Multivariate Analysis for Redesigning Development Project

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Abstract- *The paper aims at demonstrating how statistical tools can be used for re-designing social development project. Simple as well as multivariate statistical tools, namely, Conjoint Analysis have been used for such purpose. Urban areas survey data have been used and the enterprise level interview responses have been collected by face-to-face interview. Perceptions, requirements and aspirations of entrepreneurs have been reflected in the survey outcomes that will supposedly help reshaping development projects.*

Article History
Received : 29 December 2016
Revised : 15 May 2017
Accepted : 16 May 2017

Keywords
Social development project, City region development project, Conjoint Analysis, Urbanization.

JEL Classification
O18; C38

Article Citation : Rahman, M. (2016). Multivariate analysis for Redesigning Development Project. *The Business Review, 5*, 37-51, ISSN : 1996-3637

1. BACKGROUND

Urbanization refers to the concentration of population of a country in city regions. These migrations from rural to urban areas cause serious problems like congestion and environmental pollution. The modern cities grow in the unsystematic manner due to fast concentration of industries and this also causes the problems of urbanization. In the villages there are not many opportunities to get work due to lack of industries. The people of the villages also come to the cities in search of higher standard of living and better living conditions.

In a country with more than 4,000 garment factories, women have become a powerful economic force. About 1.5 million women are employed as garment workers, and their contribution has enabled the Bangladeshi garment industry to compete in the global market. Employment in export-oriented industry, and in other industries such as electronics, manufacturing, has directly opened up the labor market for poorer sections of the population, most notably young rural people with limited local employment options. Migration of such category of citizens has been one of the most visible signs of the rapid urbanization in Bangladesh. Urban population grows by about 6% year-on-year and about 28% of people now live in cities. The total urban population is expected to reach 50 million by 2015.

Migration from the countryside to the cities also causes a cultural shift and problems. Urbanization has faced immense demand and supply problems with basic needs of the citizens.The country is having a rapid spread of urbanization. According to an estimate, by 2020, nearly every other man, woman and child will live in an urban area (World Bank, 1998). If such spread is not effectively managed, the chaotic conditions and accompanying ills like pollution is likely to multiply (Gunatilake, Yang, Pattanayak, & Choe, 2007). Like many other Asian developing countries, an increasing share of the population of Bangladesh migrates to urban centers. A notable transition has occurred during the recent past (Alam & Rabbani, 2007).

However, lack of long-term vision, strategic planning and coordination among various public entities have been preventing the city regions from materializing their full economic growth potential. Capital investments have been often selected to meet the supply-demand gaps, than to promote competitive industries based on a strategic assessment of development potentials.

In this view, there was a flagship study, namely, "Inclusive Growth and Good Governance for Clustered Cities Development: Innovative interventions in South Asia", under the second package of RETA 6337: Development Partnership Program for South Asia (the RETA). Roundtable discussions were held in 2008 with key stakeholders, who positively reacted to the new approach to the urban development in Bangladesh. The proposed PPTA will be built upon the conceptual framework to be developed under the RETA, and make a concrete program for capital investments and institutional developments to be funded under the City Region Development Project (CRDP). The city region comprises a large metropolitan city (City Corporation such as Dhaka, Chittagong and Khulan), Secondary towns (Pourashavas) clustered nearby and adjacent areas (Haq, 2005; Baker, 2007; World Bank, 2009).

Thus, in order to gather a clear picture of current scenarios a baseline survey at enterprise level was conducted in 2009-2010. The principal aim of the survey was to collect primary information on service provisions, its expansions and needs. The Business survey has the objective to collect information on the type of businesses, operational status, employment positions, regulatory environment, quality of public services, expectations and willingness to pay for those services, access to services, and future demand for services.

2. Data Description and Sample Size

In two broad regions, namely, Dhaka region and Khulna region the survey was conducted. Business survey was carried out within 750 industries in the Upazila and municipalities of Dhaka, Gazipur, Narayanganj and Norshingdhi districts and 250 industries in Khulna Region. Dhaka region is situated somewhere in the middle and Khunla is situated at the extreme south of Bangladesh. One respondent (business head) per enterprise was interviewed.

The types of industries that are included:
Type A: Factory and headquarter at the same location
Type B: Factory and headquarter at the different location

3. Methodological Issues

Two types of statistical tools, namely, Descriptive statistics and Conjoint Analysis were adopted for the present study. Here, we briefly present the basic idea behind Conjoint Analysis (CA).

3.1 Function of CA

For each factor level or for each feature CA provides a value for each feature. Such a value is also termed as utility. Features/factor levels having highest such value is declared as the most important for respondents. CA secures utility scores (Called part-worths) of each level of a factor from ratings or rankings of combination of factor levels by consumers (respondents) (Churchill, & Iacobucci, 2006).

3.2 How Utilities Correspond to Preferences

We calculate one utility for each feature (level) for each respondent using preference rankings or ratings. When utility of one attribute feature (level) is added to the utility of some other attribute's feature (level), the sum of that combination will show correspondence with the position of this combination in the original preference ranking of the respondent. CA calculates utilities for different combination of features of attributes. Such calculated utilities correspond to the preference ranking of a combination of features of attributes. For example, if a particular combination shows highest utility value, it corresponds for highest preference also. It shows the importance of each level of each factor (attribute). It identifies which attribute is more important compared to others.

For each respondent utility is derived from preference ranking or rating of combinations of features of attributes. Range of utilities of an attribute can show its importance. Comparing the sets of utilities one can identify groups / segments of respondents (Stevens, 1999).

3.3 Approaches to CA

There are principally two approaches to CA viz. Two-factor evaluation and multi-factor evaluation.

In two-factor approach to large numbers of factors are involved, and combination of levels of each pair of factors is taken at a time. The Multi-factor approach is like a complete factorial design. It defines different product profiles by taking all factors together. Each profile is written on a card and it is given to the customer for his overall preference value/rating about the product. If product profiles are too many, one can select a limited number of them using orthogonal design in which effects of the main factors are studied ignoring second and higher order interactions.

One can obtain respondent's preference value either in interval scale or ordinal scale. In the former a respondent puts a value between, say, 0 to 10 while in the latter the respondent ranks product profile from highest 1 to the lowest rank as per number of combinations.

3.4 Utility (Part-Worth) by Level

Using the technique of Multiple Regression with dummy variable, the utility of each level of each factor for a respondent can be obtained. Preference value is treated as dependent (criterion) variable and levels of factors are treated as regressors in the regression model. Utilities are selected in such a way that errors between actual preference values and corresponding estimated preference values are minimized. This is the OLS Procedure of Regression. For any product profile, preference value is obtained by adding the utility values of respective levels of the factors of that profile. For example, if a profile has 3 levels having utilities 0.86, -0.27, -0.10 respectively, then that combination has utility= (0.86-0.27-0.10)=0.49

3.5 Conjoint Analysis Operational Procedure

Several esoteric softwares are available for conjoint analysis. Computer starts with random starting values of utility estimates or part- worth functions and iteratively, it modifies those utility estimates until the prediction of consumer preferences is within some tolerable error margin.

Dummy variable regression can be used to estimate the components of a conjoint analysis. Consumer/ customer/ agent preferences are treated as dependent variable and dummy variables for attributes can be treated as predictors. Such regression may look like the following one.

$$\text{Predicted preference} = \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots + \beta_k X_k$$

Here $X'S$ are dummies for attribute levels.
A value of $\beta = 0$ will indicates that the corresponding factor level does not matter. A larger β – *value* means more utility and a consumer is more inclined about that attribute.

4. Results and Analysis

We provide study results and analysis in two parts, namely, Descriptive Statistical Analysis and Conjoint Analysis.

4.1 Descriptive Analysis

Here, we present the scenarios of Dhaka and Khulna regions separately. We present the survey outcomes by heads of issues as follows.

Dhaka Region

General Information

About 60% of the industries are Type A (whereby they have their headquarters and factories at the same location); majority of the industries (83.6%) in Narsingdi district were Type A, and a significant number of industries from Dhaka, Narayanganj and Gazipur were from this category. In Savar 86.4% and Gazipur 64.6% industries fall into the Type B category (Headquarters are at different location)

Location

Much less than 50%, i.e., 37% of the surveyed industries are established in an Industrial Estate or Park. Over half of the industries in Tongi (52.3%) are built within the industrial zones, and 93.2% industries in Savar are not located in such an area. Majority industries in Dhaka, Narayanganj, Gazipur and Narsingdi districts were not established within an industrial zone. Ownership of Land is considered to be the most criterion in the selection of location. Next considerations are ease of transportation, availability of land, and presence of other firms producing similar products. Availability of public utilities like water, power, gas, waste management also considered as determinants of location. In Dhaka 19% and in Gazipur 31% respondents say so. Land for lease is a dominant factor in Tongi. Over 40% industries have more than one factory. Out of them 78% have 3 or more factories.

In general, about 45% industries are situated within 300 meters from the adjacent main road. In Dhaka 52% and in Savar 59% industries are situated within 100 meters from the main road.

Sales

During the period 2006-07 to 2008-09, percentage of sales rose significantly in all surveyed areas. However, Savar experienced the most significant growth (79.21%) by a large margin in comparison to other areas, followed by Gazipur (19.85%) and Dhaka (14.15%).

Out of surveyed industries, 48% have 100% domestic sales of their products and 10% have partial domestic sales. Such domestic sales take place within 10 km from establishment of 37% industries. About 18% do domestic sales beyond 50 km.

Materials/Inputs

The1st domestically sourced input material comes from a radial distance of 10-30km in 36% cases. However, there are notable spatial variations in this respect. In Tongi about 48% industries source their input materials within a radial distance of 1 to 10km. In Savar area, 36% of the 1st domestically sourced input materials come from a distance of 30-50km. While 46% of the total surveyed industries get delivery of materials from their main supplier 1 to 20 times a year, 33% of the industries receive supply 21 to 40 times in a year. Delivery frequency of main materials of a majority of the industries varies between 1 to 40 times annually. The most dominant mode of transportation is a truck and next is the waterways.

Employee

The garment industry employs 60% of the labor forces involved in all these sample industries. The textile industry involves about 28% of the overall labor force. All other sectors combinedly employ remaining 12% of the labor force. There was an increase of 6% employee in these industries over last one year (2008-09).

Perception on Services

Perceptions about the quality of services were assessed in the survey. Almost 99% of the total surveyed industries use road networks provided by public authorities. Besides, public drainage and storm management systems are used by 73.8% industries. However, 34% of the industries use public water supply facilities, 44% use public sewerage facilities, 44% use public solid waste disposal systems, and 17% use publicly serviced land. About 42% of the total surveyed industries use facilities from private transportation service providers.

Over 77% of the industries that obtain water supplies from public sources consider that, the cost of the services is reasonable, but 54% expressed the service is inadequate. Over 60% respondents think that improvement in road network will positively affect their business. Similar assertion was made by 49% respondents regarding water supply.

Willingness to pay

Respondents were asked about their willingness to make a trade-off between better service & more bill payment. Such outcomes by types of services are presented herein.

Water:

On the whole 76% of the total surveyed industries are willing to pay the higher water bill in line of better service & supply. Since water is a very important ingredient of industries people want better service for more bill payment.

Sewerage:

Improved sewerage facilities at a higher cost is acceptable to 79% of the total surveyed industries.

Transportation:

Around 84% of the total surveyed industries are unwilling to have improved transportation services and it is because employees of the surveyed industries live within the close vicinity of their workplace.

Khulna Region

In Khunla region, 76% industries are of type A.

Location

While 31% of the total surveyed industries within the Khulna Region are situated in an Industrial Estate or Park, 100% industries in Khalishpur are built within industrial zones, but 100% industries in Phultala are not located in such area. More than 55% of the industries in Khan Jahan Ali, Mongla and Abhaynagar are built within the industrial zones.

Among factors determining the choice of location, ease of transportation is considered to be the most dominant factor (51%) followed by ownership of land (37%), close to material suppliers (24%), and availability of workers (51%).

Sales

During 2006-07 to 2008-09, the cumulative percentage of sales rose significantly in Phultala (1546.88%). Excepting Khulna Sadar and Abhaynagar, the other surveyed area experienced sales growth, but not as high as Phultala. Daulatpur experienced the 2nd most significant growth (69.29%) by a large margin in comparison to other areas, followed by Batiaghat (19.06%) and Khalishpur (11.66%).

Of all the total surveyed industries, 77% have 100% domestic sales of their production, while, 7.60% have partial domestic sales of their total production. While 36% sell their products within 10 km 20% sell within 10-30km and 13% beyond 50 km. For domestic sales mostly trucks are used (52%) followed by river transport (29%).

Materials/Inputs

Majority 53.8% of the1st domestically sourced input material comes from a distance of more than 50km More than half of the industries in Abhaynagar (56.8%) and Phultala (60.0%) source their input materials within 1 to 10 km. In Batiaghata, Khan Jahan Ali and Mongla areas, almost 25% of the 1st domestically sourced input materials come from a radial distance of 10 – 30 km. Primary mode of transport is trucks followed by river boats. In 23% cases railways are also used.

Employee

About 65% of the total labor force in the region are in jute industry and the next is the fishing industry, contributing to almost 15% of the overall labor force in the year 2008-2009. The remaining eight sectors combined contribute about 20% of the labor force. An overall increase in the total number of people employed across all industries has increased by about 19% from 2007-08 to 2008-09.

Perception on Services

About 78% of the surveyed industries use public roads and storm management systems (28%). For operating their businesses, the majority of the industries relies on self-owned service facilities rather than on services provided by public and private authorities. However, about 20% of the industries use public water supply facilities and 10% to use publicly serviced land. The only service that industries acquire from private sources is solid waste disposal; about 5.60% of the total surveyed industries use the facility. Of those who use public networks 27% think that service is inadequate. About 77% believe that improvements in transport will have significant impact on business.

Willingness to pay

Water:

On the whole, 61% of the total surveyed industries indicate that they are not willing to pay the increased water bill cost.

Sewerage:

For improved sewerage facilities 64% of the surveyed industries are not willing to pay higher bills.

Transportation:

Over 90% of the total surveyed industries do not need improved transportation services for employees as because more than 95% employees of the surveyed industries live nearby.

4.2 Conjoint Analysis Results

Conjoint analysis has been performed for service provisions like electricity, gas and water. In this case, all the industries were considered together and not by region. Thus, Conjoint Analysis has been done for 1000 industrial establishments altogether.

Here, we show the levels of attributes for electricity supply to be used for the respondents to assess their preferences.

Attribute Price	:	10% more than the existing rate,
	:	20% more than existing rate
	:	30% more than existing rate
Attribute Hours of Supply	:	10 hours per day
		15 hours per day
		24 hours per day

One typical Example for ranking is shown below

Table 1. Possible Configuration of Attribute Level

		10% more	20% more	30% more
Service: Hours	10	2	6	1
	15	4	3	7
	24	9	8	5

We have created dummy variables for each attribute as follows.

X_1=1 if supply time = 15 hrs otherwise X_1 =0

X_2=1 if supply time = 24 hrs otherwise X_2 =0

Z_1=1 if price is 20% more otherwise Z_1 =0

Z_2 =1 if price is 30% more otherwise Z_2 =0

Predicted preference= $\beta_1 X_1 + \beta_2 X_2 + \beta_3 Z_1 + \beta_4 Z_2$

$=.53X_1 + .86X_2 - .15Z_1 - .36Z_2$

Here, we assume Price 10% and 10 hours supply as a benchmark.

There are 9 combinations of attribute levels and they were shown to each respondent and were asked to put part-worths between 0-10 as per his/ her own perception. Then regression was run. The typical example shows that the most desired choice of a person will be the least pay (10% more) and the most service (24 hours). And naturally, the highest pay and least hours service will be the lowest preference. We want to answer to the question, what are the utilities for price and service hours in determining preferences.

Conjoint Analysis Results: Utility values for Electricity

Table 2. Possible Configuration of Attribute Level- Electricity

		10% more	20% more	30% more
Hours of Service	10	00	-.15	.36
	15	.53	.38	.17
	24	.86	.71	.50

Examining the levels of attribute from the highest to the lowest rated levels we can identify the relative importance of each of the attributes. If different levels of an attribute produce different utilizes, then that attribute is important. Analyzing the trade- offs we can assess the desire of the people. For example, in the above table, the combined 10% more price and 24 hours service and also the combined 20% more price and 24 hours are the most desire of the people. As it appears, people are more concerned about service than price. So, medium price level, but highest hours of service are the most desired combination. Even after increasing the price by a certain amount people want to remain connected as long as regularity in supply is there. So, it is clear that people are quality conscious, having intention to make a trade-off between quality & price. A common practice of judging the goodness of fit of prediction is to find correlation between the original assessment of respondents and predicated utilities. We have obtained such correlation coefficient to be r=0.789 which indicates quite good capture of consumer preferences. We naturally expect a linear behavioral movement in the price of electricity and hours of its supply.

Conjoint Analysis Results: Utility Values for Water

Water is one of the most important consumable items for industrial activities. Considering the fact that the supply of water is inadequate, access to water is quite problematic and it is quite expensive as well, respondents' desire was assessed in the framework of Conjoint Analysis. Following Levels of attributes are for the respondents to assess their choices and preferences in the framework of Conjoint Analysis.

Attribute Price : 10% more
: 20% more
: 30% more

Attribute Supply: W_1 : Continuous 12 hours supply with normal pressure
W_2 : Continuous 15 hours supply with normal pressure
W_3 : Continuous 24 hours supply with more pressure

A typical example of ranking is given below

Table 3. Possible Configuration of Attribute Level

		10% more	20% more	30% more
Supply:	W_1(12hrs)	5	2	1
	W_2(15hrs)	8	4	3
	W_3(24hrs)	9	7	6

We have created dummy variables for each attribute as follows.
X_1=1 if supply time = 15 hrs otherwise X_1 =0
X_2=1 if supply time = 24 hrs with more pressure otherwise X_2 =0
Z_1=1 if price is 20% more otherwise Z_1 =0
Z_2 =1 if price is 30% more otherwise Z_2 =0

Predicted preference= $\beta_1 X_1 + \beta_2 X_2 + \beta_3 Z_1 + \beta_4 Z_2$

$=.58X_1 +.49X_2-.27Z_1-.18Z_2$

We show the estimated utilities below.

Estimated utilities for Water

Table 4 . Possible Configuration of Attribute Level - Water

		10% more	20% more	30% more
Supply:	W_1 (12hrs)	00	.58	.49
	W_2 (15hrs)	-.27	.31	.22
	W_3 (24hrs)	-.18	.40	.31

Results in above table clearly suggest that people are more concerned about the quality of service compared to rise in price. Considering water is a highly essential item, people can make a trade-off between high price and regularity in water supply. The correlation between the original assessment of respondents and predicated utilities is 0.596.

Conjoint Analysis Results: Utility Values for Gas

Gas is one of the most important consumption items. Considering the fact that the supply of gas is inadequate, access to gas is quite problematic and it is quite expensive as well. Respondents' desire was assessed in the framework of Conjoint Analysis. Following levels of attributes were posed to the respondents to assess their choices and preferences.

Attribute "Price'' : 10% more
: 20% more
: 30% more

Attribute 'Supply' G_1: Continuous 12 hours supply with normal pressure
G_2: Continuous 15 hours supply with normal pressure
G_3: Continuous 24 hours supply with more pressure

A typical example of ranking is given below.

Table 5. Possible Configuration of Attribute Level

		10% more	20% more	30% more
Supply:	G_1 (12hrs)	5	2	1
	G_2 (15hrs)	8	4	6
	G_3 (24hrs)	9	3	7

We have created dummy variables for each attribute as follows.
X_1=1 if supply time = 15 hrs otherwise X_1 =0
X_2=1 if supply time = 24 hrs with more pressure otherwise X_2 =0
Z_1=1 if price is 20% more otherwise Z_1 =0
Z_2 =1 if price is 30% more otherwise Z_2 =0

Predicted preference= $\beta_1 X_1 + \beta_2 X_2 + \beta_3 Z_1 + \beta_4 Z_2$

$=.58X_1 + .49X_2 - .27Z_1 - .18Z_2$

We show the estimated utilities below.

Estimated utilities for Gas

Table 6. Possible Configuration of Attribute Level-Gas

		10% more	20% more	30% more
Supply:	G_1 (12hrs)	00	.58	.49
	G_2 (15hrs)	-.27	.31	.22
	G_3 (24hrs)	-.18	.40	.31

Results in above table clearly suggest that people are more concerned about the quality of service compared to rise in price. Considering gas is a highly essential item, people appear to be ready to make a trade-off between high price and regularity in gas supply. The correlation between the original assessment of respondents and predicated utilities is 0.513. Several policy implications have emerged from the study outcomes and these are presented in the next section.

5. Conclusions and Recommendations

In this paper statistical analyses were performed on data collected in a baseline survey conducted in Dhaka City Corporation (DCC) and the other 5 municipalities and Khulna region. The survey was conducted on enterprises in DCC, Municipalities and Khulna region. Survey outcomes appear to be very useful for planning and augmenting CRDP.

Baseline survey results based on Descriptive Analysis and Conjoint Analysis suggest several things that are useful for policy makers for effective launching of CRDP. These are delineated below.

1. Uninterrupted or almost regular 'power supply'
2. Uninterrupted or almost regular 'gas supply'
3. Measures to reduce pollution are needed
4. Make easy access to power, gas and 'water connection'
5. Modify traffic rules and operations to lessen the burden on people.
6. Making a trade -off between 'raising price of electricity' and ensuring 'regular power supply' can fulfill the desire of the majority citizens
7. Providing 'regularity and quality of water supply' at a higher cost is acceptable to the citizens. Easy access is also a concern of the citizens.
8. Consumers appear to be happy to make a trade-off between 'regularity in gas supply' and its increased price.
9. Poor and insufficient service system of DCC & municipalities regarding 'drainage and waste management' need to be taken care of.
10. Increase in public transport facilities is of serious importance to be taken into account so that people can comfortably render services to the society. Here, also people put more emphasis on 'availability' and 'quality of services' compared to 'price', although the majority of employees resides within the closest vicinity.

It is imperative that the above mentioned aspirations as expressed by entrepreneurs need to be under consideration of CRDP. Thus, CRDP goal can be achieved and thereby entrepreneurial initiatives in city regions will improve which will in turn improve social conditions and well-being.

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