International Research Journal of Management and Commerce
ISSN: (2348-9766)
Impact Factor 5.564 Volume 4, Issue 11, November 2017
Website- www.aarf.asia, Email : editor@aarf.asia , editoraarf@gmail.com

Developing a Multiple-Item Scale for Assessing Adoption of LED Lights: Special Reference to Mumbai District of Maharashtra, India

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Abstract: *It is well recognised fact that there is no life without light, the principal source of lighting solar system is Sun which provides natural light to our mother planet earth. Light has dependably been assuming a critical part in our life and to the extent artificial light is concerned it has experienced numerous changes, LED is the most recent innovation accessible to us and is a standout amongst the most productive wellspring of light technology. The purpose of this study is to develop multiple item scale for assessing adoption of LED lights with Special Reference to Mumbai District of Maharashtra, India because no such scale has been performed so far. Data is collected from Industry experts and consumers across Mumbai. Through Cronbach's Alpha Test of Reliability we prepared reliable scale for assessing adoption of LED lights with Special Reference to Mumbai District of Maharashtra, India.*

Key words: Light, Adoption, LED.

INTRODUCTION:

Light is the most indispensable component for humans and nature, use of sunlight in photosynthesis, to make oxygen and carbohydrates from carbon dioxide and water, is a process first established over two billion years ago by cyanobacteria. They made the large quantities of oxygen in the atmosphere which allowed oxygen-breathing life to evolve. Plants use chlorophyll to achieve the same result, keeping the atmosphere breathable, and providing food energy for us and all other advanced life forms.

Of course, humanity has discovered different wellsprings of light finished the course of history. Fire is clearly the most punctual of these, from the camp fires of our cave-dwelling ancestors to the spirit lamps still used where there is no electricity. But electricity is the source of artificial light today, starting with the invention of the incandescent light by Joseph Swan and Thomas Edison and progressing via fluorescent lighting to modern light emitting diode (LED) lights.

Mankind has also learned to control light. The use of mirrors and lenses to divert light, or to magnify images, dates from pre-history. Microscopes and telescopes, using multiple mirrors and/or lenses are two closely related inventions from just a few hundred years ago. They allow

us to study objects smaller than our naked eyes can see, and objects at large distances, whether ships at sea, or astronomical bodies at enormous distances.

Status of LED lighting in India –

To promote and encourage people to adapt LED lights Government of India has launched Ujala Scheme 2015 - The power ministry's UJALA programme to replace 77 crore inefficient bulbs with energy-efficient LED bulbs has taken off in a big way across the country . UJALA or the Unnat Jyoti by Affordable LEDs (UJALA) is the world's largest LED program for the residential sector. As many as 15.45 crore LED bulbs have already been distributed under the program across rural and urban areas of India. Officials said that over 5.15 crore Indian households have benefitted from this programme.

By 2019, EESL targets to sell about 77 crore LED bulbs all across the country

Objectives of National LED Programme

1. Promote the use of the most efficient lighting technology at affordable rates to consumers
2. Reduce energy consumption in lighting which helps DISCOMs to manage peak demand
3. Enhance the awareness of consumers about the efficacy of using energy efficient appliances
4. Increase the demand of LED lights by aggregating requirements across the country and reduce costs; in fact cost have already reduced over 80% in last 2 years
5. Encourage and support domestic manufacturing of LED bulbs by sustaining demand and making it consistent with the 'Make in India' policy of the Government
6. Create robust arrangements for monitoring and verification of energy savings in a simple and transparent manner.

After so many initiatives by Government of India and technological changes in lighting industry

According to Menanteau and Lefebvre (2000), there has been only partial adoption of Compact Fluorescent Light (CFL) technology for a number of reasons. For example, both CFL and modern LED lamps are characterized by high initial costs for consumers, and this serves as a barrier to their adoption. The price of LED lamps are high compared to CFL lamps and incandescent lamps, given an approximate number of lumens or roughly an equal amount of visible light emitted by them. For example, a well-known brand of LED light with 470 lumens in Thailand costs approximately $53, while the CFL lamps of that same brand with 400 lumens cost around $5, a substantial difference for the consumer. Further, the incandescent lamps produced by the same brand with 430 lumens cost around $0.5. It is therefore likely that the high initial purchase cost of LED lamps will be an obstacle to their adoption; that is to say, price will be negatively related to the intention to buy LED lamps.

Generally speaking, perceived value occurs when consumers perceive that an innovation offers greater benefits or lower costs than existing alternatives. In other words, products with high perceived value may be more readily adopted than those with low perceived value. Furthermore,

the value of an innovation for the consumer is affected by its perceived relative advantage; that is, the extent to which it is perceived to offer benefits that are superior to those of existing products. In fact, research indicates (Henard & Szymanski, 2001) that a product's perceived advantage is one of the most important predictors of the success of a new product.

The convenience of purchasing a product or its availability is likely to be a factor in the purchase of a given product. For instance, some studies (Byrne , 1991; Davies , 1995) have identified that if "green" or organic foods are not available in stores it can be a barrier to their purchase.

LITERATURE REVIEW

Partanen, Jukka Kohtamaki, Markoa Parida, Vinit Wincent, Joakim (2017) the scale and its constructs are developed by combining the key insights from prior literature and practitioners gained through expert interviews validating the constructs by 3 item-construct validation rounds with 9 academic experts; and by testing and further revising the scale, with a sample of 91 manufacturing firms.

Leelakulthanit (2014) The factors affecting the intention to buy LED lamps on the part of adult Bangkokians that are the purchase decision-makers and are aware of LED lamps. A multiple regression model was employed to investigate the factors affecting the intention to buy LED lamps. Thirteen motives for adopting LED lamps were identified. They were: price, quality, energy saving, durability, trustworthiness of LED lamp performance, compatibility of LED lamps with the lighting fixtures, brand, product availability, promotion and corporate social responsibility, environmental consciousness, social well-being, and perceived effectiveness of environmental behaviour. In addition, the effects of demographic variables (i.e., gender, age, education, and household income) on the adoption of LED lamps were examined. A total of 555 responses were collected from the adult shoppers. The results of the multiple regression analyses suggest that the factors affecting the intention to purchase LED lamps in the low household income segment are quality, compatibility of LED lamps with lighting fixtures, product availability, and corporate social responsibility. In the high household income segment, they are energy saving and perceived effectiveness of environmental behaviour.

Szoradi (2013), CEO of Independence LED states that it depends only on finding the right time to select an led light over a fluorescent tube. Three criterions define the adoption of led's- trust, technology and cost. Manufacturers have improved the temperature performance and led's have found a way into fortune 100 companies, health and education related institutions as well. It is important to clear the ambiguities consumers have about the lumen output, driver performance, ballast efficiency and colour consistency. Initial investment costs are high, but payback is provided in the next three to five years. Regarding the warranty, longer warranties are being made available now. He says property owners and managers should not focus on low prices, but on higher performances.

McKinsey (2011) states that 70 per cent of lighting in the societies would depend on LED lights by 2020. As of now, the number of consumers of LED is low in the lighting industry because of the higher costs, but this condition is now witnessing a change rapidly. If the consumers are convinced that LED systems provide a quick pay back value, it may prove beneficial for both, the consumers as well as the industry.

Maria & Morel (2010) based on the recommendations of DeVellis (2003), we proceeded to develop our scale in several steps. First, we generated a large pool of items to represent consumer doubt. Second, we showed the items to a set of experts and asked them to review the scale items for conciseness and clarity. Third, we proceeded with scale testing and conducted an exploratory factor analysis (EFA) to examine the unidimensionality, convergent validity, and discriminant validity of each construct. The model was then further validated using partial least squares modelling as recommended by Anderson and Gerbing (1988). We chose partial least squares modelling as the statistical tool, since it is exploratory in nature, and therefore well suitable for scale development that lacks a previous set model. Finally, the scale and its form were validated, and potential response biases assessed.

Srinivasan and Ratchford (1991) examine how factors such as knowledge, experience, word-of-mouth, etc., may affect the amount of effort exerted by consumers while purchasing a new durable. Other notable studies in the area are Hauser, Urban and Weinberg (1993) and Moorthy, Ratchford and Talukdar (1997). These studies do not examine the impact of different information sources on the consumer choice behaviour. There are few studies that examine the impact of different information sources on consumer choice process. Narayanan, et al (2005) study the relative impact of detailing (information from salesforce), other marketing expenses (OME) and word-of-mouth. Erdem, et al (2005) use surveys to invoke the various information sources used by consumers while researching a new product that they plan to purchase. However, all of these studies looked at influence of various information sources on consumer choice behaviour. The process of information search by firm for a new product adoption has largely been ignored. Consumer decision making under uncertainty has received considerable attention in the marketing literature. Horsky and Raban (1989) model the choice behaviour of a consumer who is uncertain about quality and price of brands. The consumers update their perceptions about the brands, after each instance of consumption, through bayesian learning mechanism. Along the same lines, Erdem and Keane (1996) model consumer learning about quality and the forward-looking behaviour of consumers. Narayanan, et al (2005) propose a model of physician learning about the efficacy of new drugs. While Horsky and Raban (1989) and Erdem and Keane (1996) examine individual level data of consumer packaged goods, Narayanan, et al (2005) look at aggregate data of pharmaceutical products. To the best of our knowledge, this dissertation is the first study to use individual firm level data to model uncertainty and learning in the diffusion of a new industrial product.

Chatterjee and Eliashberg (1990) Arguing that Bass' diffusion model should take individual heterogeneity into account, Chatterjee and Eliashberg (1990) take an individual level decision approach to examine the pattern of innovation diffusion. In this micro-level model, the authors

incorporated heterogeneity in the population by postulating individual adoption times as an explicit function of (1) individual initial perceptions of the performance of the innovation (both expectation of performance and the degree of perceptual uncertainty), (2) key determinants of preference (degree of risk aversion and price sensitivity), and (3) responsiveness to information about the innovation. Results showed that the micro-modeling approach provides a rigorous theoretical basis for explaining a wide variety of diffusion patterns under various scenarios. The authors also derive a diffusion curve by aggregating the predicted individual adoption behaviour over the populations. Conditions under which their model can reproduce the Bass (1969) model were also provided. Another advantage of following the individual-level explanation is that the variables involved can be measured via a consumer survey prior to launch, which consequently may show more managerial attraction.

Russell (1980) in a critique of Bass' model, Russell (1980) assumed that "the distribution of resource among the potential users in a country or region determines the, pattern of adoption of the new products." Russell also preferred an individual based model, and he argued that traditional economic heterogeneity can explain innovation diffusion, which Bass assumed to result from the social contagion, in a most natural way. To illustrate, Russell assumed that individuals belong to groups within which they share an identical threshold price toward an innovation, while between groups the threshold prices are different. As time goes by, the price of innovations will fall, and therefore gradually covers the highest threshold price from group 1 to the lowest of group n. If the price falls linearly, the slope of the final sales curve will mainly depend on the density of the population of group 1 to n, which in turn relies on the density of the distribution of the parameters by which the individual group differs. Based on economic theories, income heterogeneity could be the parameter that results in the different density of the population among groups. Therefore, Russell supported that income heterogeneity, as well as the corresponding reservation price differences

Rogers' (1962, 1983) theory of innovation diffusion, he assumed that four main elements should be relevant to diffusion. These elements are innovation, communication channels, social system and time. "Innovation" refers to the characteristics of the new product, also termed as perceived attributes, which consist of relative advantage, complexity, compatibility, trialability, and observability, as well as the perceived risk of using the innovation.

Bass (1969) A key contribution of Rogers' theory is that he depicts a general map of all relevant elements on innovation diffusion; however, this theory (1) fails to quantitatively demonstrate how these important elements influence the adoption and, in turn, diffusion, and (2) assumes that the normal distribution of adopters does not vary among product categories, while, in reality innovators in one product category might not be innovators in other categories (Kotler 1991.)

OBJECTIVE OF STUDY

To develop a scale to Assessing Adoption of LED Lights by Industries in Mumbai District of Maharashtra, India.

METHODOLOGY

The overview instrument was created in view of input from Industry specialists utilizing Delphi Technique and available literatures. The factors incorporated into the examination have been adjusted from the current writing. A total of 70 variables related to adoption by the researcher from the literature review. After removing repeated and irrelevant statement 14 items were finalized for the first round. Total 50 users of LED have participated in the study. Further to prove the internal reliability of the scale, we performed Cronbach's Alpha Test of Reliability. Applying this test specifies whether the items pertaining to scale, each items are internally consistent and whether they can be used to measure the proposed phenomena e.g. Adoption of LED. The questionnaire consisted of two section. Section one dealt with demographic information related to the participants. Second section consist 14 item for assessing adoption of LED Light. Respondents were asked to state their level of agreement with the series of statements using a five-point scale ranging from "strongly disagree" to "strongly agree."

DATA ANALYSIS

This study is conducted for developing a reliable measurement scale Assessing Adoption of LED Lights by Industries with Special Reference to Mumbai District of Maharashtra, India. The collected data in the study is analysed using Cronbach's Alpha Test of Reliability

According to Nunnally and Bernstein (1994) Cronbach's alpha test of reliability is the most popular estimate for measuring the internal consistency (reliability) of items in a scale.

For the purpose of study, researcher collected sample data of 50 respondents, the results for cronbach's alpha values applied on 14 items is 0.802.

Reliability Statistics

Cronbach's Alpha	N of Items
.802	14

The final scale was developed using independent variables of demographic information of the respondents. Various demographic items are included like Industry Type , Sector , Location .

S.no	Statement	SA	A	N	D	SD
1.	We will use LED Lights even if the initial cost is high					
2.	LED has less operating cost in comparison to conventional lights					
3.	LED lights consumes less electricity					
4.	Government policies are guiding us (Industries) to use LED lights					
5.	LED lights are environment friendly					
6.	LED lights are more durable					
7.	LED lights are better in terms of safety					
8.	LED lights are readily available					
9.	LED lights gives more light than conventional lights					
10.	Electricity cost is going by day by day					
11.	LED light has low replacement in comparison to conventional light					
12.	LED lights has longer life (burning hours) in comparison to conventional lights					
13.	LED lights has low maintenance in comparison to conventional lights					
14.	LED lights are easy to use in comparison to conventional lights					

CONCLUSION AND SCOPE FOR FURTHER

Many researches has been done on adoption in India, however to assess adoption of LED Lights in Mumbai Region of Maharashtra, India hasn't done ever. Along these lines, to satisfy this hole analyst created scale to gauge adoption of LED Lights, for this specialist distinguished a few things from related writing and investigated utilizing Cronbach's Alpha Trial of Dependability. The scale is divided into two parts, one dealt with demographic explanations and another dealt with important features of LED Light. This scale can be used as base to find-out dimensions for Adoption of LED Lights and will also helpful for researcher who are working on Adoption of LED Lights.

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Mr. Anand Hindolia is a research scholar at Devi Ahilya University Indore. He has worked in lighting industry for more than six years and has good understanding LED lighting as a product and its market in India. He has worked with Lighting companies like M/s Bajaj Electricals Ltd , M/s Surya Roshni Ltd and M/s Polycab wires Pvt Ltd . He has been awarded by Mr. Shekhar Bajaj (CMD , Bajaj Electricals Ltd) for his outstanding performance in Luminaire business unit in year 2014.

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