0/1	0.15	0.36
Other			
Grew-up in city (if grew-up in the city currently residing in, otherwise 0)	0/1	0.60	0.49
Responsible for water bill (1 if respondent responsible for water bill, otherwise 0)	0/1	0.71	0.45
Household Characteristics			
Ownership of Household			
Mortgage or loan (1 if household is owned via a mortgage or a loan, otherwise 0)	0/1	0.47	0.50
Rented (1 if household is rented, otherwise 0)	0/1	0.31	0.46
Other			
Number of cars in household (cars)	0/8	1.49	0.93

The final survey sample's raw data indicated that only 18% of respondents had no interest in being actively involved in the decision-making process for water infrastructure needs. Approximately 20% of the respondents stated that they did not trust their water provider to make appropriate decisions, denoting potential for opposition or unstable relationships with the public in the absence of participatory involvement. By understanding the public attitudes towards the different retooling alternatives and accounting for the public views in decision-making, some of the indicated distrust between the public and utility providers may possibly be alleviated, allowing for the transition towards more sustainable infrastructure systems.

The results in Tables 3-7 show the quantification of the significant parameters that increase the propensity towards agreeing/supporting (disagreeing/opposing) with the implementation of specific retooling alternatives. A positive (negative) parameter indicates an increased likelihood of agreeing/supporting (disagreeing/opposing) with the respective alternative, with the marginal effects of each parameter shown in the adjacent column.

Table 3: Significant parameters and marginal effects for survey responses to the statement “I think my city should invest in more infrastructure”

Independent Variable	Parameter (t-statistic)	Marginal Effect
Constant	-0.855 (-8.644)	
Income indicator (1 if less than $35,000, otherwise 0)	0.239 (1.704)	0.080
Ownership of household (1 if someone in the household rents the household, otherwise 0)	-0.370 (-2.372)	-0.115
Primary news source (1 if social media, otherwise 0)	0.453 (2.599)	0.160
Cleveland, Ohio indicator (1 if residing in Cleveland, otherwise 0)	0.454 (2.419)	0.162
Gary, Indiana indicator (1 if residing in Gary, otherwise 0)	0.702 (1.693)	0.263
Trenton, New Jersey indicator (1 if residing in Trenton, otherwise 0)	0.824 (2.047)	0.311
Log Likelihood	*-250.691*	
AIC	*517.70355*	
BIC	*550.34525*	

Table 4. Significant parameters and marginal effects for survey responses to the statement “I think my city should raze or decommission infrastructure”

Independent Variable	Parameter (t-statistic)	Marginal Effect
Constant	-1.652 (-8.701)	
Cars in the household (1 if household has more than two cars, otherwise 0)	0.490 (1.917)	0.083
Primary news source (1 if internet, otherwise 0)	0.357 (1.713)	0.041
Flint, Michigan indicator (1 if residing in Flint, otherwise 0)	0.601 (1.713)	0.112
Ohio State indicator (1 if residing in Ohio, otherwise 0)	-0.510 (-2.265)	-0.058
Log Likelihood	*-114.9553*	
AIC	*240.04435*	
BIC	*260.51025*	

Table 5: Significant parameters and marginal effects for survey responses to the statement “I think my city should repurpose infrastructure”

Independent Variable	Parameter (t-statistic)	Marginal Effect
Constant	-1.766 (-6.186)	
Gender (1 if male, otherwise 0)	0.284 (1.918)	~~0.074~~
Age (1 if over 50, otherwise 0)	-.0477 (-3.252)	-0.126
Relationship Status (1 if single, divorced, or separated, otherwise 0)	0.282 (2.016)	0.075
Primary news source (1 if internet, otherwise 0)	0.359 (2.261)	0.091
Primary news source (1 if television, otherwise 0)	0.311 (1.802)	0.077
Frequency of following the news (1 if daily, otherwise 0)	0.377 (1.913)	0.090
Log Likelihood	*-213.1905*	
AIC	*440.6311*	
BIC	*469.2233*	

Table 6: Significant parameters and marginal effects for survey responses to the statement “I think my city should invest in the maintenance of the current infrastructure”

Independent Variable	Parameter (t-statistic)	Marginal Effect
Constant	-0.908 (-3.090)	
Age (1 if less than 35, otherwise 0)	0.458 (2.029)	0.170
Employment status (1 if out of work and looking for work, otherwise 0)	0.564 (2.043)	0.221
Cars in the household indicator (1 if household has cars, otherwise 0)	0.375 (1.800)	0.142
Primary news source (1 if newspaper, otherwise 0)	0.276 (2.176)	0.109
Pennsylvania State indicator (1 if residing in Pennsylvania, otherwise 0)	-0.402 (-1.984)	-0.151
Trenton, New Jersey indicator (1 if residing in Trenton, otherwise 0)	-1.318 (-2.355)	-0.372
Log Likelihood	*-296.415*	
AIC	*609.154*	
BIC	*641.79115*	

Table 7: Significant parameters and marginal effects for survey responses to the statement “I think my city should do nothing to the current infrastructure”

Independent Variable	Parameter (t-statistic)	Marginal Effect
Constant	0.751 (2.231)	
Age (1 if less than 35, otherwise 0)	-0.456 (-1.893)	-0.153
Income indicator (1 if less than $35,000, otherwise 0)	-0.284 (-1.825)	-0.082
Employment status (1 if retired, otherwise 0)	-0.328 (-1.819)	-0.090
Ownership of household (1 if someone in the household owns the house with a loan or mortgage, otherwise 0)	0.332 (2.285)	0.099
Number of cars in the household (cars)	-0.247 (-2.820)	-0.073
Indicator that city currently residing in is the same as grew up in (1 if grew up in the city currently residing in, otherwise 0)	-0.331 (-2.444)	-0.100
Responsible for water bill indicator (1 if responsible, otherwise 0)	-0.422 (-2.708)	-0.133
Primary news source (1 if internet, otherwise 0)	-0.355 (-2.462)	-0.110
Scranton, Pennsylvania indicator (1 if residing in Scranton, otherwise 0)	0.679 (1.763)	0.241
Log Likelihood	*-231.8582*	
AIC	*484.211*	
BIC	*524.91985*	

4 DISCUSSIONS

When exploring viable infrastructure retooling alternatives, decision-makers may use the estimated models to identify the demographic and locational parameters of individuals having an increased likelihood of opposition (i.e., disagreeing with an alternative). Educational outreach or incorporating participatory processes involving these groups of residents may mitigate potential public resistance towards the alternative(s). In the statistical analyses, locational parameters were recurring, significant parameters for indicating an initial propensity to agree or disagree with the implementation of the different infrastructure retooling alternatives. Specific locations in which residents had an increased propensity to agree with the implementation of an alternative included:

- **Cleveland, Ohio.** Cleveland residents have a 0.162 increase in the probability of agreeing with measures to invest in more physical water infrastructure.
- **Flint, Michigan**. Flint residents have a 0.112 increase in the probability of agreeing with decommissioning or razing water infrastructure.
- **Gary, Indiana.** Gary residents have a 0.263 increase in the probability of agreeing with investing in more physical water infrastructure.
- **Scranton, Pennsylvania.** Scranton residents indicated a 0.241 increase in agreeing that the probability that the utility providers should maintain the status quo (i.e. do nothing).
- **Trenton, New Jersey.** Trenton residents have a 0.311 increase in the probability of agreeing with measures to invest in more physical water infrastructure.

The locations in which residents disagreed with select retooling alternatives were:

- **Shrinking cities in Ohio.** Residents of shrinking cities in Ohio have a 0.058 decrease in the probability of agreeing with decommissioning or razing water infrastructure.
- **Shrinking cities in Pennsylvania.** Residents of shrinking cities in Pennsylvania have a 0.151 decrease in the probability of agreeing with increasing the financial investment of maintaining the current water infrastructure.
- **Trenton, New Jersey**. Trenton residents have a 0.372 decrease in the probability of agreeing with measures that increase the financial investment of maintaining the current water infrastructure.

Location parameters are important to consider for decision-makers when considering viable, sustainable retooling alternatives to explore further for potential implementation. The initial propensity to agree/support or disagree/oppose with different infrastructure retooling alternatives may be due to a communication gap or lack of awareness regarding infrastructure issues typical to shrinking cities. For instance, albeit being residents in shrinking cities, the residents of Cleveland, Gary, and Trenton are more likely to support investing in more infrastructure, indicating a lack of knowledge regarding the relationship between the fixed grid infrastructure system and the declining population. This location specific information may be a conversation starter between the public and utility providers on how to move forward towards a sustainable infrastructure system, to dispel incorrect information regarding utilities in the context of urban decline, or to discuss the viability of infrastructure alternatives to promote increased likelihood of support of the implemented infrastructure retooling alternative.

The five models also revealed many demographic characteristics to be significant in influencing the attitude towards retooling alternatives. Age was a signification demographic variable, with individuals younger than 35 years old being more likely to disagree with the status quo/do nothing alternative and more likely to support maintaining existing infrastructure. Conversely, individuals over the age of 50 were more likely to oppose repurposing infrastructure. These findings may be capturing a resistance to change as openness for progressive change has been shown to decline as individuals age (Westerhoff 2008).

Men are more likely to agree with repurposing infrastructure, possibly reflecting the importance that males can play in household incomes and decision-making (Wang et al. 2013). Additionally, individuals who are single, divorced, or separated, are more likely to agree with repurposing infrastructure further supporting that retooling alternatives may be viewed as a viable method to stabilize costs when living expenses are not shared amongst partners.

Individuals with incomes less than $35,000 are more likely to agree with increasing the investment in more infrastructure and less likely to agree with doing nothing. However, those individuals who are out of work are more likely to agree with investing in maintaining the current infrastructure, likely recognizing this alternative to be seemingly less financially burdensome on the customers/rate-payers.

Ownership of cars increased the likelihood of disagreeing with the 'do nothing' alternative. Consistent with this finding is that individuals with more than two cars were more likely to support decommissioning or razing infrastructure, and households with at least one car were more likely to agree with maintaining existing infrastructure. This finding may be capturing some measure of wealth and mobility that would make individuals in these groups less likely to be impacted by increasing investments for maintenance, or may simply reflect the economics involved in owning additional cars which results in less disposable income. This measure of wealth associated with less disposable income may be a motivation to find a way (decommissioning or razing infrastructure or maintain infrastructure) to stabilize future utility rates.

Ownership of homes was a significant parameter. Renters were more likely to disagree with investing in more infrastructure, possibly capturing a disinterest in investing in an area that the renter is not permanently tied to or the economics involved in renting a household and having less disposable income (as discussed with car ownership). If the home is owned via a loan, the individual is more likely to agree with doing nothing to the water infrastructure. This home-ownership parameter seemingly captures the decrease in disposable income due to loan payments, and the view that doing nothing in the near future will not require increasing the water rates that further strain the low incomes rampant in these cities.

Those individuals who are responsible for their water bill were found to be less likely to agree with the doing nothing for water infrastructure retooling alternative. Additionally, individuals who were raised in the city, or individuals who have retired from regular employment are less likely to agree with doing nothing for water infrastructure. As the average income in shrinking cities is typically below the average income for the state (US Census Bureau 2011), these individuals may see these alternatives as viable methods to stabilize or reduce water service costs, one of many living expenses.

The primary source of news of the respondents was a significant parameter in many models. The significance of this parameter may be due to the different age groups using the medium as the primary source of news. For instance, radio is often the primary source of news for older generations (Kohut et al. 2010). Another reason for the significance of this parameter may be due to the stories that are highlighted via the medium and the flexibility to search for own stories of interest. The Internet provides for flexibility to choose from a wide range of news, whereas the radio provides the listener with limited flexibility.

5 SUMMARY AND CONCLUSIONS

As cities experiencing urban decline explore water infrastructure retooling alternatives, understanding the sources of opposition/disagreement and which alternatives are likely to be supported/opposed by the community may possibly mitigate opposition towards the implemented alternative(s). In this study, less than 20% of the survey respondents expressed no desire to participate in the decision-making processes regarding water infrastructure. This low percentage indicates that communication avenues must be open between the utility providers and the public making decisions regarding water infrastructure. Incorporating some level of participatory decision-making may allow for sustainable outcomes and increased support with efforts for stabilizing or reducing the costs of services. This paper contributes to the body of knowledge by illustrating the viability of evaluating public attitudes towards underground infrastructure and potential infrastructure retooling alternatives using survey analyses and statistical modeling.

Underground infrastructures (e.g., water, wastewater, natural gas) are unseen, and the public generally lacks the same level of awareness of operations and conditions of these systems compared to those of above-ground infrastructure systems, such as roads and bridges. However, price elasticity studies (e.g., USEPA ND; Espey et al. 1997; Lipsey and Chrystal 1999; NRDC 2012) have shown that consumers are sensitive to price changes with water utility services, illustrating that consumer behavior is directly tied to the utility service provided. Infrastructure retooling alternatives have the potential to reduce or stabilize the costs of service. However, depending on how the necessity of these alternatives is perceived, the public may not agree with a specific alternative. Understanding public attitude is critical for the successful implementation of retooling alternatives since decisions lacking adequate public support may lead to inefficient or unsuccessful implementation (Susskind and Cruikshank 1987; Global Water Partnership Technical Advisory Committee 2000, Gerasidi et al. 2009, Nancarrow et al. 2010, Faust et al. 2013).

The statistical analyses show that a wide variety of factors influence the attitudes of residents in shrinking cities pertaining to water retooling alternatives. Results from the five water infrastructure retooling model estimations show that many of the same socioeconomic and demographic variables influenced the attitudes spanning the five models. These socio-economic and demographic findings may be used to evaluate the population in specific shrinking cities to determine the initial viability of different retooling alternatives, and to tailor information campaigns for specific groups to mitigate potential opposition towards different infrastructure retooling alternatives. Specific socio-economic and demographic results that had an increased propensity towards agreeing or disagreeing with different retooling alternatives included age, gender, income, number of cars, employment status, and primary source of news. Understanding the sources of support/opposition among the populations, while considering these attitudes in the decision-making process may allow for shrinking cities to transition towards strategies for stabilizing or reducing the per capita costs of utility services.

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