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PATTERN OF RESIDENTIAL ELECTRICAL ENERGY CONSUMPTION IN CHITTAGONG CITY

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Abstract-*Electrical energy consumption within the residential users are increasing day by day in Bangladesh due to several factors. We need to improve the energy efficiency to solve the ongoing energy crisis in Bangladesh and it should be backed by data on energy consumption pattern at different levels. This research aimed to study the electricity consumption pattern within the residential users in Chittagong Metropolitan City Area (CMCA) and to correlate this electricity consumption pattern to the family sizes and family income levels. Data have been collected by a questionnaire survey and field investigation. Results showed that the mean electricity consumption due to lighting (tube-light and energy saving-light) was 339.51 watt hours and for ceiling fan was 1741.19 watt hours in the bed room for low income families. While in middle income families they were 540 watt hours and 2260 watt hours, and in upper middle income families they were 794 watt hours and 2435.2 watt hours, respectively. This study unrevealed the urgency of conducting more similar type of study in different metropolitan city of Bangladesh to help the policy makers in the future electricity planning to minimize the electricity consumption and increase the energy use efficiency among the residential users.*

Keywords: Electricity, energy consumption, electricity demand, energy efficiency, an energy planning.

INTRODUCTION

Economic development of a country and the development of the living standard of its people in this high-tech era is highly dependent on availability and efficient utilization of electricity [1, 2]. Sufficient and consistent supply of electricity is a prerequisite for a managed, efficient and sustainable economic growth and poverty reduction [3]. The demand for electricity is soaring alarmingly in Bangladesh due to rapid economic growth and associated urban sprawling, profligate industrial expansion and changes in consumer behavior with changing high-tech lifestyle and living standard. According to Bangladesh Power Development Board (BPDB) statistics, the installed power generation capacity in Bangladesh was 11,683 MW with on average daily generation of around 8000 MW and daily load sheading of around 3500 MW as on August, 2015 [4].Therefore, the crisis of electricity has become a major problem, with the potentially to become even larger problem as most of the gas based power plants will be phased out in near future. Misuse, system loss, inefficient utilization, and corruption in power sector are the main causes behind this electricity supply-demand shortage [5].We are in urgency to enhance power consumption efficiency at industrial as well as at the small scale consumer level. Electricity is mainly consumed in the residential building in terms of heating, cooling, bathing, cooking, lighting, ventilation, etc. The electricity consumption in any building and the resulting power consumption efficiency is a function of residence structure as well as household behavior. Though there are studies on energy scenarios simulation for the power sector in Bangladesh [6] or electricity crisis and load management in Bangladesh [7], there is no study on the pattern of household power consumption. We assumed that there are variations in on energy use and efficiency among the residential users due to differences in their income levels, family sizes, ownership of gazettes and level of awareness. Electricity consumption is supposed

to increase with the increase in family members and electricity consumption pattern may change with the increase in the family income. We need to know the pattern of consumption of power in accordance with these factors in order to determine the efficiency in energy use and to find the means in better energy consumption policy making and planning. This study was carried out to find out the electricity consumption patterns among the residential users in different residential areas of Chittagong Metropolitan City Area (CMCA). We have collected household level data by using a structured questionnaire focusing on total power demand, power consumption by different purposes and uses, and finally by different household spaces. We have tried to find out what are the present electricity consumption patterns in the study area and what are the dominating factors of electricity consumption in CMCA.

MATERIALS & METHODS

Questionnaire survey

The study was based on household survey on the electricity consumption pattern of the residential users of some selected residential areas in CMCA. Personal interview by using a structured questionnaire has been used to collect data. Data has been collected on family sizes, monthly income of the household members, electricity uses for different purposes such as lighting, heating, cooling, cooking, entertainment, ventilation etc. Besides, variation in electricity consumption at different rooms such as living room, bed room, drawing room, and dining electricity consumption in kitchen, bath room etc., has also been recorded. Duration of use and wattage of different electric house hold appliances have been collected and matched through users interview and on-field survey.

Collection of secondary data

Secondary data have been collected from published research articles and various reports and also from the BPDB, International Energy Agency (IEA), Ministry of Power, Energy and Mineral Resources, Bangladesh (MPEMR) websites.

Classification of respondents

In this study, the families were categorized based on their size into four categories (small, medium, large and very large) and income into three categories (low, middle and upper middle).

Analysis of data

Data entry and then data processing and analysis were carried out by using statistical packages SPSS 20.0 and Microsoft Office Excel 2007.

FINDINGS

Pattern of Tube light use

The number of tube-lights used in bedroom varied a lot in relation to the family size (figure 1-A). In medium and large families the number of tube light used has been high but overall the median number of tube lights increased with the family size. However, in large families, the median number of tube light use was small, which might be due to their income level or small sample size. Boxplot figure 1-B showed the variation of the duration of using tube-lights in bedroom in the studied families. In large families the duration of using tube lights was shorter. The electricity consumption due to the use of tube-lights in bedrooms varied between medium and large families (figure 1-C). The median values of the electricity consumption due to tube-lights use was increased with family size. The mean value of the number, duration and electricity consumption for tube-lights in bedroom were 1.74, 4.06 and 400 watt-hours, respectively (figure 1-A, B and C). Figure 1-D shows the electricity consumption for tube-light in drawing room. It showed an increasing pattern of electricity consumption with the family size but the variation between medium and large families showed inverse relationship.

Pattern of Energy bulb use

The median number of energy-bulbs in bedroom was increased gradually in different family size. The variability in number of energy bulbs was more in medium family, while it was less for small and large families. In very large families the variation was the least (figure 2-A). The mean electricity consumption for energy-bulbs in bed, drawing and kitchen were 81.2, 123.9 and 119.8 watt hours, respectively. Figure 2-B shows that the consumption of electricity by energy-bulbs in bedroom was uniform in terms of median value though for small and medium families the variations were high and it was low for large and very large families. Figure 2-C shows the electricity consumption for energy-bulb in drawing room in studied family size. The median electricity consumption increased slightly with family sizes but these variations

were not statistically significant. Figure 2-D plotted the electricity consumption for energy-bulb in kitchen room in studied family size. For small and medium families the median consumption remained the same and they had similar internal variability. On the other hand, the median consumption was higher for very large families.

Pattern of Ceiling fan use and energy consumption by them

The number of ceiling fans in bedroom remained the same for small, medium and large families while it was higher for very large families (boxplot figure 3-A). However, the internal variability among data was high for which the inter-quartile ranges were larger. In accordance with this result we can see higher electricity consumption as the family sizes goes up which has been portrayed in figure 3(B). In this case also, determination of statistical variability needs to increase the sample size.

From Boxplots in figure 3, we see the consumption due to the use of ceiling fans in drawing room and in dining rooms, respectively. They have the same pattern in terms of energy consumed. It was similar for small and medium families while slightly higher but similar for large and very large families. The mean value of the consumption for ceiling fan in drawing and dining are respectively 518.5 and 253.6 watt hour which was due to affect of variability in the data.

Variation in electricity consumption inrelation to family income

The low and middle income families had the similar appliance use and energy consumption pattern in most of the cases such as number of different types of lights in the bedroom (Table 1, Table 2, Table 3), compared to upper middle income families which showed higher number of appliance use and higher energy consumption pattern.

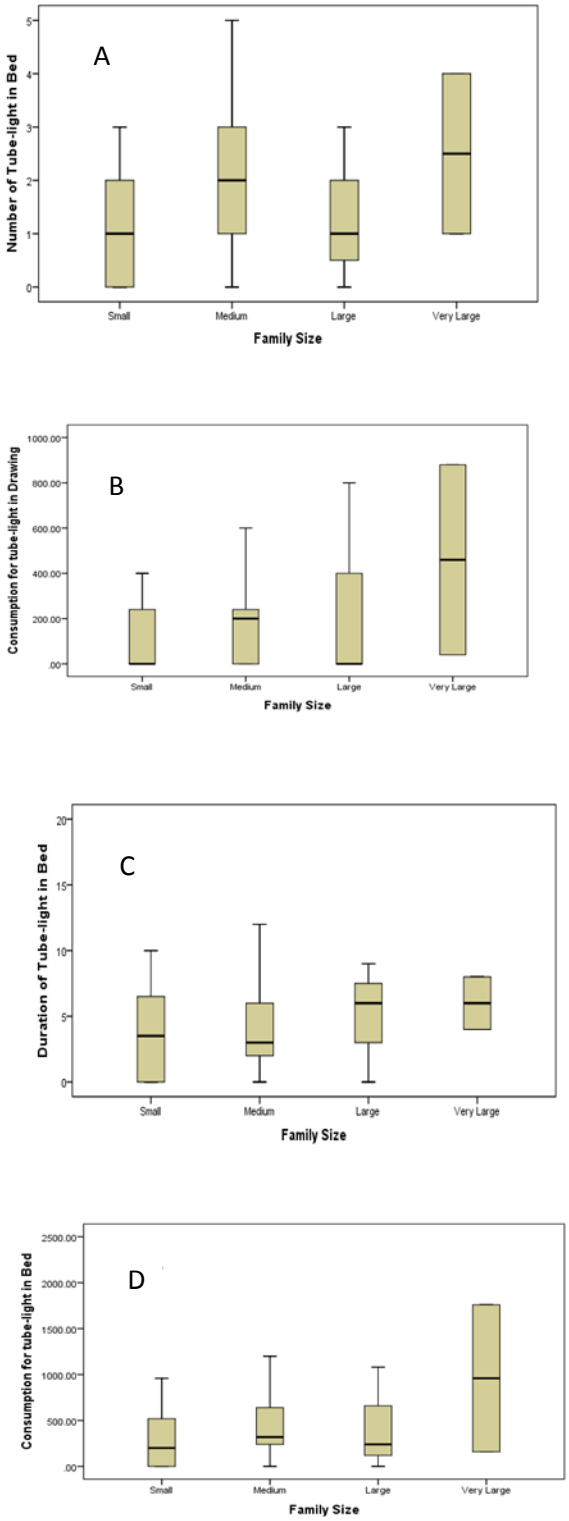
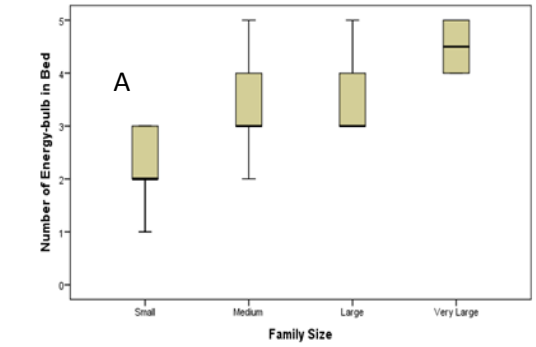
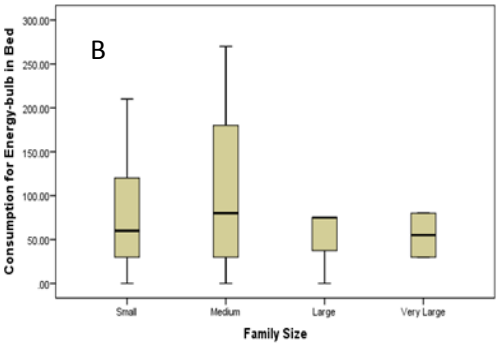
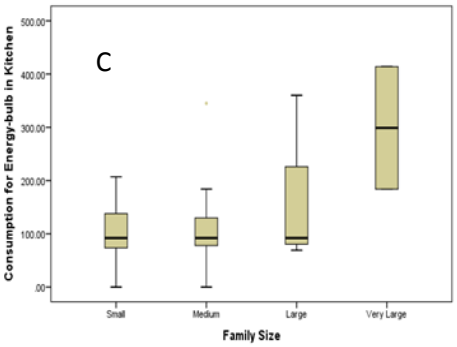


Fig.1: Variation in the use of tube lights with family sizes (A) Number of lights in bedroom (B) Consumption of power in Drawing room (C) Duration of use in bedroom and (D) Consumption of power in bed room.







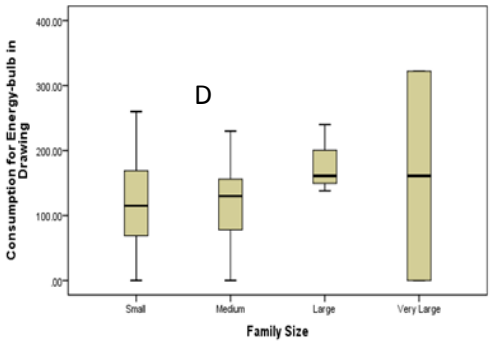
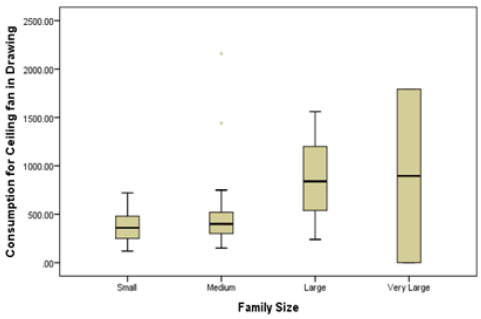


Fig.2: In relation to family size (A) number of energy bulb used in bed room (B) power consumption by energy bulb in bed room, (C) power consumption by energy bulb drawing and (D) power consumption by energy bulb kitchen room with family size.



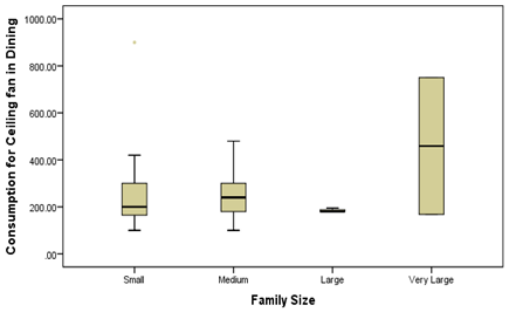


Fig.3: Relationship between consumption for ceiling fan in drawing and dining room with family size.

Table 1: DMRT for relationship between family income and number of tube lights in bedroom

Family Income Class	N	Subset for alpha = 0.05	
		1	2
Low	21	1.10a	
Middle	24	2.17ab	2.17ab
Upper Middle	5		2.40b
Sig.		.085	.703

Table 2: DMRT for relationship between family income and number of energy bulbs in bedroom

Family Income Class	N	Subset for alpha = 0.05	
		1	2
Low	21	2.43a	
Middle	24	2.83a	
Upper Middle	5		3.80b
Sig.		.373	1.00

Table 3: DMRT for relationship between family income and number of energy bulbs in bathroom

Family Income Class	N	Subset for alpha = 0.05	
		1	2
Low	21	3.95a	
Middle	24	5.04ab	5.04ab
Upper Middle	5		7.80b
Sig.		.450	.060

CONCLUSION

It is quite impossible to solve overall electricity crisis but possible to control load demand by using low consuming electrical appliances by the residential user.This research will be helpful and contributory one for policy making about residential electricity consumption in Bangladesh.

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