DUBAI BUSINESS SCHOOL
1st International Conference on Advances in Business, Management and Law (2017) Volume 2017

Users' Satisfaction of Public Utility Services – Multivariate System Analysis

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Abstract

This research develops a multivariate system framework for assessing user satisfaction of public water utility organization in a developing country and predicts quality, quantity and overall user satisfaction for policy initiatives. The model framework is applied to the data collected by Public Affairs Centre (PAC) based on the Citizen Report Card approach pioneered by it. Wald test confirms that there exits cross equation correlation across quality, quantity and overall users' satisfaction dimensions. Based on the system model, the study identifies statistically significant factors that explain users' loyalty to express satisfaction and voice to express dissatisfaction of users. Policy initiatives are proposed on key factors to reduce voice factors set so that the service provider could improve its service delivery. The system model correctly predicts 85% of satisfied customers across quality, quantity and overall satisfaction dimensions.

Keywords: Multivariate, Logit, Discrete choice Model, Public Sector Utility service provider

http://dx.doi.org/10.30585/icabml-cp.v1i1.12

1. INTRODUCTION

A number of factors have combined to reignite global interest in water policy as it relates to urban water utilities in the 21st century. Starting from their essential nature as natural monopolies operating within the network industries, countries around the world with initially similar settings in delivery networks and treatment systems have progressively evolved very different approaches to urban water utilities, especially in the chosen mix of privately and publicly owned entities and the extent of regulatory intervention governing pricing and standards (Bakker 2010). However, recent circumstances have added impetus to these longstanding developments. These include declining rainfall associated with climate change, pressing needs for maintaining and expanding expensive water supply infrastructure, jurisdictional, sectoral, and environmental conflicts over existing surface and groundwater supplies, and rapid population growth and urbanization (Uitto and Biswass 2000, Productivity Commission 2011, CSIRO 2012, UN 2012, NWC 2012, OfWat 2012). In response, governments and international agencies worldwide have refocused on improving the management and delivery of urban water services.

There is now substantial ongoing concern about the ability of the urban water sector as it stands to achieve productive and efficient outcomes and thereby reassure key stakeholders, especially users, of the sustainability of the sector and this key resource. Part of this draws on the conventional view that the inherent conditions of urban water utilities (supply variability, high transport costs, scale economies, and public health) place significant limits on the scope for effective competition and efficient markets in urban water (Frontier Economics 2008). Part is also from the observation that the inefficiencies associated with current pricing arrangements, water restriction regimes, and deficiencies in supply and demand planning and investment processes, have caused additional and ongoing problems for the sector in terms of deteriorating infrastructure, threats to water quality, rising supply costs and reductions in consumer welfare (Productivity Commission 2011, NWC 2012). A final part reflects the apparent inability of the urban water sector to maintain the needed pace of policy reform (Frontier Economics 2008). In fact, on World Water Day 2011 United Nations Secretary- General Ban Ki-moon urged the world's governments "…to recognize the urban water crisis for what it is—a crisis of governance, weak policies and poor management, rather than one of scarcity" (UN 2012).

In response to these pressing policy demands, an increasing number of studies worldwide have sought to estimate and measure efficiency and productivity in urban water utilities. By assessing the efficiency and productivity of the sector, these studies endeavor to highlight current deficiencies in the management of urban water utilities, recognize and quantify the impacts of the regulatory and structural factors surrounding them, provide recognition of the barriers to productive and efficient outcomes in the sector, and yield quantitative inputs into the future reform process.

2. CUSTOMERS SATISFACTION

Over the last few decades, the analysis of customer satisfaction has gained an increasingly relevant role in the private sector with reference to the production of goods or services. In fact, while purchase patterns show what customers buy, customer satisfaction gives an idea on what they would like to buy (Hand 2012). Until recently, less interest has been paid to customer satisfaction by public administrations, especially in the case of public services, even though it is precisely in this sector that investigations on customer satisfaction should be more useful. While private companies can be aware of customers' dissatisfaction with a product, for example because its purchasing decreases, a public enterprise providing a service and operating in a monopoly might well be unaware of the lack of satisfaction among its users if these users cannot switch to other providers, refuse or reduce the service, since Hirschman's "exit" becomes difficult or impossible (Hirschman 1970). Furthermore, a good knowledge of satisfaction for different aspects of a service in connection with the characteristics of its users can suggest a multiple and more satisfactory provision of that service. Therefore, a careful evaluation and monitoring of user satisfaction through specific surveys and investigation could be useful in the public sector, where Hirschman's "voice", i.e. listening to customers' needs, appears fundamental.

Customer Satisfaction is defined as the overall evaluation of an organization's expectations based on the total purchase and consumption experience with products and services as a result of customer experience over time (Kendall, 2006; Parasuraman et al, 1994; Anderson et al, 1994). Brudney and England (1982) argue that satisfaction with the 'impacts' of services is significant in itself but also provides important descriptive information to policy makers, which they suggest is especially important in the absence of the market mechanisms of private ownership and competition. Satisfaction with urban services can be understood in a number of different ways. Customer satisfaction can be

defined as the difference between one's expectations of service performance and an evaluation with the actual outcomes of service delivery (Cronin and Taylor, 1994). In this model, if technical performance is higher than expectations then the customer is satisfied. If performance is less than expectations then the consumer is dissatisfied. However, someone with low expectations may find low service quality exceeds expectations and so would be as satisfied as a customer with high expectations and better quality of service. Other definitions of customer satisfaction refer to the interaction between customers and employees rather than the tangible service characteristics (Zadek et al, 1997).

Customer satisfaction with service delivery in this case might relate to the interpersonal skills of service providers, such as being caring, courteous, understanding, informative, sympathetic, sensitive, communicative, credible, helpful, knowledgeable, responsive etc. (Parasuraman et al, 1985). Ultimately, reported satisfaction with services may be influenced by a multitude of background factors, only some of which will be linked to the characteristics of the service itself (Deichmann & Lall, 2003). Fuller and Matzler (2008) state that customers need to experience this Excitement Quality to be able to talk about it. Delighting customers is of prime importance as it generates that Excitement Quality essential to driving loyalty and to using customers to promote products via the 'word of mouth' mechanism. Whether they are called satisfaction, delight or excitement, the attitudes customers hold about an organization determines their future behavior towards it.

2.1 Measuring satisfaction for public services: issues and sources of bias

Public service satisfaction data are usually collected through opinion survey questionnaires containing items whose answers are personal judgments or perceptions about public services (see, for example, European Commission 2006). These items are the observed variables that, through statistical methods and models, enable us to evaluate satisfaction. There are important issues to be taken into account for a suitable assessment and monitoring of customers' satisfaction:

(i) There are concerns involving the reliability of respondents connected to both voluntary (e.g. respondents do not want to reveal their opinion) and involuntary (e.g. different scale perception) behaviors;

(ii) Satisfaction is a complex concept and cannot be directly observed; it should be assessed not by a single item with few response ordinal categories but ideally intended as a continuous latent variable evaluable rather through multiple observed variables, which can be considered as separate components or proxies for satisfaction;

(iii) The observed variables usually involve point-scale or ordinal variables which must be dealt with in an appropriate statistical way; and

(iv) Usual models of analysis should be properly adapted when applied to the analysis of satisfaction.

Point (i) is more connected to psychological aspects such as personality, perception and individual cognitive processes, while points (ii)–(iv) are principally statistical issues. With regard to point (i), a scale perception bias is sometimes present in responses to this kind of items, especially with sensitive topics (León, Araña, and De León 2013; Tourangeau, and Smith 1996). Respondents may have different reactions to the same question according to their cultural background, education and environment. For instance, the same answer on satisfaction for the price of a service on a Likert scale may have a different meaning for people coming from different countries or having different age or income. Therefore, issues of comparison can arise in these cases. Moreover, when dealing with satisfaction for public services, answers from the public are self-reported expressed opinions and can be affected by other sources of bias: respondents might feel uncomfortable and distressed about revealing their opinion (for example, with services such as the police, prison services and health services), especially when they feel that their views are in the minority (Ho, Chen, and Sim 2013; Noelle Neumann 1974). Sometimes respondents may have a negative attitude towards public service and have an interest to under-report their satisfaction, due to a "not-in-my-backyard" mentality, or have an incentive to strategically misrepresent their preferences in survey studies, with the aim of influencing policy decisions (Ansolabehere and Konisky 2009; Wardman 1988). Furthermore, nonresponsive rates can also be high and post-survey validation of results hard to perform (Gray et al. 1996; Mannetje et al. 2011; Riphahn and Serfling 2005). Even if researchers have considerable experience and knowledge on survey respondent behavior, developing diverse approaches to solve problematic aspects in choice surveys and experiments (McFadden et al. 2005), significant bias may still exist.

Despite all these problems, surveys are often the only source of information enabling the measurement and monitoring of user satisfaction. Bias must, thus, be handled when performing the analysis. In the following sections, we discuss this problem. The issues recalled in points (ii)–(iv) can be dealt with by the careful use of suitable statistical methods. One of the most important of these issues is the nature of the items, and hence the nature (ordinal/categorical, not numerical) of the

resulting variables. In many cases, survey respondents are given a Likert scale (see, Likert 1932) or a list of ordered categories (see Agresti 2013) to choose from. In both these cases, labels are used to assess the order of the categories (from the lower to the higher or vice versa) but not their real values. Even if they are numerical, as in a Likert scale, the distances between subsequent labels do not reflect a quantitative scale. This implies the need of adapting current methods and models of analysis, or searching for new ones.

Another important aspect is the complexity of the concept of satisfaction and the fact that from a statistical point of view it is more suitably measured using a set of observed variables (items) whose relevance or weight are not determined a priori and contribution may not be additive. With all these problems in the treatment of data coming from public service opinion surveys, a well-managed statistical analysis has to be adopted. A new stream of successful statistical methods developed to solve these problems has flourished in the last years (for a recent review see Kenett and Salini 2012), and we will discuss some of them in what follows.

In this paper, we draw attention to the most recent statistical methods and models of satisfaction data analysis. In particular, we focus on the objectives of these analyses, the interpretation of their results and their potential use in public administration. More specifically, after a brief discussion on the problems related to customer satisfaction data collection, typology and related analysis, literature review in Section 3, some dependence models and reduction techniques for customer satisfaction analysis will be presented in Section 4. Applications to PAC data for a better understanding of their potential and comparison are also therein described in section 5. Section 6 concludes and outlines some possible future research directions.

2.2 Research problem and questions

Many low income countries attempted to provide infrastructure services by forming state owned monopolies, as large scale provision of infrastructure is favored because of the economics of scale. But in recent decades, it has become clear that many public water monopolies are inefficient providers of utility services, resulting in poor service quality (McIntosh, 2003; Jamison et al, 2004; Hall, 2006; Das et al, 2010). The urban poor customers are often served by a wide range of service providers (such as water kiosks, water tankers) operating in the informal market and usually pay more to obtain water than when supplied from the public piped network. In the absence of competition (IUCN, 2010), utility customers have little option if the quality of service provision remains poor. Albert Hirschman (1970) theory of exit, voice and loyalty states that; any individual, business firms and organizations under any socio-economic or political system, are subject to lapses that might range from efficient, virtuous, rational, law abiding, or otherwise functional behavior and failures of some institutions are bound to happen, no matter how well some actors in the society live up to it. It states further that ***"each society learns to live with certain amount of these failures, and in order to prevent these failures from transforming into a societal decay, forces must be marshaled within it, which will make the faltering actors revert back to the behavior required for it to function properly."*** Utility customers, who are recipients of the service provision, should be involved in exerting pressure on urban water service providers to improve their performance. Customers who are not happy with the service level can either do nothing about it or they can seek to improve the situation through voice. The research question that addresses the research problem is: ***"How can the performance of public water utilities in a developing country be objectively assessed in terms of service quality from the customers' point of view and highlight their priorities for improvement over a period of time"?***

2.2.1 Research aim and objectives

The aim of the current research is to develop a multivariate system framework for assessing user satisfaction of public water utilities in a developing country in terms of service quality and to identify the priority areas of service for improvement, from the customers' point of view. To achieve this aim, the measurable objectives are:

1. Identify factors that determine quality, quantity and overall user satisfaction of services of public water utilities.
2. Predict quality, quantity and overall user satisfaction for policy initiatives to improve the services of public water utilities

2.2.2 Justification of the Research

Service quality has been explored in the past by numerous researchers with varying perspectives, but majority of these studies have focused on organizations in a competitive market (Parasuraman et al, 1985, 1988, 1994; Zeithaml et al, 1988, 1990 and 2003; Cronin and Taylor, 1992; Teas, 1993) to the detriment of organizations in a monopoly. There is a need to study service quality within the context of

a monopoly in a water service domain, considering all processes and operations associated with the delivery of product and customer services in low income economies. Also, the important service quality attributes perceived by customers vary from sector to sector (Kim and Kang, 1995; Baker and Tremolet, 2003). A better understanding of customer satisfaction and how this can be measured is required to provide a prominent role for customers to lead to an efficient water supply service. Hence, the justification of the critical review of customer voice in a monopoly market structure experience, in an emerging economy. The needs of the consumers are not often considered by governments and service providers (Sohail and Cavil, 2006; Thampi, 2005). The customer voice has been slow to develop in the water sector, unlike other sectors of the economies such as telecommunications and energy (Clarke and Wallsten, 2003), where consumer organizations have demanded accountability from marketers and service providers.

3. LITERATURE REVIEW

There is a growing concern about the performances of public utilities responsible for supplying potable water and treating sewage (Khatri and Vairavamorthy, 2007). Faced with difficulties of maintaining aging infrastructure in times of tightening financial constraints, problems associated with service quality and reliability, and the acknowledgment of the role played by utilities in allocating insufficient water resources. These concerns have led to a heightened scrutiny of these agencies with increased interest in reforming their operations (Hall, 2006; Renzetti & Dupont, 2003). The general public and the World Bank are concerned with the increasing failure of the public water utilities in developing countries to provide water supply; and the alternative small scale private water delivery systems (informal service providers), gives much cause for concern. It is therefore worrisome that the developing countries population, which accounts for 76% of the world population and constitutes an important part of the global economy (Ramamurti, 1992, Khatri and Vairavamorthy, 2007) is lacking behind in the Millennium Development Goals (MDG) to halve the population of people without sustainable access to safe drinking water and sanitation by year 2015. According to WHO/UNICEF (2006) report, the world is on track for reaching the Millennium Development Goals (MDG's') drinking water target, to half the population without sustainable access to safe drinking water and basic sanitation by 2015. The major challenges of achieving the MDG's are: Keeping the current coverage levels against the rapid pace of urbanization; The back log of rural people yet to be served with safe drinking water and basic sanitation.

Literature have shown that the service quality requirements of infrastructure services in low income countries are usually defined on the basis of Industrialized (developed) countries standards, hence such standards are usually above the minimum acceptable standard to the poor in low income developing countries (Baker and Tremolet, 2003). There is a need to develop customer satisfaction indicators for objectively measuring and monitoring the service quality of public water utilities in low income countries, from the customer's point of view over a period of time (Myhal et al, 2008).

V. R. Shinde1, N. Hirayama2 & S. Itoh3 (2014) developed a model to evaluate and quantify customers' satisfaction (CS) with water supply service using statistical analyses, and developed a relationship between the CS and selected performance indicators of supply service systems to understand how the performance of the system is affected by changes in CS. This study used an Internet based questionnaire survey to evaluate the CS, and was conducted in the Kansai region of Japan in December 2011. A five point Likert scale was used to evaluate the responses received for the questionnaire items based on a literature review for an insight into what consumers in Japan really want or expect from their water utilities. Quantification of the CS was done by factor analysis which suggested that 'Trust in water utility' and 'Good quality water' are the main variables of the CS factor, which are both intrinsically related to water quality. In addition, 'Price of water' and 'Equity of distribution' are among the other variables that have some influence on the customers' satisfaction factor. In order to understand the impact of CS on different components of the supply system, a regression relationship was developed between the CS and selected performance indicators used to evaluate the system performance.

Over the last years, the European Union (EU) has gradually shifted its policy on public sector governance towards the so-called "Europeanization of public services" (Zatti 2012). The regulatory reform process on privatization and liberalization started in the 1980s has been viewed as the main way to improve citizens' well-being, as the liberalization/privatization process should imply increased competition and greater consumer choice towards improved welfare and greater satisfaction (see Clifton, Comín, and Díaz-Fuentes 2006). To monitor this, the EU introduced from the 1990s instruments to evaluate citizens' and consumers' perception and satisfaction about services of general interest (SGI) (Clifton and Díaz-Fuentes 2010). Satisfaction monitoring tools adopted by the EU and other EU-related institutions are mainly in the form of opinion surveys or portals, such as the

Eurobarometer (EB) Survey (European Opinion Research Group 2002), the European Quality of Life Survey (Anderson et al. 2009) and the "Your voice in Europe" portal (Lodge and Sarikakis 2011). More recently, the European Commission (EC) (2010) has focused on addressing the question of vulnerable consumers and lower satisfaction in the belief that behavioural economics can be mobilized as a tool to design demand-side regulation (Clifton, Díaz-Fuentes, and Fernández-Gutierrez, forthcoming). This increased interest in customer satisfaction with public services should be beneficial to improve the efficacy of policy intervention/action.

3.1 Measuring Service Quality

To successfully measure the service quality of water service providers, quantifiable and verifiable performance indicators are required. Meyrick (2002) have suggested that verification of indicators is usually achieved by independent external scrutiny of service provider's measurement and reporting systems, while Kaufmann & Lowry (2002) posit that service quality indicators should satisfy four criteria. The four criteria are that:

- They should be related to the aspects of service that customers value;
- They should focus on monopoly services;
- Utilities should be able to affect the measured quality and that
- The indicators should not ignore pockets of service quality problems.

The most popular measure of service quality is SERVQUAL, an instrument developed by Parasuraman et al. (1985; 1988). Not only has research on this instrument been widely cited in the marketing literature, but also its use in industry has been quite widespread. SERVQUAL method is a technique that can be used for performing a gap analysis of organizations' service quality needs. The best way of obtaining a better understanding of customers' needs and expectation is to ask them (Parasuraman et al. 1994). SERVQUAL is founded on the view that the customer's assessment of service quality is paramount. This assessment is conceptualized as a gap between what the customer expects by way of SERVQUAL from a class of service providers (Buttle 1996) i.e. all water utilities, and their evaluations of the performance of a particular service provider (e.g. a single water utility like Severn Trent Water). SERVQUAL is presented as a multidimensional construct. In their original formulation, Parasuraman, et al. (1985) identified ten SERVQUAL components such as: reliability; responsiveness; competence; access; courtesy; communication; credibility; security; understanding/knowing the customer and tangibles.

RATER model was modified from the original SERVQUAL methodology, which was used for product quality assessment; but now encompasses the service industry (Parasuraman, 1988). RATER model defines five dimensional attributes that customers are believed to consider in their assessment of service quality (Parasuraman, 1988). These five dimensions, derived from collapsing the original ten SERVQUAL components (Reliability, Assurance, Tangibles, Empathy, and Responsiveness) have been found to be relevant to most organizations and sectors, although the importance of each dimension will vary from industry to industry. Data are collected through a sample of customers who respond to a series of questions, based on around a number of key services dimensions. In this research, we use a modified framework suitable to monopoly water service provider as in table 3.1.

3.2 Theory of Exit, Voice and Loyalty

Exit, voice and loyalty is a theoretical concept derived from the work of Albert Hirschman (Hirschman, 1970; Withey and Cooper, 1989; Gehlbach, 2006), which elaborates on two essential options in an event of organizational or state decline. Hirschman (1970) hypothesized that if a firm's product and services decline in quality, customers have three alternative responses, which is known as the Exit-Voice-Loyalty trilogy. Exit occurs when customers stop buying a firms product and services, causing drop in revenue, and forcing management to correct whatever faults that led to exit; voice, when customers express their dissatisfaction, forcing management to search for causes and remedy causes of dissatisfaction; and loyalty on the other hand, reflects the attachment people have for organizations, which inevitably affects their willingness to exit or voice out their grievances. Hirschman (1970) philosophized that Individuals, business firms and organizations under any socio-economic or political system are subject to lapses that might range from efficient, virtuous, rational, law abiding or otherwise. Asserting further that functional behavior and failures of some institutions are bound to happen, no matter how well some actors in the society live up to; and that each society learns to live with a certain amount of these failures. In order to prevent these failures from transforming into a societal decay, forces must be marshaled within the society itself to make the faltering actors revert back to the behavior required for it to function properly.

The continuing popularity of Hirschman's book – "forty eight years after publication of exit, voice and loyalty: responses to decline in firms, organization, and states" - can be attributed to the ability of this simple model to analyze certain economic processes which have shed light on a wide range of

socio-political, economic and moral phenomena which can be translated into the traditional language of economic analysis. While Hirschman's (1970) exit, voice, and loyalty focused primarily on dissatisfaction with the performance of an organization, subsequent work addressed the application of exit and voice in diverse ways as the theory of household behavior (Katz, 1997, Gershuny et al, 2005; Hirschman, 1978; Rogowski, 1998), trade protection (Aggarwal et al, 1987), theory of revolution (Hirschman, 1993; Pfaff &Kim 2003; Latin, 1998), globalization (Schoppa, 2006), labor organization (Schoppa, 2006; Freeman & Medoff, 1984) and education (Chubb & Moe, 1988; Witte, 2001).

In principle, voice and exit are applicable to organizations in a competitive market when quality of products and service deteriorates, but exit is not always feasible in a monopoly market structure. The absence of exit options in an organization can sharply increase the possibility of the voice option being widely and effectively taken up by its customers. Exit is associated with the market and depends on choice in service provision and so unthinkable in a monopoly. Exit is a costly decision, which may be prevented through an appropriate choice of policy by the leadership of an organization (Gehlbach, 2006), Gehlbach (2006) sees voice as the capacity of an organization's members to participate in the setting of policy; which on the contrary can be costly, but provides a share of the surplus from avoiding exit. For exit to work as a mechanism to improve service delivery when performance deteriorates it is necessary to have a mixture of alert and loyal customers; the alert customers provide feedback, while the inert customers provide the firm with the time and money needed to improve performance. Gehlbach (2006) further stated that customer voice is a product of demand and supply. He describes voice (in contrast to exit) an option for customers receiving poor quality of service toexert pressure on public service providers to improve their performance. Andreassen and Lindestad (1998) state that people might be loyal to a company for three reasons: high switching barriers, lack of alternatives or customer satisfaction. In Hirschman's model loyalty is ambiguous. Lowery et al (1992) however, present loyalty as both positively and negatively constructive. Positively when customers are satisfied with services or belief that service providers will sort out any problem that arise; and negatively when customers are indifferent to any situation, which can be a sign of a possible neglect of services by communities.

3.2.1 Relationship of Exit, Voice and Loyalty in a Monopoly Market

Exit and voice and loyalty are three conceptually distinguishable responses to dissatisfaction where individuals or customers don't like the way things are going or when services are deteriorating in a competitive setting. Exit, voice and loyalty as responses to dissatisfaction of an organization or society, has its root in Hirschman (1970). Hirschman (1970) argued that firms, organizations and states recover from declines through exiting (withdraw or moving away from the relationship) or voice (attempting to improve it through communication of complaint, grievance or proposal for a change); and loyalty is the reason why anyone would use voice when exit is available (Withey & Cooper, 1989). However, while both exit and voice can be used to measure a decline in an organization, voice by character is more informative as it provides a reason for the decline; while exit alone provides the warning sign of decline in an organization. The interplay of loyalty can however affect the cost benefit analysis of whether to use exit or voice. By understanding the relationship between exit and voice and the interplay that loyalty has with choice, organizations can develop the means to better address their customers' concerns and thereby effect improvement.

3.3 Conceptual Framework

Based on the foregoing literature review, a model framework is proposed for analyzing the issue of service quality from the customer's perspective; in the context of urban water services in a developing economy, as a solution to the poor quality of service which has been a source of concern to the general public (customer groups and development agencies). The dependent concepts of interest in this study as shown in Figure 3.1, based on the literature reviewed, are: Urban service provider; Customers (internal and external); Service quality; Customer service (technical and functional service attributes); Customer satisfaction/dissatisfaction; Customer exit, voice and Customer loyalty.

The urban water service provider in the conceptual framework in figure 3.1 provides water services to the customers (internal and external) through its employees, who are also classified as internal customers in the first level of the framework. This is guided by literature, that the service culture and employees impact the service quality of public service providers, which in turn affects the satisfaction of the external customers (see Figure 3.1). In the second level of the framework, the service quality provided by the water service provider is determined by their expectation and service encounter (pre and after sales experience) of the customers. The demographic and socio-economic variables like gender, age and education are cross-tabulated with overall customer satisfaction to determine the level of their influence (Omonona, 2009).

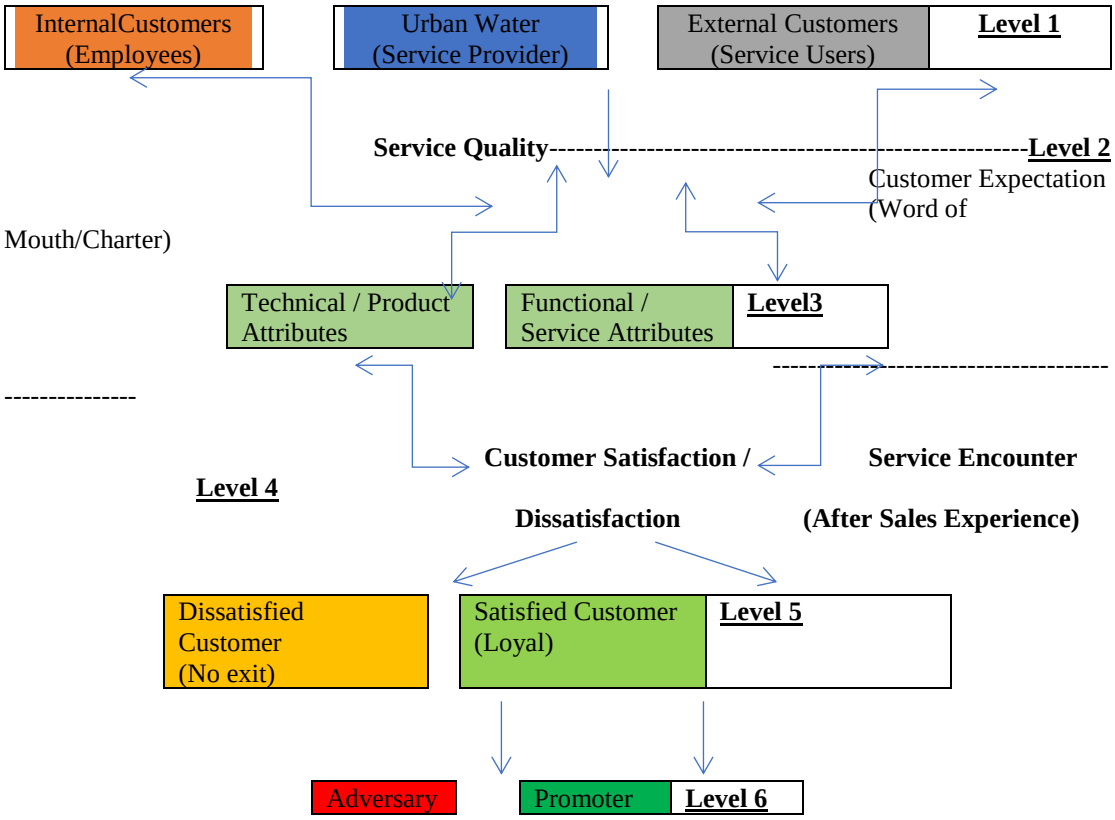

Figure 3.1: Schematic Concept of Model Framework

In an increasing number of countries attention is being focused on the quality of public services as measured objectively by customer satisfaction (Hill, 2007). In the third level, quality between the technical aspects of service delivery (known as Product quality) and the functional aspect (known as the customer experience) of service delivery is distinguished by literature (Zeithaml, 1988; Gronroos, 1983; Cronin and Taylor, 1994). Gronroos (1983) introduced the terms technical quality and functional quality to refer to this distinction. This model framework includes the technical and functional quality of services, which basically refers to whether the service does what it's supposed to; can be measured by conformance with engineering based specifications, unlike the SERVQUAL model. Non-technical or functional quality refers to the service user's definition of quality, which is a more subjective concept (Myers and Lacey, 1996).

In the fourth level, the level of customer satisfaction can easily be used to detect the variance in the quality of service by those with non-technical expertise, such as the customer groups and development agencies, using identified customer satisfaction indicators. In level five, customers whose expectations are not met and are dissatisfied with the level of service provided, have the option of voicing their dissatisfaction through a voice mechanism available or exit. And since physical exit is not practicable, the customers turn to an adversary of the service providers in level six. On the other hand, customers whose expectations are met and are satisfied with the service provider end up being loyal customers who promote the water service providers, also in level six.

Also of interest is the demographic characteristic of the customers, which includes Service area; Type of dwelling; Size of household; Gender; Age group; Educational level and Income group. It is important to determine the socio-economic characteristics of respondents to be compared with satisfaction. Using regression model, Omonona (2009) identified some factors that correlate with poverty and their influence on household; they include size of household, marital status and type of family, dwelling type, safe access to water, gender, age and education.

4. METHODOLOGY & MODEL DEVELOPMENT

4.1 Variable Measurement

To achieve the stated primary research question, information was collected at six levels on the following key elements. They comprise demography/socio-economic; water supply and willingness to pay; billing and connection; complaint management; customer requirements and priorities; customer satisfaction and loyalty. The information solicited from household members at individual and household level is included in table 4.1. The research model framework is used to help interpret the empirical data to be compiled during this research by evaluating the effectiveness of customer's satisfaction in assessing the service quality being provided by urban water service providers (utilities).

Table 4.1: Definitions of Conceptual Variables in a Monopoly Public Water Service Provider

	Concepts	Indicators and Variables	Indicative Hypothesis
1	Demography:	Service area i.e. type of dwelling; household composition; gender; age group; education and income of respondents.	H-1: User satisfaction declines if the demography is unfavourable (like rented house, living in higher floors, low occupation type, low education level, large family size, more females in family, low annual income level).
2	Product Service Quality:	Characteristics of water supply i.e. the pressure and regularity of supply;	H2: Sole dependence on public water service provider (monopoly) reduces user satisfaction
3	Service Quality attributes: (a sort of provider efficiency)	Pre and post sales service such as connection/disconnection of premises, tariff structure, billing accuracy	H3: Lower the service quality, lower the User satisfaction
4	Customer Satisfaction & Provider's complaints handling process attributes	Satisfaction or dissatisfaction with water supply service received i.e. reliability of water supply, color and appearance, water pressure, taste and smell, safety for drinking, level of customer service provided, the ease of contacting Water Board staff, clarity and information/advice provided, time taken to respond to Complaints, the way enquiries/complaints are dealt with, helpfulness and interest showed by staff as a valued customer.	H4: More service alternates if available leads to higher User satisfaction due to substitute effect H5: If alternates breakdown frequently lower the user satisfaction
5	Process Attributes – Customer Voice:	Complaint management i.e. how are complaints made if respondent has complained before, overall satisfaction with the way complaint was handled, acknowledged complaints, advice how long complaint would take to resolve, write or call to inform that complaint has been resolved, advice on right of appeal if not satisfied and provide information how complaint would be dealt with and time frame.	H6: If the process of service availability is good, the user satisfaction is high
6	Customer Loyalty:	If opinion about Water Board has changed or unchanged, how likely would water service provider remain a chosen water service provider if given the choices, how likely water service provider would be recommended to family and friend by the user?	H7: If service attribute experienced by the user is good, the user derives higher satisfaction

A summary of some of the methodologies most used in the last few years to evaluate user satisfaction with public services and their characteristics are reported in Table 4.2.

Table 4.2. Summary of the characteristics of some of the main methodologies available to analyze satisfaction for public services.

Methodology	Category	Characteristics	Early Research Studies
Logit, probit and linear regression	Model-based	Dependence analysis. Satisfaction is explained by some hypothesized determinants. Only one response variable (one item at a time) is considered	Manzi and Ferrari (2014) Cameron and Trivedi 2005 Jilke and Van De Walle (2013) Fiorio and Florio (2011)
Multilevel models (ML)	Model-based	Dependence analysis. Satisfaction is still explained by some hypothesized determinants as above but at different levels, e.g. at individual and country levels. Useful for hierarchical data. Only one response variable (one item at a time) is considered	Conway and Nicoletti 2006 Bacchiocchi, Florio, Gambaro (2011). Fiorio et al. (2007) Clifton, Díaz-Fuentes and Fernández-Gutierrez Rahmqvist and Bara (2010)
Nonlinear principal component analysis (NPCA)	Synthetic measures &composite indicators	The focus is on measurement. More items (aspects) of satisfaction can be taken into consideration and weighted accordingly. Level of satisfaction, importance of items and optimal quantifications of answers are determined	Ferrari, Annoni, and Manzi (2010) Gifi (1990) Michailidis and De Leeuw (1998) Ferrari and Barbiero 2011
Rasch model (RM)	Synthetic measures & composite indicators	The focus is on measurement. Level of satisfaction and quality of items (aspects) of satisfaction can be assessed	Rasch (1960)
RM + NPCA	Synthetic measures & composite indicators	The complementary use of RM and NPCA allows for the joint representation of quality and importance of items in order to provide a set of indicators to decision-makers	
NPCA + ML	Synthetic measures & composite indicators + models	Both synthesis and explanatory analyses are considered. The ML model is applied on a synthetic measurement of satisfaction obtained via NPCA	
Bayesian networks	Model-based	Models of cause and effect. Only one response variable is processed at a time	Salini and Kenett (2009) Annoni (2007) Annoni and Brüggemann (2009)
Averaging	Synthetic and comparative tools	Immediate synthetic indicator. Comparative analysis based on conditional mean values of observations	Clifton and Díaz-Fuentes (2010)
PLS (Partial Least Square Method)	Model based	Structured Equation Modeling	Wold 1982 Tenenhaus et al. 2005
LISREL	Model based	Linear Structured Relationship	Jöreskog 1970; O'Brien and Homer 1987
ANN	Model-based	Artificial Neural Network for Water Demand Forecasting (WDF)	Jain et al. (2001) Jain and Ormsbee (2002) Bougadis et al. (2005) Adamowski (2008) White and Fane, (2002)

4.2 Models Application to PAC – Bangalore-India - A Case Study

In this section, we show how the methods described above are apt to take into consideration the different facets of a complex concept such as satisfaction with public service provision. Public Affairs Centre, Bangalore carried out 'An Assessment of Bangaore Water Supply and Sewerage Board's (BWSSB) Services" in Bangalore based on the Citizen Report Card approach pioneered by it. The study was based on user feedback generated through a scientific random survey of users and service providers. Median Insights and Research, one of the social and market research organizations based in Bangalore conducted the field survey. The objectives of the study were as follows:

- To systematically assess the quality, responsiveness and outcomes of the basic services provided by Divisional, Sub-divisional and Service Stations to the public;
- To generate a better understanding of the problems and constraints being faced by the BWSSB staff in their role as service provider to the community; and
- To assist the BWSSB to use the information and knowledge generated through the study so that actionable policies and remedies can be formulated.

Public Affairs Centre (PAC) is a leading not-for-profit independent think-tank dedicated to mobilizing a demand for good governance in India. PAC's tools are designed towards allowing citizen-monitoring of public service delivery and it's most famed innovation, the Citizen Report Card (CRC)approach, has received much acclaim globally, earning extensive mention in the World Bank's World Development Report 2004, 'Making Services Work for Poor People'. PAC's work is primarily organized around the premise that an informed and active citizenry is the key to improved governance. The Citizen Report Card (CRC) is a simple and credible tool to provide systematic feedback to public agencies about various quantitative and qualitative aspects of their performance. CRCs elicit information about users' awareness, access, usage and satisfaction with public services. This assessment of delivery of services at the level of Divisional, sub-divisional and service stations was done through a random sample survey of consumers and BWSSB staff. The survey of consumers focused on their experience in availing the services from BWSSB and thus shed much needed light on an area where the department spends a major part of its resources and deploys large number of its manpower. Interviews with the BWSSB staff on the other hand, elicited their views on how well they are able to provide services to their users and the difficulties and constraints they face in the course of this work.

The research design involved in-depth scoping exercises among a small sample of users and providers to collect information, which was then used to populate three types of data collection instruments – for consumers, for senior-level BWSSB officials and other BWSSB personnel. The development of a scientific sampling design, finalization of the questionnaires, and implementation of the CRC survey after receiving approval from the BWSSB Core Committee followed this. Data collection was carried out through the CAPI (Computer Assisted Personal Interview) method using ODK software. Intense quality monitoring exercises were carried out to ensure data credibility. Upon completion of the survey, data analysis and interpretation were conducted. In all, more than 2600 interviews were carried out among various segments of stakeholders. The report was qualitative and basic and is available by accessing the link: http://pacindia.org/

As a pilot experiment, this research focuses on users' satisfaction of water supply services to keep the study tractable. We focus on the least known in the econometric context, referring to Florio (2013) for other analyses. Specifically, we focus in this paper the unique Multivariate Choice Model (MCM-not applied so far in users' satisfaction context in the past) and compare it with Logit model, which has been rarely applied in user satisfaction context. In our next paper, we extend multivariate choice model to an alternative artificial neural network (ANN) framework for prediction and policy formulation.

All the analyses are performed on the same type of data set using 1944 samples which contained full information. Following specific variables are identified for MCM analysis (Table 4.3.) and specific hypotheses are stated with the expected sign on the various dimensions of users 'satisfaction of water service provider.

Table 4.3 Variables for MNL Modelling from PAC USER Survey

Category	Variable (X_i)	Description (Units of metric)	Hypothesis	Expected sign on the variable
Demography	X_1	Occupancy status of the house (1/2/…./4)	H_1: User satisfaction declines if the demography is unfavourable and the service attribute is weak (like rented house, living in higher floors, low occupation type, low education level, large family size, more females in family, low annual income level.	-
Demography	X_2	Number of floors (1/……./6)	Same as H_1	-
Demography	X_3	Occupation of the main earning member (1/…./8)	Same as H_1	-
Demography	X_4	Education level (1/……./9)	Same as H_1	-
Demography	X_5	Family size (1/……/9)	Same as H_1	-
Demography	X_{5b}	Total females in the family	Same as H_1	+/-
Demography	X_6	Annual income Currency INR (1/……../6)	Same as H_1	-
Usage pattern	X_7	Main source of water used (1/…….8)	H_2: Sole dependence on public water service provider (monopoly) reduces user satisfaction	-
Product Service quality	X_{7a}	Water connection	Same as H_2	-
Product Service quality	X_8	Frequency of water supply (1/…../5)	H3: Lower the service quality, lower the User satisfaction	+
Product Service quality	X_9	Duration of water supply (1/…../5)	Same as H_3	+
Product Service quality	X_{13}	How often the user would like to get the service (1/.4)	Same as H_3	+
Product Service quality (Technical attribute)	X_{14}	Pressure of supply (1/2/3)	Same as H_3	+ (Numerically coding is reversed so -)
Coping strategy – Physical service attribute	X_{14a}	Coping strategy coping yes/No	Same as H_3	+ Numerically coding is reversed so -)
Coping strategy - Physical service attribute	X_{15}	Frequency of bore well water supplied (substitute) 1/../6)	H_4 :If more alternates are available higher the User satisfaction due to substitute effect	+
Coping strategy - Physical	X_{17}	Breakdowns experienced in substitute?	H_5 : If alternates breakdown frequently lower the user satisfaction	-

service attribute				
Y_1		Satisfied by quantity supplied? (1/2/3)	If the supply meets their daily requirement, there is more satisfaction.	
Y_2		Satisfied by quality supplied? (1/2/3)	User is more satisfied if the water is drinkable.	
Process attributes	X_{20}	How did you apply for a new connection? (1/2)	H_6 : If the process of service availability is good, the user satisfaction is high	+
Process attributes	X_{24}	Where did you get the info on the process of getting connection from? (1/….5/6)	Same as H_6	+
Process attributes	X_{25}	Details of forms required	Same as H_6	+
Process attributes	X_{26}	Were you able to produce all necessary documents easily? (1/2)	Same as H_6	+
Process attributes	X_{27}	Visit details – form submission	Same as H_6	+
Process attributes	X_{28}	Visit details – follow-up	Same as H_6	+
Process attributes	X_{29}	Visit details - installation	Same as H_6	+
Process attributes	X_{46}	Do you have rainwater harvesting (RWH) substitute system in your house? (1/2)	H_4 : More alternates if available higher the User satisfaction due to substitute effect	+
Service attribute	X_{51}	Water meter- bill-accuracy	H_7 : If service attribute experienced by the user is good, the user derives higher satisfaction	+
Service attribute	X_{52}	Water meter – monthly bill-payment	Same as H_7	+
Service attribute	X_{53}	Water meter – impression tariff	Same as H_7	+(Numerically coding is reversed so -)
Service attribute-Complaints resolution	X_{54}	Problem resolution – irregular supply	Same as H_7	-
Service attribute-Complaints resolution	X_{55}	Problem resolution – problem - BWSSB	Same as H_7	+
Service attribute	X_{57}	Are you aware of the info booklet (BWSSB Consumer Charter) (1/2)	Same as H_7	+
Service attribute	X_{58}	Are you aware of any customer interaction meetings held by BWSSB in various technology platform for creating awareness	Same as H_7	+

		of BWSSB services? (1/2/3)		
Overall Satisfaction	Y_3	Considering all aspects of services, how satisfied are you with the BWSSB services? (1/2/3)	Cumulative effect of all services considered determines the overall satisfaction	

4.3 Logit Model

Unordered-choice models can be motivated by a random utility model. For the *i* th consumer faced with *J* choices, suppose that the utility of choice *j* is

$$U_{ij} = \mathbf{z'_{ij}}\ \boldsymbol{\beta} + \varepsilon_{ij}$$

If the consumer makes choice *j* in particular, then we assume that U_{ij} is the maximum among the *J* utilities. Hence, the statistical model is driven by the probability that choice *j* is made, which is

$$\text{Prob}(U_{ij} > U_{ik}) \text{ for all other } k \neq j.$$

The model is made operational by a particular choice of distribution for the disturbances. Two models have been considered, logit and probit. Because of the need to evaluate multiple integrals of the normal distribution, the probit model has found rather limited use in this setting. The logit model, in contrast, has been widely used in many fields, including economics, market research, and transportation engineering. Let Y_i be a random variable that indicates the choice made. McFadden (1973) has shown that if (and only if) the *J* disturbances are independent and identically distributed with type I extreme value (Gumbel) distribution,

$$F(\varepsilon_{ij}) = \exp(-e^{-\varepsilon ij}),$$

Then, $\text{Prob}(Y_i = j) = e^{z'ij\beta} \div \sum_{j=1}^{J} e^{z'ij\beta}$ which leads to what is called the **conditional logit** model.

The conditional logit method of analysis is done to explore the characteristics that discriminated between User satisfactions due to quality, quantity, process of service provider. This procedure is preferred to the various statistical and econometric models used by earlier authors detailed in Table 4.2, for four main reasons: (i) the dependent (three-categories of user satisfaction) variable is categorical and discrete in nature instead of continuous dependent variable viz., quality satisfaction, quantity satisfaction and overall satisfaction which are unordered; (ii) probability values in discriminant analysis fall outside 0 and 1 range; (iii) since the three user satisfactions are independent from each other, assumption of independence of irrelevant alternatives (IIA) is not violated thus, MNL model estimates are robust, and (iv) the methodology richly captures behavioural aspects of decision makers (see Ben and Lerman (1985) for more business applications). The conditional logit model is of the following empirical form:

$$\textbf{Probability } (Y_i = j) = \sum_{k=0}^{2} e^{\beta' X_j} \div e^{\beta' X_k} \qquad \textbf{where j = 0, 1 and 2}$$

The right hand side variables in equation 1 are regressors vector **X** which are the independent factors listed in Table 4.3. β are the maximum likelihood logistic coefficients (estimated by the model using iterative maximum likelihood procedure), and explain the impact of each of the independent factors on the probability of improving the User satisfaction. As the β coefficients in MNL model are difficult to interpret, we focus our discussion in this paper on marginal effects[1]. The marginal effect is the change in the conditional probability of the user satisfaction associated with a one-unit change in the independent variable away from its mean, holding remaining independent variables at their mean values.

4.4 Multivariate Choice Model

An extension of the probit model would be to allow more than one equation, with correlated disturbances, in the same spirit as the seemingly unrelated regressions model. The general specification for a two-equation model would be

$$Y_1^* = X_1'\beta_1 + \varepsilon_1,\ Y_1 = 1, \text{ if } Y_1^* > 0,\ 0 \text{ otherwise}$$
$$Y_2^* = X_2'\beta_2 + \varepsilon_2,\ Y_2 = 1, \text{ if } Y_2^* > 0,\ 0 \text{ otherwise}$$
$$E[\varepsilon 1 \mid \mathbf{x}1, \mathbf{x}2] = E[\varepsilon 2 \mid \mathbf{x}1, \mathbf{x}2] = 0,$$
$$\text{Var}[\varepsilon 1 \mid \mathbf{x}1, \mathbf{x}2] = \text{Var}[\varepsilon 2 \mid \mathbf{x}1, \mathbf{x}2] = 1, \textit{and } \text{Cov}[\varepsilon 1, \varepsilon 2 \mid \mathbf{x}1, \mathbf{x}2] = \rho.$$

[1]The marginal effect of the factors on the probabilities of the export performance is given by the expression: $\boldsymbol{\delta P_j / \delta X_i = P_j\,[\beta_j - \beta]}$

The Lagrange multiplier statistic is a convenient device for testing for the absence of correlation in this model. Under the null hypothesis that ρ equals zero, the model consists of independent probit equations, which can be estimated separately. Moreover, in the multivariate model, all the bivariate (or multivariate) densities and probabilities factor into the products of the marginals if the correlations are zero, which makes construction of the test statistic a simple matter of manipulating the results of the independent probits. In principle, a multivariate model would extend bivariate probit to more than two outcome variables just by adding equations. The practical obstacle to such an extension is primarily the evaluation of higher-order multivariate normal integrals. Some progress has been made on using quadrature for trivariate integration, but existing results are not sufficient to allow accurate and efficient evaluation for more than two variables in a sample of even moderate size.

5. Model Results and Discussion

We first run Logit models for Y1, Y2 and Y3 independently and then multivariate system model jointly to check the robustness of the model results. In all these models (Y_{ij} = 1, 2, 3, satisfied and highly satisfied users are coded as 1 and dissatisfied users 0). Using Variance inflation factor (VIF) as diagnostic tool, all regressors with VIF > 10 which signify multi-collinearity are dropped from the model estimation. Probability in Logit (Y_1) is expressed as relative probability of quality satisfaction (1) relative to quality dissatisfaction. Table 5.1 summarizes the results of Logit model for Y_1 (Quality Satisfaction) of users. Demographic variable X_2 represents the living status of the users, whether the user stays in house with 1 floor, or 2 floors or 3 floors….. Coded as Ground-2; Ground + first – 3; Ground + two – 4; Multi-storeyed – 5 ;…..).

Demographic variable X_3 represents the user's occupancy status, (coded as labourer -1; petty business – 2; self-employed-3; Government service -4; Private Service -5). Demographic variable X_{5b} represent female gender (coded as 1-male; 0 female). All these demographic variables are found to be significant for explaining user's quality satisfaction. Standalone they have no meaning. Hence they have to be combined as interacting variables with various dimensions of attributes. We focus our discussion with statistically significant variables as below.

Frequency of water supply (X_8) is a service quality dimension variable (frequency of water supply coded as 1 – every day; 2-once in 2 days; 3-once in 3 days; 4 - 4 to 5 days; 5-irregular supply). This variable has negative sign and is statistically significant at 5% error level. This implies that, user is dissatisfied if the supply is irregular and infrequent. The marginal effect shows that if the frequency improves from irregular to frequent, the user's quality satisfaction improves by 0.0286%.This variable (X_8) when combined with the floor occupancy (X_2) as an interaction variable, i.e., $X_2 * X_8$ is found to be positive but not significant. This implies that users staying at lower level of their house and having high frequency (or regular) water supply are satisfied which makes sense. But this variable jointly is not significant while standalone both are significant.

Table 5.1 Summary of Statistically Significant Factors Discriminating Various Dimensions of User Quality Satisfactions relative to quality Dissatisfaction [Probability of (Y_1 to relative to Y_0)]

Code	Variable description	Quality Satisfaction	Linkage to Hypotheses (H)
	Demographic factors	**Marginal Effect**	
X_2	House – Number of floors	0.0106**	H1
X_3	Occupation of the main earning member	-0.00232	H1
X_{5b}	Gender - Female	-0.00527**	H1
	Usage Pattern & Service Attributes		
X_8	Frequency of water supply	-0.0298**	H3
	Coping Strategy Attributes		
X_{15}	Alternative water supply (provision of bore water)	0.0261**	H4
	Water – Complaints & Resolutions		
X_{54}	Prior notification from the supplier	-.0529***	H7
X_{58}	Customer interaction meetings arranged by the service provider with users	0.0522***	H7
	Interaction of Demography with various attributes		
	$X_3 * X_{15}$	-0.0034**	H1 & H4
	$X_3 * X_{54}$	0.00624***	H1 & H7
	$X_3 * X_{58}$	-0.00501**	H1 & H7

*** Statistical significance at α 0.001; ** Statistical significance at α 0.01 to 0.03; * Statistical significance at α 0.05

Availability of bore water from provider (X_{15}) is a service quality dimension coping strategy variable (coded as 1 – daily; 2-once in 2 days; 3-once a week; 4 –do not receive). This variable has positive sign and is statistically significant at 5% error level. This implies that, user is satisfied if the supply is regular and frequent. This variable (X_{15}) when combined with user occupation (X_3) as an interaction variable, i.e., X_3* X_{15} is found to be negative but significant at 5% error level. This implies that users at the high occupation level (government or private sector users) and having irregular bore water supply are dissatisfied which makes sense. The marginal effect shows that if the bore water supply improves from irregular to daily, the user's quality satisfaction improves by 0.0034%. This variable jointly is significant at 5% error level.

Prior notification from the supplier (X_{54} coded as always -1; sometimes -2; never-3) is highly significant with negative sign for user quality satisfaction. Together with user's occupation level (X_3), i.e., X_3 * $X_{54}$the interaction variable has positive sign and is statistically significant at less than 1% error. This implies that if the user is of high occupation level (like government and public service) and if they are well informed in advance about the irregular supply, user's probability of quality satisfaction increases (the marginal effect being 0.00624%).

With regard to customer interaction meetings arranged by the service provider with users (X_{58} coded as yes-1; no-2; I don't know -3), the sign of relationship with user quality satisfaction was positive and significant at 5% error level. This implies more such meetings from the providers help users to become aware of the processes of the water provider in making alternative arrangements in case of emergency of non-supply or interruptions if any. This makes sense. Together with user's occupation level (X_3), i.e., X_{58} * $X_3$the interaction variable has negative sign and is statistically significant at 5% error. This implies that if the user is of high occupation level (like government and public service) and if they are not well informed about the providers activities their probability of quality satisfaction decreaseswhich makes sense (the marginal effect being 0.00501%).

Pseudo-R^2 of the Logit – Y_1model is 36.55% which indicates the Logit model reasonably fits the behaviour of users'quality satisfaction dimensions under the framework, considering the fact that the data is cross-sectional from survey responses. The model also correctly classifies 98% of the satisfied users and 29% of dissatisfied users with overall correct classification of 92.80%.

Logit model results for Y_2 (Quantity Satisfaction) of users.

Similar to Quality Satisfaction of Users, Demographic variable X_2 representing the living status of the users, Demographic variable X_3 representing the user's occupancy status, Demographic variable X_{5b} representing female gender (coded as 1-male; 0 female) are found to be significant for explaining user's quantity satisfaction. Standalone they have no meaning. Hence they have to be combined as interacting variables of various dimensions. We focus our discussion with statistically significant interactive variables as below (Table 5.2).

Duration of water supply (X_9) is a service quality dimension variable in terms of number of hours water supply is available for the user on the day of supply (coded as 1 – less than a hour; 2-one to two hours; 3-two to three hours; 4 –three to five hours; 5-more than 5 hours). This variable has negative sign and is statistically significant at 10%. This implies that, user is dissatisfied if the supply is for longer duration which does not make sense. However, this variable (X_9) when combined with the user's occupancy status (X_2) as an interaction variable, i.e., X_2* X_9 is found to be positive and significant at 10% error level. This implies that users at the low occupancy status (like ground floor and first floor) when they have long duration of water supply they are satisfied which makes sense. The marginal effect is 0.0128%.

Table 5.2 Summary of Statistically Significant Factors Discriminating Various Dimensions of User Quantity Satisfactions relative to quantity dissatisfaction [Probability of (Y_2 to relative to Y_0)]

Code	Variable description	Quality Satisfaction	Linkage to Hypotheses (H)
	Demographic factors	**Marginal Effect**	
X_2	House – Number of floors	0.0277***	H1
X_3	Occupation of the main earning member	-0.00546**	H1
X_{5b}	Gender - Female	-0.0117***	H1
	Usage Pattern & Service Attributes		
X_9	Duration of water supply	-0.0315*	H3
	Coping Strategy Attributes		
X_{13}	How often would you like to get water?	-0.018*	H3
X_{14}	On the day of supply, what is the pressure of water	-0.000273	-
X_{15}	Alternative water supply (provision of bore water)	0.0419*	H4
	Water – Complaints & Resolutions		
X_{54}	Prior notification from the supplier	-.0431	
X_{58}	Customer interaction meetings arranged by the service provider with users	0.0063	
	Interaction of Demography with various attributes		
	$X_2 * X_9$	0.0129*	H1 & H3
	$X_2 * X_{54}$	-0.0247*	H1 & H7
	$X_3 * X_{14}$	-0.00924**	H1 & H3
	$X_5 * X_9$	0.00716*	H1 * H3
	$X_9 * X_{15}$	-0.0116**	H3 & H7

*** Statistical significance at α 0.001; ** Statistical significance at α 0.01 to 0.03; * Statistical significance at α 0.05

Similarly interaction of total family size (X_5) with the duration of water supply (X_9) as an interaction variable, i.e., $X_5 * X_9$ is found to be positive and significant at 10% error level. This implies that users with large family size when they have long duration of water supply, they are satisfied which makes sense. The marginal effect is 0.00716%.

As to the question how often the user like to get water (X_{13} coded as all day – 24 hours 1; more than once a day-2; once a day-3; at least once in 2 days) is significant at 10% error level for user's quantity satisfaction and is negatively related. This means, if the service provider reduces the frequency of water supply, then the user's probability of dissatisfaction increases. This makes sense (the marginal effect being -0.0180%).

Pressure of water supply from provider (X_{14}) is a service quality dimension coping strategy variable (coded as 1 – High pressure; 2-Medium pressure; 3-Low pressure). This variable has positive sign and is statistically not significant. This variable (X_{14}) when combined with user occupation (X_3) as an interaction variable, i.e., $X_3 * X_{14}$ is found to be negative but significant at 5% error level. This implies that users at the high occupation level (government or private sector users) and having low pressure of water supply are dissatisfied which makes sense. The marginal effect is -0.0094%.

While alternative water supply (provision of bore water X_{15} coded as daily-1; alternate days - 2; once a week-3; and do not receive at all - 4), singly impact user's quantity satisfaction positively and is significant at 10% error level. This implies availability of alternative water supply satisfies the user quantitatively. But jointly with user's family size (X_5), the interaction variable has negative sign and is statistically significant at 5% error. This implies that availability of alternative water supply from the provider to large family size reduces the probability of quantity satisfaction as the quantity of bore water is inadequate for the large families (the marginal effect being -0.0116%).

Prior notification from the supplier (X_{54} coded as always -1; sometimes -2; never-3) is not significant and has negative sign for user quantity satisfaction. But together with user's floor occupancy (X_2), the interaction variable has negative sign and is statistically significant at 10% error level. This implies that low level occupants (like ground and first floor users) if they are not informed in advance about the water supply interruption, their probability of quantity satisfaction decreases which makes sense (the marginal effect being -0.0247%).

Pseudo-R^2 of the Logit – Y_2 model is 8.98% which indicates the Logit model explains the behaviour of users' quantity satisfaction dimensions under the framework only to the extent of 8.98%.

The model correctly classifies 99.8% of the satisfied users and 3% of dissatisfied users with overall correct classification of 91.82%.

Logit model results for Y_3 (Overall Satisfaction) of users.

Only demographic variable X_2 representing the living status of the users is found to be significant at 10% error level for explaining user's overall satisfaction. Interestingly the interaction of this variable with other attributes was found to be insignificant. The only single attribute that explained the user's overall satisfaction was related to information awareness for getting water supply connection (X_{25}) processed through websites, staff members, neighbours, relatives and friends. That too the variable has negative sign and was significant at 10% error level. This implies that self-awareness of the connection process is more important to the user than soliciting information from outside sources for getting water connection. This self-awareness totally satisfies the user about the provider's services. Table 5.3 summarises model results of Logit (Y_3) of users' overall satisfaction of provider services.

Table 5.3 Summary of Statistically Significant Factors Discriminating Various Dimensions of User Overall Satisfaction relative to overall dissatisfaction [Probability of (Y_3 to relative to Y_0)]

Code	Variable description	Quality Satisfaction	Linkage to Hypotheses (H)
	Demographic factors	**Marginal Effect**	
X_2	House – Number of floors	0.00156	
	Usage Pattern & Service Attributes		
	None significant		
	Coping Strategy Attributes		
	None significant		
	Water – Complaints & Resolutions		
X25	Information availability to the user about service connections	-0.423	
	Interaction of Demography with various attributes		
	None significant		

*** Statistical significance at α 0.001; ** Statistical significance at α 0.01 to 0.03; * Statistical significance at α 0.05

5.4 Multivariate Discrete choice Model Results

Table 5.4 displays multivariate choice model (system) results.

Table 5.4 Summary of Statistically Significant Factors Discriminating Various Dimensions of User Quality, Quantity and Overall Joint Satisfactions as a System

Code	Variable description	Linkage to Hypotheses (H)	Quality Satisfaction (Y_1)	Quantity Satisfaction(Y_2)	Overall Satisfaction (Y_3)
			Probability of Y_i conditional on $Y_{j\ ij}$ = 1,2,3		
	Demographic factors		**Marginal Effect**	**Marginal Effect**	**Marginal Effect**
X_2	House – Number of floors	H_1	0.173**	0.218***	0.310**
X_{5b}	Gender - Female	H_1	-0.0867**	-0.103***	0.0466
	Usage Pattern & Service Attributes				
X_7	Main source of water used	H_2	0.0325	0.0450	-0.434
X_8	Frequency of water supply	H_3	-0.387	-0.212	-0.681
X_9	Duration of water supply	H_3	-0.214	-0.175	-0.0912
	Process & Coping Strategy Attributes				
X_{14}	On the day of supply, what is the pressure of water	H_3	-0.340	-0.197	-0.986
X_{14a}	Coping strategy yes/no	H_3	-0.368	0.120	1.196
X_{15}	Alternative water supply (provision of bore water)	H_4	0.379	0.529**	-0.520
$X_{26\_}$	Providing all necessary documents easily?	H_6	-0.00430	-1.188**	4.364
	Water – Complaints & Resolutions				
LnX_{52}	Water meter – monthly bill-payment	H_7	0.0974	-0.148	-0.178
X_{53}	Water meter – impression tariff?	H_7	0.209	-0.724**	0.442
X_{54}	Prior notification from the supplier	H_7	-0.664*	0.0214	0.717
X_{55}	Problem resolution – with service provider	H_7	0.359*	0.313	0.689*
X_{58}	Customer interaction meetings arranged by the service provider with users	H_7	0.713**	0.180	0.390
	Interaction of Demography with various attributes				
	X_2* X_7	H_1 & H_2	0.161	-0.145**	0.362
	X_2* X_8	H_1 & H_3	0.165*	0.210**	-0.0212
	X_2* X_9	H_1 & H_3	0.0445	0.135**	0.283
	X_2 * X_{53}	H_1 & H_7	0.0275	0.371***	-0.0353
	X_2 * X_{58}	H_1 & H_7	-0.158	-0.241**	-0.191
	X_{5b} * X_8	H_1 & H_3	-0.196**	-0.0534	0.232
	X_{5b} * X_9	H_1 & H_3	0.0838*	0.0397	-0.0225
	X_{5b} * X_{14}	H_1 & H_3	-0.0186	-0.0458	0.430**
	X_{5b} * X_{14a}	H_1 & H_3	-0.140	-0.150	-0.671**
	X_{5b} * X_{15}	H_1 & H_4	-0.0821	-0.189***	-0.359
	X_{5b} * X_{52}	H_1 & H_7	0.0640	0.0881*	0.0250

*** Statistical significance at α 0.001; ** Statistical significance at α 0.01 to 0.03; * Statistical significance at α 0.05

Demographic variable X_2 represents the living status of the users, whether the user stays in house with 1 floor, or 2 floors or 3 floors….. Coded as Ground-2; Ground + first – 3; Ground + two – 4; Multi-storeyed – 5 ;…..). Demographic variable, X_{5b} represent female gender (coded as 1-male; 0 female). These demographic variables are found to be significant in system for explaining user's quality, quantity and overall satisfaction. Standalone they have no meaning. Hence they have to be combined as interacting variables with various dimensions of attributes (Omonona, 2009). We focus our discussion with statistically significant variables in Table 5.4.

Similarly interaction of females (X_{5b}) with the duration of water supply (X_9) as an interaction variable, i.e., X_{5b}* X_9 is found to be positive and less significant at 10% error level to explain quality

satisfaction of users but not quantity and overall satisfaction. This implies that females when they have long duration of water supply, are satisfied which makes sense. The marginal effect is 0.0867%.

With regard to the sources of water which the users resort to (tap at home coded as 1, public tap coded as 2, ….., tanker supply (free of cost coded as 6 and tanker supply with cost coded as 7), the relationship was not significant in all three equations. But when combined with demographic variable of number of floors (X_2) the relationship was negative and significant at 5% error level in Y_2 equation (and not in Y_1 and Y_3 equations). This implies that users residing in low floors were not satisfied with the alternative supplies when it involved cost quantity.

Frequency of water supply (X_8) is a service quality dimension variable (frequency of water supply coded as 1 – every day; 2-once in 2 days; 3-once in 3 days; 4 - 4 to 5 days; 5-irregular supply). This variable has negative sign and is not statistically significant across Y_1, Y_2, and Y_3 equations jointly. This variable (X_8) when combined with the floor occupancy (X_2) as an interaction variable, i.e., $X_2 * X_8$, is found to be positive and significant at 10% error level in equation Y_1 and 5% error level in Y_2 equation but not in Y_3 equation. This implies that users staying at lower level of their house and having high frequency (or regular) water supply are satisfied both with quality and quantity but are not overall satisfied. This variable X_8 together with female gender variable X_{5b} has negative sign in Y_1 equation and not in Y_2 and Y_3 equations signifying that females are not satisfied if the frequency of water supply is irregular.

Duration of water supply (X_9) is a service quality dimension variable in terms of number of hours water supply is available for the user on the day of supply (coded as 1 – less than a hour; 2-one to two hours; 3-two to three hours; 4 –three to five hours; 5-more than 5 hours). This variable has negative sign and is not statistically significant across all 3 equations. However, this variable (X_9) when combined with the user's occupancy status (X_2) as an interaction variable, i.e., $X_2 * X_9$ is found to be positive and significant at 5% error level in equation Y_2 (and not in equations Y_1 and Y_3). This implies that users at the low occupancy status (like ground floor and first floor) when they have long duration of water supply they are satisfied quantity-wise (but not quality-wise and overall). The marginal effect is 0.135%.

Pressure of water supply from provider (X_{14}) is a service quality dimension coping strategy variable (coded as 1 – High pressure; 2-Medium pressure; 3-Low pressure). This variable has negative sign and is statistically not significant across all three equations. This variable (X_{14}) when combined with female gender variable (X_{5b}) as an interaction variable, i.e., $X_{5b} * X_{14}$ is found to be positive and significant at 5% error level in equation Y_3. This implies that female users when they have high pressure of water supply are overall satisfied which makes sense. The marginal effect is 0.43%.

As to the question of how users cope up with daily water requirement (X_{14a}) (purchase from outside coded as 1, borrow from neighbours coded as 2, and others coded as 3), the variable had no significant impact in all the 3 equations. But when combined with female gender variable (X_{5b}) the relation was negative and significant at 5% level in equation 3. This implies that particularly female users were overall not satisfied if they have to purchase from outside or borrow from neighbours to cope when the service provider did not supply regular water.

Availability of bore water from provider (X_{15}) is a service quality dimension coping strategy variable (coded as 1 – daily; 2-once in 2 days; 3-once a week; 4 –do not receive). This variable has positive sign and is statistically significant at 5% error level in Y_2 equation but not in Y_1 and Y_3 equations. This implies that, users are satisfied with the quantity if the supply is regular and frequent. This variable (X_{15}) when combined with female gender variable (X_{5b}) as an interaction variable, i.e., $X_{5b} * X_{15}$ is found to be negative but highly significant at less than 1% error level. This implies that female users in the family are highly not satisfied with the quantity of alternative supply provided through bore water. The marginal effect shows that if the bore water supply improves from irregular to daily, the female user's quality satisfaction improves by 0.189%.

As to the process attribute, were the users provided all necessary documents easily to get service connection (X_{26}), the relation was negative and significant at 5% error level. This implies that the documentation was probably not easier to process and hence were not satisfied. This suggests the need for the service provider to simplify documents and making it easy for compliance by the users for obtaining service connections.

With regard to user impression of monthly water bill payment (Ln X_{52}), there was no significant on the user's satisfaction across all three equations. However interaction of this variable with female gender variable (X_{5b}), there was positive relationship across all the three equations but less significant relation in Y_2 equation. This implies that female users in the family were generally satisfied with the tariff charged by the supplier.

Similarly, with regard to impression of users on tariff charged for the services (X_{53} High tariff coded as 1, just right 2, and low coded as 0) there was negative and significant relationship with Y_2.

This implies that users were generally happy as the tariff reduced the satisfaction increased. When combined with demographic variable number of floors (X_2), the relationship was positive across all three equations and was highly significant at error level less than 1% in equation Y_2. This signifies that users residing in low level floors were highly satisfied with tariff charged by the service provider.

Prior notification from the supplier (X_{54} coded as always -1; sometimes -2; never-3) is less significant with negative sign for user quality (but not quantity and overall) satisfaction. This implies that if the users are well informed in advance about the irregular supply, user's probability of quality satisfaction increases (the marginal effect being 0.664%).

With regard problem resolution (X_{55}) the relationship was positive and less Signiant at 10% error level in equation 1 and 3. This means that users generally were overall satisfied with the way problems were handled on quality attributes but not on quantity attributes.

With regard to customer interaction meetings arranged by the service provider with users (X_{58} coded as yes-1; no-2; I don't know -3), the sign of relationship with user quality (but not quantity and overall) satisfaction was positive and significant at 5% error level. Together with demographic variable number of floors of the house (X_2), the users staying in low level floors are satisfied with customer interaction meetings although they are not overall satisfied. This implies more such meetings from the providers help users staying in low level floors to become aware of the processes of the water provider in making alternative arrangements in case of emergency of non-supply or interruptions if any. This makes sense.

5.5 Model Diagnostics

Table 5.5 summarizes the diagnostics of the three Logit and joint system MCM evaluated so far in Tables 5.1 to 5.4.

Table 5.5 Summary of Model Diagnostics

	Independent Logit Results			**Joint/System Multivariate Choice Model Results (Table 5.4)**		
	Model Y_1 (Table 5.1)	Model Y_2 (Table 5.2)	Model Y_3 (Table 5.3)	Y_1	Y_2	Y_3
Log Likelihood	-341.5***	-503.13***	-70.43***	Log likelihood = -868.28077***		
LR χ^2 (chi square)	393.42	99.33	54.12	Wald $\chi^2(135)$ = 382.58***		
Probability χ^2	0.0000	0.0000	0.0000	0.00000		
Number of Observations	1944	1944	1944	1944		
AIC	772.998	1066.27	180.87	2018.57		
BIC	1023.76	1233.44	292.32	2804.28		
Correct Classification (1)	98.32%	99.83%	100%	85.4%		
Correct Classification (0)	28.57%	2.5%	0%	2.02% (12.58% classification belong to 6 other categories of 1 & 0) which is unique to Multivariate probability prediction		
Total correct classification	92.8%	91.82%	99.13%			
(Cross equation 1 & 2) $\rho\varepsilon_{12}$					0.28404***	
(Cross equation 1 & 3) $\rho\varepsilon_{13}$						0.226846*
(Cross equation 2 & 3) $\rho\varepsilon_{23}$						0.754642***

Likelihood ratio test of $\rho\varepsilon_{12} = \rho\varepsilon_{13} = \rho\varepsilon_{23} = 0$: $\chi 2(3) = 42.3216$ Prob > $\chi^2 = 0.0000$

By considering the significance of cross equation error correlation in the multi-variate choice model (across three equations) and significance of Wald test for cross equation error ρ, the results of joint estimation (as in Table 5.4) is preferred to single equation logit results (i.e., Table 5.1 to 5.3). so, the discussion of results in section 5.4 would be desirable for policy initiatives.

6. STUDY CONCLUSIONS, LIMITATIONS AND FUTURE DIRECTIONS

6.1 Conclusions

The study objectives were: to identify factors for predicting overall users' satisfaction besides quality and quantity in a system context for assessing the services of public water utility firm; and to prescribe policy initiatives to improve the service delivery for ensuring higher users' satisfaction. Seven sets of hypotheses were formulated and tested.

Initially we applied Logit qualitative choice modeling methodology to a set of data collected by PAC in India to evaluate the users' satisfaction on quality, quantity and total satisfaction of water services provided by the public provider and several attributes were identified in the process to explain significant factors. These results were then checked in a system context using multi-variate methodology to check for the robustness and to check model specification. Wald test confirm that there exits cross equation correlation across quality, quantity and overall users' satisfaction dimensions. Based on the system model, the study concludes as below:

1. The system specification of the problem as in Table 5.4 is appropriate considering significance of Wald test.
2. User quality satisfaction (conditional to quantity and overall satisfaction) is significantly and positively influenced by:
   - Alternative water supply (X_{15} provision of bore water);
   - Service provider support in problem resolution (X_{55}) for the users;
   - Interaction meetings arranged by the service provider with users (X_{58}) ; and
   - User residence with low floors (X_2) with higher frequency of water supply (X_8).
   - Females (X_{5b}) with longer duration of water supply (X_9)
   - Females (X_{5b}) with correct bill payment for service provider (X_{52})

   All these attributes enable users to develop **loyalty to the service provider** due to high degree of quality satisfaction.
3. User quality satisfaction (conditional to quantity and overall satisfaction) is significantly and negatively influenced by:
   - Absence of prior notification by service provider about supply interruptions (X_{54})
   - Females (X_{5b}) experiencing irregular frequency of water supply (X_8)

   These attributes create anxiety and provides opportunity to users to **voice their quality dissatisfaction** of service provider.
4. User quantity satisfaction (conditional to quality and overall satisfaction) is significantly and positively influenced by:
   - Service provider support in problem resolution (X_{55}) for the users;
   - Interaction meetings arranged by the service provider with users (X_{58}) ;
   - Residing at lower levels (X_2 i.e., residing in ground and first floor) in their house and having supplies with higher frequency (X_8)
   - Females (X_{5b}) experiencing supplies with increased duration (X_9)

   All these attributes enable users to develop **loyalty to the service provider** due to high degree of quantity satisfaction.
5. User quantity satisfaction (conditional to quality and overall satisfaction) is significantly and negatively influenced by:
   - Non-easy documentation for service connection (X_{26})
   - Unfavourable impression of users on meter tariff (X_{53})
   - Females (X_{5b}) experiencing irregular infrequent supplies (X_8)
   - Higher number of floors (X_2) coupled with alternate water sources which require cost (X_7)
   - Higher number of floors (X_2) coupled with less interaction meetings arranged by the service provider with users (X_{58})
   - Females (X_{5b}) experiencing the alternate bore water supplies which entail cost (X_{15})

   All these attributes forces users to **voice their displeasure** on quantity supplied by the service provider.
6. User overall satisfaction (conditional to quality and quantity satisfaction) is significantly and positively influenced by:

- Ease with which service provider solves the problem of the user (X_{55})
- Females (X_{5b}) experiencing high pressure of water supplies (X_{14})

All these attributes enable users to develop **loyalty to the service provider** due to high degree of overall satisfaction.

7. User overall satisfaction (conditional to quality and quantity satisfaction) is significantly and negatively influenced by:
   - Females (X_{5b}) experiencing alternate supply of bore which entail cost to cope with their daily requirement (X_{14a})

6.2Policy Implications

It is prudent for the service provider to take note of the **voice attributes** summarised above and take corrective steps to continuously improve these features so that users are satisfied both by quality, quantity and overall satisfaction of the service provided. The policy initiatives in this regard help in developing users' loyalty to the service provider.

6.3 Limitation& Future Directions

The study used one period data which limits the analysis of users' behaviour. We propose to overcome this limitation through pattern recognition of the survey data using artificial Neural Network (ANN) in our next part of the PAC research.

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