

# Technology Diffusion: A Marketing Perspective

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## **Abstract :**

Technology is essential in every aspects of our life. Technology is used every where including agriculture, manufacturing and service sector. Both developed and developing countries need to use technology for substance and growth. Promotion of technology development and application are key for survival. At the national level technological progress can occur through invention and innovation at the organisational level. The primary objective of this paper is to undertake a state of the art review of literature related to the concepts of technology and technology diffusion. Since market based development has become dominant in last three decades, the paper concludes with a market mix framework for technology diffusion considering solar products and services in rural area as a case.

## **1. INTRODUCTION**

Technology has the potential to satisfy survival needs and enhance competitiveness of an organisation (Kauffman et al 1999, 2000). Diffusion of innovation is the process in which an innovation is communicated through certain channels over time among the members of the social system. Technology diffusion relates to spread of a process/product technology, it determines the extent to which the new technology is being put to productive use determining the level of technological dynamism in a firm, industry or an economy" (Rogers, 1961). Diffusion of technology into the different realms of society has produced significant impact both positive and negative in the life of people.

In the context of poorer region, lack of availability of reliable technology at a affordable price hinders the pace of socio-economic development. Since last three decades, like technology, market based approach to development has been all pervasive. Hence, there is a need to relook technology diffusion in rural areas from the marketing sense. Rest of the paper is presented in three sections. The first section gives an overview of technology and the process of diffusion of innovation models. The second section describes the different factors that affect diffusion in general and renewable energy in particular. In the last section demand side aspects of diffusion from marketing perspective is presented.

### **1.1 DEFINING TECHNOLOGY**

Technology has made our life easy with its existence everywhere. Although it is not easy to define technology, but here an attempt has been made to provide different literature on technology.

Technology is a tool, skill, applying of knowledge, art and science of solving a problem (Merrill, 1986, Galbraith, 1972, Teese, 1976, Hawkins and Gladwin, 1981; Natarajan and Tan, 1992, Levin 1996, Reisman 2006). However some of the authors have also indicated technology is a finished product, a patent, engineering aspects of a product, production process (Lovell, 1998, Burgelman et al. 1996, Tihanyi and Roath, 2002, Maskus 2003). It is the combination of four things; Technoware, the physical object, humanware, the operators for the technoware, orgaware, the institution, the practices or principles where the technoware can be used and infoware, which is the recorded documents that give the knowledge required to operate the technoware (Panda, 1996).

Here the author believes that technology is an integration process of physical objects, the process of making the objects and the meaning associated with it, it is the application of scientific and other organised knowledge, the process of know-how. Technology helps in running the society, it is the sub-system of the society. It has the ability to bring a significant change in the society. It has got many advantage. From organisational point of view, it brings changes into the organisational value chain, organisational hierarchy, helps in monitoring and bringing inter and intra firm relationship (Hannan and Freeman, 1989). For instance the of diffusion of internet bought a change in the organisational hierarchy of Australian stockbrokers, which led to price wars among the brokers, bringing in competition and further helped in gaining viable relationship with the customers (Gharavi, 2004).

Operationally, technology helps in understanding the organisations cash flow needs and preserve precious resources such as time and physical space, thus helping in attainment of organisation efficiency. From security point of view, technology helps in protecting the financial data and other proprietary information leading to competitive advantages. Over all, for a business to survive, it helps in growing and acquiring new opportunities.

In the field of agriculture, farming has evolved with technology. In sowing, harvesting and storage, use of tractors, power tillers, mechanized equipment for tilling, ploughing and harvesters are used, thus influencing the traditional package of practices. Genetic modification of seeds promises high productivity with minimal use of agricultural resources and agrochemicals, both on a seasonal and long-term basis. New age water lifting devices such as DC pumps and efficient water management systems such as solar drip

irrigation allow regular release of water directly to the roots of the plants through a network of economically designed plastic pipes. Research and development units, both at private and government level are conducting in-house field research and process development for environment-friendly agricultural practices and for educating farmers on land use patterns. Technology diffusion through its integration has the potential to transform the entire agribusiness value chain, from agricultural production and origination to trading. It is helping the farmers to take informed decisions. With the application of Internet of Things, mitigating risks and tracking crop from field to farm is now much easier (RM Bureau, 2017).

In the field of medical science, it has helped the humanity in several aspects. It helped in treating people, savings lives by combating against harmful diseases. In present day diagnosis has been easier and more accurate, especially through advancements in the areas like nuclear medicine, imaging technology, radiology, remote surgery etc. Use of life saving drug has helped people stay longer. Infant mortality rate in India has declined by three points from 37 per 1000 live births in 2015 to 34 per 1000 live births in 2016 (SRS, 2016). Looking from healthcare facility, patient files are now can be kept in databases that can be accessed from anywhere resulting in ease and time saving, further resulting in significant savings in health care costs as well as improved patient health and safety. In the field of education technology has improved in the method of learning. For instance, delivering teaching through online learning resources, using of apps, online learning management systems, students can remotely login to access course material and also attend live classes with teachers. Pre-recorded lectures, videos can be uploaded into learning platform making it easy for students to go through it multiple times. It helps in promoting distance education where the students or working professionals are learning the courses remotely through online access and interact with faculty via online classroom.

These examples show how technology can cause a change. A single innovation can quickly and significantly change the course of entire society. Today's technological advances are faster and more fundamental (break-throughs in genetics). They are driving down costs (computing and communications) at a pace never before seen. For example the use of internet, wireless, mobile phone etc. have enabled us to communicate and obtain information in ways which was never before possible, thus opening up possibilities to participate in decision that affect our life.

Technological innovation is essential for human development and its progress (UNDP 2001). For example from use of printing press to computers, the first use of vaccines, people have devised tools for improving health, raising productivity, facilitating learning and communication. Break through in digital, genetics and molecular technology are helping to eradicate poverty. Technology is helping in enhancing the human capability, to live a long and healthy life. It helps achieving knowledge and be creative, to enjoy a decent standard of living, participating in the social, economic and political life of a community. It also helps in economic growth through the productivity gains (UNDP 2001). Countries which have used technology effectively have achieved a higher growth rate (UNDP 2001). Technology has enhanced human's life capability to work on and deal effectively in any situation, it has the ability to satisfy survival needs of a human being (Kauffman et al 1999, 2000).

## 1.2 DIFFUSION OF TECHNOLOGY

The origin of diffusion was first given by Tarde (1904) as an "imitation" which is today called "adoption". He introduced the S-curve and the opinion leadership which was further conceptualised by Rogers (1962). Rogers (1962), described diffusion as, "The process by which an innovation is communicated through certain channels over time among the members of a social system where a social system is a set of interrelated units that are engaged in joint problem solving to accomplish a common goal". Similary Fichman (2000), described diffusion as, "The process by which a technology spreads across a population of organisations".

Here the units differ in their behaviour, by means of homo (similarity between the individuals, that with respect to education level, beliefs and social status) and heterophily (where individuals differ on these attributes).

Rogers emphasised that diffusion of technology depends upon various factors; the knowledge, communication channels and opinion leaders or the change agents. Change agents are those individuals who influences users innovation decisions in a direction desirable by the change agency (a firm or an NGO which tries to implement the technology), who arrive from outside the community through interpersonal and mass media communication. Here interpersonal communication act as a powerful tool in convincing a population to accept the new innovation which passes from first exposure of the innovation until its adoption or rejection takes place. It also depends upon the innovation diffusion process, where the potential adopters of a technology progress over time through five stages (knowledge, persuasion, decision, implementation and confirmation). Further diffusion also depends on individual innovativeness theory, where the individuals who takes risk will adopt an innovation earlier in the process of adoption/diffusion.

The rate of adoption is "The relative speed at which an innovation is adopted by the members of the social system". It takes place through a slow, having a gradual growth period, followed by dramatic and rapid growth, and then a stabilization and finally a decline stage. The perceived attributes of this theory gives the complexity, trialability, observability, relative advantage and compatibility as the attributes for diffusion" (Rogers, 1962).

Apart from these attributes Tornatzky and Klein (1982), gave factors like profitability and social approval were also responsible for adoption process. Additionally Rogers and Shoemaker (1971), analysed that, people decides whether to adopt a new technology or reject it depends upon the categories of people and the factors associated with it. They identified five categories; called as innovators, early adopters, early majority, late majority and laggards having factors like; venturesome, risky, cosmopolite, respect by peers, opinion leaders, willingness, skeptical, suspicious respectively. People who adopt the technology earlier or use it earlier in

the society are innovativeness. A study was done on farm operators perceiving the innovativeness, it was found that apart from earlier factors early adopters do also show leadership qualities, have instinct of learning more, information seeking and they merely do not depend on a single source of information (Timothy, 1993). Further Moore (1991), expanded it and studied these categories in relation to the adoption of technological products in business, suggesting that the success or failure to adopt a particular technology or an innovation is more critically dependent on the gap between early adopters and early majority called chasm. This occurs when a new product or service cannot be translated into a significant benefit. Early adopters can create bad references for the early majority. This needs to be bridged if an innovation is going to be successful in the mass market, Moore (1991). Further to above readings different models has been studied to find out other factors for explaining the innovation adoption.

### 1.2.1 THEORY OF REASONED ACTION (TRA)

Fishbein, Ajzen (1975) and Ajzen, Fishbein (1980), gave this concept from psychology and focuses that people actions consist of various components; consumer attitude, consumer belief and motivation, which affects consumer decision to adopt any innovative product. Explaining this theory it is concerned with determinants of actual and intended behaviour: behaviour is determined by a intention which in turn is determined by a person's attitude towards behaviour and the norm. Attitude towards a behaviour is determined by person belief and the behaviour will lead to certain outcome.

### 1.2.2 THEORY OF PLANNED BEHAVIOUR (TPB)

Ajzen (1985), gave this theory and explained the behavioural intentions and behaviour. It is similar to TRA, only difference is the adding of behavioural control as an additional factor of intentions and behaviour. Here people have volitional control (individual deciding on commits to a particular course of action) over the behaviour of interest (realise that they are capable of performing the behaviour if they so desire)

Taylor and Todd (1995), considered the factors relative advantage, complexity and compatibility of Rogers (1983) to derive theory of planned behaviour. Population groups and individual may perceive the same innovation differently, depending upon certain attribute of the product. The first and the most important attribute is the relative advantage. Relative advantage refers to the degree to which an innovation provides benefits which are better than the previous product and includes the factors like convenience, image, enhancement and satisfaction (Rogers, 1983). Here consumers sees a product and judge the product in terms of relative advantage in terms of economic returns. Moreover there are other factors such as user satisfaction and prestige that influence an individual's perception of the relative advantage of innovations (Greenhalgh et. al, 2004)

Rogers (1983), further explains another factor called complexity which affects a consumer decision to buy. Complexity refers to which an innovation is perceived to be difficult, which signifies that simpler technological product have a higher rate of adoption (Davis et al, 1989). Lastly he gave the factor called compatibility, which means the product should be align to the existing values, previous experience and needs of the consumers (Rogers, 1983). Ease of use, usefulness, compatibility are associated with attitude, peer influence, superior's influence is associated with norm, the standard of behaviour (Shih and Fang, 2004). Hoerup (2011), did a study on compatibility factors for teaching, and found that each innovation influences teachers's opinions, beliefs, values and teacher's views. If an innovation is compatible with an individual needs, then uncertainty will decrease and the rate of adoption of the innovation will increase. Naming the innovation is also an important part of compatibility, it should provide meaning to the potential adopter, which is also a complexity attribute.

### 1.2.3 TECHNOLOGY ACCEPTANCE MODEL

Davis (1989), gave the TAM model which was adapted from TRA model. It replaces attitudinal factors with perceived usefulness and perceived ease of use (free of effort). Igarria's (1993), gave a study of microcomputer technology acceptance based on TAM, and found factors, like complexity of the system, motivational factors and system usage affects adoption. Here three main motivational factors affecting technology acceptance were examined intrinsic motivation (enjoyment and fun); extrinsic motivation (usefulness) and social pressure were responsible for technology diffusion. Similarly Chidambaram and Kwon (2000), studied the diffusion of cellular telephone and found acceptance of new technology is affected by individual difference (gender, age, education and profession); perceived ease of use; perceived usefulness and intrinsic motivation (enjoyment and fun); extrinsic motivation (usefulness) and social pressure.

### 1.2.4 EXTENSION OF TECHNOLOGY ACCEPTANCE MODEL

Ventatesh and Davis (1996), further added new factors to perceived usefulness and perceived ease of use. The factors were subjective norm (the perceived social pressure to perform or not to perform the behaviour), output quality, image, job relevance, result demonstrability. Park (2009), did a study on university students in Korea who had attended e-learning course and finding out what factors is affecting the final acceptance of such courses by students. It turned out that self-efficacy (one's belief in one's ability to succeed in specific situations or accomplish a task) was the factor that most affects the behavioural intention followed by social influence (occurs when a person's emotion, opinions or behaviours are affected by other). Similarly Saade, Nebebe and Tan (2007), did a study on university students who attended courses in multimedia learning system, where the purpose was to evaluate students

satisfaction with multimedia tool using TAM. It was found that “perceived usefulness” had a significant impact on attitude to use multimedia tool and as a consequence “attitude” played an important role in the use of behavioural intentions.

### 1.2.5 AIDA MODEL

Garber and Dotson (2002), stated the AIDA model, but was originated by E.K. Strong. This model consists of awareness-interest-desire- action. It is assumed that learning about a product will lead to feelings about the product that result in the purchase of the product, desire for action is the best predicting factor for behavioural changes between attention and interest for action (Bahram, Shaemi and Jolodar, 2011). AIDA model is also widely accepted as an adoption decision model (Engel, Blackwell & Miniard, 1995). To examine this Hasa, Hartoyo, Sumarwan and Suharjo (2012), did a study on environmental friendly air condition with an objective to analyse to the factors which influence the desire to buy a eco-innovative product. They found that the external factors like promotion effort of change agent, that is communication activities with clients (Rogers, 2003), social interaction, media selection (Rogers, 2003) do also influences consumer desire to buy or adopt the product. The amount of effort spent in communication activities with clients will increase interest and desire of buy the product. Personal factors include lifestyle, personality, and environmental knowledge also do influence the desire to buy a environmental friendly product. Here relative advantage was in savings in energy, compatibility in the bigger size of AC and more wealth, complexity in terms of easy to use, trialability in terms of having a trial period for AC, and observability, were such factors influencing the desire to buy the product.

### 1.2.6 OVERVIEW AND CONSUMER BEHAVIOUR

This section focuses on understanding the consumer behaviour and decision making towards purchasing a product from an angle of marketing perspective. Schiffman and Kanuk (1998), defined Consumer behaviour as the behaviour that consumers display in searching for purchasing, using, evaluating and disposing of products, services and ideas. We need to understand the consumer needs and their preferences before we need to diffuse any product into the market. Analysis of a consumer preferences depends on following factors who is buying the product, who makes the decision to buy the product? who influences the decision to buy the product? how is the purchase decision made? why does the consumer buy? why is the consumer preferring one brand over another? where do consumers go to buy the brand? when do consumer buy a product? what is the product’s perception? what demographic factors (age, sex, income and education) and social factors (reference groups, family, the role and status) influences the purchase decision? These factors needs to taken care of before introducing any product into the market, Schiffman and Kanuk (1998).

### 1.2.7 CONSUMER DECISION MAKING AND GREEN CONSUMER BEHAVIOUR

Consumer decision making is a process for identify his/her needs, collect information, search for alternatives and make the purchase. It is an important aspect when a consumer goes for purchasing any product. There is a need to understand the consumer first and then the marketers can push the product, (not understanding the consumer, acts as a barrier for entry of any product). Consumer focused approach should be given more emphasis (Bargh, 2002) so the products can penetrate into the market. Further consumer behaviour is also traced to green consumer behaviour from the study of societal marketing. It gives two categories, first studying the consumer behaviour and the second the study of ecology products. Ecology products are those which do not harm the environment whether in their production, use or disposal (AQS, 2010). Peattie (2010), defines green consumer as “Purchase choice, product use and post use and behaviour reflecting some degree of environment related motivation.”. Bagozzi et. al. (2002), has analysed this definition and gave green consumer behaviour is not limited to purchases of green products, but also involve the use and disposal of these products, services and practices of using it. From consumer decision perspective Caird and Roy, (2006), analysed that when people go for deciding to adopt, use or reject ecological products/systems they seek four sets of factors that those are socio-economic factors (product distribution, service, product standard etc.), communication sources (industry, Govt and interpersonal), consumer factor (personality, family, income, education, knowledge, lifestyle, habits, attitude, values etc) and product/system factor (performance, ease, reliability, efficiency, image, brand, appearance, price of product etc). Jackson (2005), further gave other factors such as availability of incentive, personal capability to buy the product, attitude influence the consumer to buy the green product. The above is rightly said as the key to a “sustainable energy future”, is to analyse the consumer preferences as a success parameter in promoting renewable energy resources (Nakarado, 1996).

In India, majority of the population is below poverty line, the decisions to adopt renewable energy products become a challenge, buying process to be risky (Gibler and Nelson (2003), Mitchell (1999), Gronhaug, Kleppe and Haukedal (1987), Beatty and Smith (1987). Technological products related to renewable energy products like solar lights, solar pumps have still not crossed the introductory stage and are new innovative, which are yet to reach their potential.

## 2. FACTORS AFFECTING TECHNOLOGY DIFFUSION

Here an attempt has been made to find the various factors pertaining to the technology diffusion irrespective of the technology being used to penetrate in the population.

Galacz, Dessewffy (2008), Ret (2008), Attewell (1992), Lambe, (1984), Riesenber and Gor, (1989) and Reddy (1987), did a study on diffusion of internet in the country of Hungary and found accessibility, requirement for the product, price, skills, abilities, nature of the individuals to use technology, interest level, knowledge level, income level, education level, age, attributes of the product

with in, decision to adopt it or reject it, effort shown by the client to adopt it and lastly what are the client needs is to be looked into are essential for the diffusion to take place. Further Ryan & Gross (1943), did a study on hybrid corn and found that exchange of personal experiences between the farmers and the salesman, played an important role in the diffusion process. Apart from the above factors reading habits was also influencing the diffusion process. Similarly Coleman et al., (1957), did a study on drug diffusion study in four cities of US about a new antibiotic called "Tetracycline". It was found that cosmopolite, inter-personal friendship (religion and age were the main determinants of friendship links) network were responsible for diffusion of the drug. Peer pressure to adopt the product was also influencing the diffusion process.

Deutschmann and Fals Borda's Saucio (1960), did a study involving six innovations; chemical fertilizers and spray guns for insecticides and fungicides, concentrated poultry and livestock feed and a potato fungicide. It was found that apart from educational level, cosmopolite, factors such as farm size, exposure to mass media and opinion leadership were the most important variables for innovativeness, further traveling outside of the village to market, towns and cities and have a higher degree of learning of new ideas.

A study was done on diffusion of Nokia cell phone when it was introduced in US in 1983. It was found that portability, colour, shape, size, less cost of the phone along with short message service was responsible for diffusion of Nokia cell phone. The company used the attributes of trialability from Rogers diffusion theory, by providing free trial to consumers, giving free service to consumers was adopted by the company to encourage adoption. Incentives were also provided like giving of free cell phones to consumers were also responsible for diffusion of Nokia cell phone in US.

According to Windrum and Berranger, (2002), Dholakia and Kshetri, (2004), Sekabira *et al.*,(2012) and Jacobs and Herselman (2006), did a study on traders and farmers adopting ICT in rural Iran. It was found that apart from above factors (education, income, monthly expenses, experience, attitude and knowledge) cost effectiveness and speed of information transfer, organizational characteristics like business size, system characteristics like availability and accessibility to ICT services were responsible to diffusion. Further they also analysed that family size and land farmed also influenced the adoption process.

Phillips (1972) and Cooper (1966), did a study on cable television in US, it was found that emergence of cable television was more due to public demand, the television dealers motivated the latent demand into sales. It was also found the colour television created a need for better quality which cable could supply.

Similarly Helper (1995), did a study of adoption of CNC machine in auto supply industry in US. He tested for three factors; expected efficiency gain (defined as a reduction in operating cost), market power of the firm (proxied by market share), and the stability of the firm's relationship with its customers, which guarantees the presence of future demand. From the study it was found that relationship with the customers was important, employees need to be trained to operate the new technology (skill requirement) and giving them incentives to adopt a technology if it is profitable for them to do so.

Hubbard (1998), did a study on on-board IT devices, giving emphasis on two products trip recorders and electronic vehicle management systems (EVMS). A trip-recorder enables firms to monitor their drivers by providing data, among other things, the speed of the truck, how long the truck was inactive, and when the truck was turned on and off. The data from the trip-recorder, however, is only available when the truck returns to its base. Therefore, it does not assist in coordination of hauls. EVMS provides the same data along with the information on the truck's geographic location. It could relay the data to the base thorough a satellite or land link, and allows real-time data and voice communication between the driver and a dispatcher. Thus an EVMS helps in both coordinating dispatch and improving drivers' incentives. Here researcher found that transactional relationships between the trucking firm and the shipper determined the effectiveness and therefore the adoption of on-board IT. In addition to this the nature of relationship with customers, determined whether the benefits are coordination-related or incentive-related. If the customer relation was stable, either through a contract or vertical integration, then on-board IT in the form of a trip recorder helped more with the monitoring the task. However, if the transactional relationship is not governed by a contract and takes place in a spot market, then the benefits were more coordination-related and EVMS was more likely to be adopted.

Kennickell and Kwast (1997), did a study and found evidence that the role of education, consumer skills and learning was important for the adoption in electronic banking. 70% of all American households used some form of electronic banking in 1995, but only a small fraction of households used the recent and advanced forms of electronic banking such as paying of bills. The most common use of electronic banking was for making direct deposits, which was a relatively well-established and old technology, one that is widely used throughout the world, indirectly confirming the existence of a learning effect. When technology develops and improves, more and people become familiar with it and comfortable about using it, and this accelerates the speed of adoption.

Saloner and Shepard (1995), did a study for the adoption of ATM machines by banks related to network effect. A technology has a network effect when the value of the technology to a user increases with the number of total users in the network. It is of two types called direct and indirect. For example the benefit from having a telephone directly depends on the number of telephone sets in the network since the benefit will increase as more people can be reached by the phone. From indirect approach for example purchasing a DVD player may be increasing with the total sales of DVD players, since the availability of appropriate software will increase as more DVD players are sold. This is called the "hardware- software" relationship, where the availability of software increases as more hardware is sold because of the complementarity between the hardware and the software. Similar network effects is also present in the case of durable goods where beliefs about post-purchase service may depend on the total number of sales, and therefore consumers will prefer to purchase from a firm that is older or more popular. Baker (2001), did a study on the effects of the provision of health insurance on the adoption of new medical procedures. He argues that by providing reimbursement for the

use of advanced and costly procedures, a generous insurance system often helps in adoption of new techniques and methods of treatment. Cutler and McClellan (1996), found evidence for the positive effect of a generous insurance environment on adoption decisions. They studied the use of heart attack treatment procedure called angioplasty during the period from 1984 to 1991, they found that the insurance environment, along with state regulations related to the use of new medical technology, and the interactions between physicians and hospitals, are the most important factors determining the use of angioplasty.

## 2.1 DIFFUSION OF RENEWABLE ENERGY TECHNOLOGY

Human activities are surrounded by energy, it is the main root for human development. Achieving universal access to modern energy has become enshrined in the new U.N. Sustainable Development Goals (UN, 2015), because of its related effects on human development (Sovacool, 2012). People has been using commercial fuel like coal, kerosene etc in large scale from 19th century, it gave birth to industrial revolution. Subsequently industries came up, infrastructure grew and it harnessed coal and other energy sources in huge capacity. However during recent days people have realised that if we use these resources without control and monitoring then a time will come where it will finish and will bring everything to halt. Our minds towards the use of these sources of energy needs to change with a further change in world energy systems.

Renewable energies are sources of clean, inexhaustible and increasingly competitive energy acting as an indispensable partner in the fight against climate change.. They differ from fossil fuels principally in their diversity, abundance and potential for use anywhere on the planet, but above all in that they produce neither greenhouse gases – which cause climate change – nor polluting emissions. Compared to conventional energy sources such as coal, gas, oil and nuclear - reserves of which are finite - clean energies are just as available as the sun from which they originate and adapt to natural cycles, hence their name “renewables”. This makes them an essential element in a sustainable energy system that allows development today without risking that of future generations.

Billions of people in the developing world are living without electricity who rely on inferior lighting systems (kerosene lamps) and pay more per unit than the developed world. They live in dark and are unable to engage in many types of evening activities that those in the developed world take for granted (Kanagawa and Nakata, 2008). There is a need for high quality lighting technologies to be available at affordable price. Solar electricity is an ideal, cost effective power source for many lighting requirements (Schweizer-Ries, 2008). Here compatibility term in lighting refers to the categories of lighting depending upon the luminaries (Schweizer-Ries, 2008). PV systems are seen as an affordable technology at a commercial level, but are incompatible with personal priorities and compatibility, which is a basic criterion of a consumers ‘willingness’ to pay for the technology (Berger, 2001). Kaplan (1999), focused on adoption of renewable energy systems requires more marketing activities that increase familiarity, greater awareness by consumer education programs, marketing materials and informing about processes involved that is through installation and service.

### 2.1.1 FACTORS AFFECTING DIFFUSION OF SOLAR PRODUCTS

Gross et al, (2003), did a study in Ghana on diffusion of solar PV systems and found that price of the innovation plays a big role but the more important is the availability. Brown (1981), focused that until Govt, entrepreneurial or non-profit organisation makes the innovation available at or near the location of the potential adopter, that person or household will not have the option to adopt in the first place.

Caird et al’s (2008), Akinboro et al (2012), Ijeoma vicent-Akpu (2012), Mulvey (2003) and Heimburger et al. (2002) and Leach (1992), did an investigation into the energy efficiency and renewable energy technologies and found that adoption of these technology mostly depends upon financial aspects of the product (cost), practical issues regarding installation and general level of knowledge, awareness level, income level, education level. However it was not clear that if the costs are reduced and information is made available to the consumers then adoption level would increase or not. Apart from above factors repairing of broken parts and time lag between breakdown and repair were responsible for diffusion of solar energy products. Lay et al., (2013), did a study in Kenya and found the factors affecting the diffusion of lights were education level, income level of the household heads, the household expenditure, ownership of the dwelling, rural setting of the household, the prevalence of solar home systems (SHS) in the area. and availability of technical assistance for installation and service. Further it was also found that quality aspect of the product like the hours of operation also do affect the diffusion process. Reddy and Painuly (2003), did a study on barriers for solar technology diffusion in Pune and Mumbai involving households, industrial firms and commercial establishments. Their study analysed that awareness, knowledge level of the adopters, cost of the product, consumer perceptions of the quality and usefulness of the product and advice of their friends were the major factors affecting the diffusion process. Apart from the above factors other factors like unavailability of skilled workers and technical specifications of the product also played a role for its diffusion.

Similarly, Maruvi (2010), did a study on solar water heater in the city of Visakhapatnam. From the study it was found that education level and those having high income were aware of the product, moreover it was found that family and friends were having strong role in the diffusion of the product. Other factor like size, cost, awareness, availability and serviceability were also do affecting the product diffusion.

From the above study a number of factors affecting diffusion of technology has been found out which are summarised and given in Table: 01

**Table: 01: Summary of Factors Affecting Technology Diffusion**

Proponents	Factors
Scott (1976), Ajzen and Fishbein (1980) Jerald and Scott (1981) Brown (1981) Durham et al (1988) Bernardo and Kilayko (1990) Reddy and Painfully (2003)	Awareness Level, Interest, Trial and Consumer Perception, Knowledge level, Advice from Peer, Cost, Role of Opinion Leadership quality, Distribution Channels Communication process and Learning, Diffusion Agent, Opinion Leader, Motive, Ownership, Performance of the Product Demonstration of product, Payback period
Bhatia (1987) Vagela (1993) Vernon (1996) Caird and Smith (2009)	Affordability, Reliability and Good Services Financially Viable Repair and Maintenance
Patricia (1980) Lowenberg-DeBoer (1998) Eleri et al (2011) Xiarchos and Viek (2011) Lay (2013)	Age, Gender, Education level, Occupation, Skill, Awareness level Govt regulations Subsidy, Income level Cost
Yarosh Connor (1980) Brown (1981) Mbogo (2001)	Maintenance, Installation Cost, Incentive schemes and Warranty
Vagela (1993) Garett and Tomas (2008) Sui, Liy (2011)	Advertising, Brand Image, Price of the Product and Competition, Demand and Supply Chain, Usefulness, Prior Experience, Brand Image, Innovation, Peer, Social Network, Incentives, Managerial support
Card et al (2008)	Attitude, Beliefs, Life style, Norms and Culture
Caird and Smith (2009)	Cost of the Product, Efficiency, Communication
ADEME, UNDP (2010)	Cost, Quality of the Product, Geographic and Climatic Conditions, Skill people availability and Awareness Level

## 2.2 CLASSIFICATION OF FACTORS ON THE BASIS OF MARKETING MIX

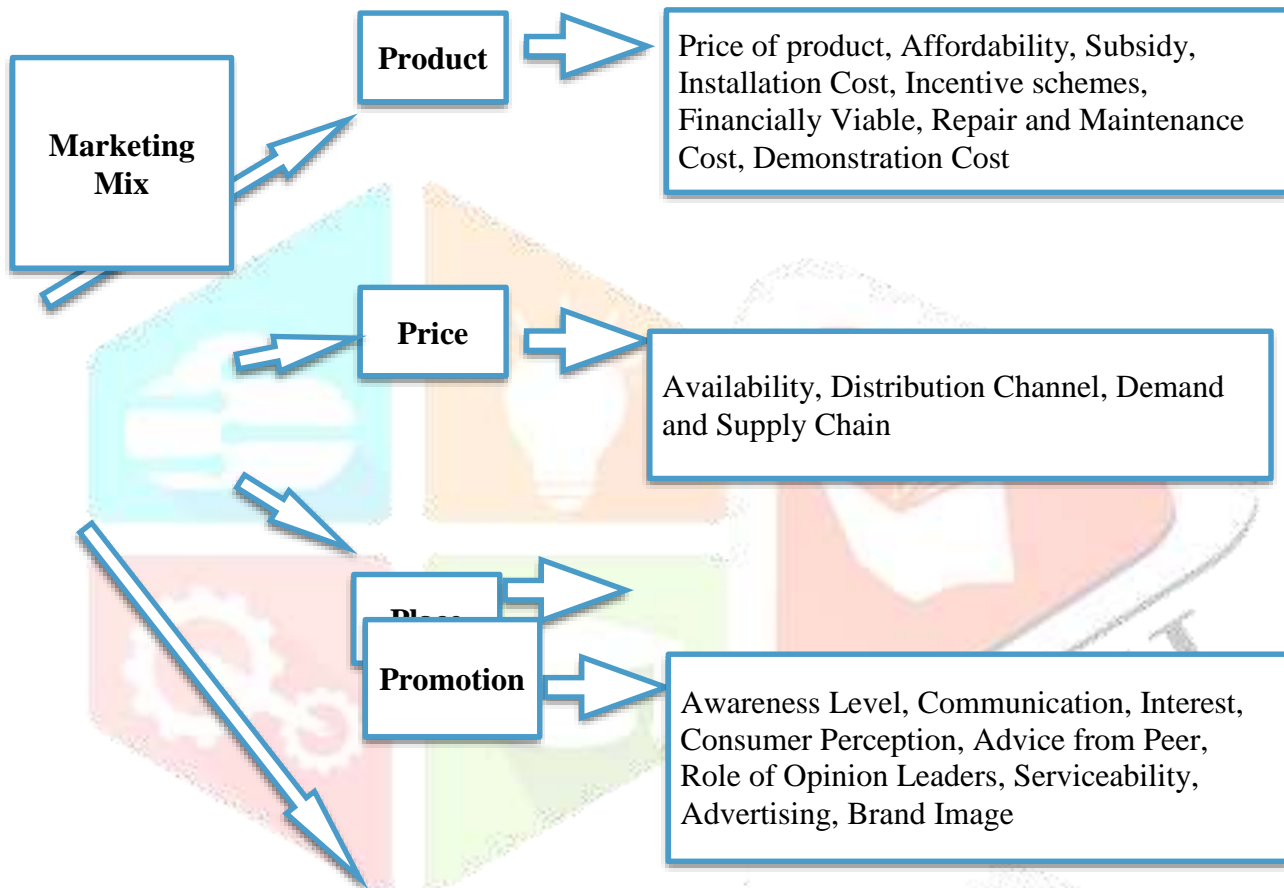
Here in this section we have tried to classify the factors affecting technology diffusion on the basis of marketing mix. Below a description has been provided on origin of marketing mix.

According to McCarthy, (1960), "Marketing mix is a pack of four sets of variables, namely product variable, price variable, promotion variable, and place variable". In simple words marketing mix means a marketing programme that is offered by a firm to its target consumers to earn profits through satisfaction of their wants. Such a marketing programme is a mixture of four ingredients, namely Product mix, Price mix, Place (Distribution) mix and Promotion mix.

Product mix indicates the decisions of the firm regarding the product design, product range, product packing, product quality, product branding, product labelling and after sale service. Price mix reflects the managerial decisions of the business pertaining to pricing policies and strategies, terms of credit, terms of delivery, margin of profit, discount and allowances. Place (distribution) mix is made up of managerial decisions about the channels of distribution, transportation, warehousing and inventory control, lastly promotion mix covers variables such as personal selling, advertising, publicity, sales promotion, public relations, trade fairs and exhibitions used in promotion of sales. Below an attempt has been made to classify the factors affecting diffusion of renewable energy products on the basis of marketing mix.

Packaging, Reliability, Ease of Use, Performance, Usefulness, Quality, Technical specifications, Size, Efficiency, Running of the product.

FIGURE: 01: MARKETING MIX FRAMEWORK : CLASSIFICATION OF FACTORS



Apart from the above factors like age, gender, educational level, occupation and skill also plays an important role in marketing of the product. Here marketing mix for solar products can take place as for products to be offered in solar power system with the promise to provide end-to-end service. Price can be derived from cost incurred, and need to be sold in low price, which would help as a path for income generation activity, can be provided in EMI schemes, going for bundle strategy, giving subsidy and tie up with banks for its selling the product. Focus is on rural people, where there is no electricity and it is available in scarcity, can be used in industrial cluster, telecom tower operators, can be used in places like hospitals, airports, petrol pumps, ATMs etc. For promotion of solar lights B2B channels, events, national and international exhibition, event sponsorships, can be organised, can be demonstrated in haats, panchayat meetings, cultural events, etc. (MNRE, 2016).

### 3. Conclusion

Technological Innovation is essential for human development and its progress, for example improvement in health, increase in productivity, use of technological products etc. has impact on our lives. Technology has played an important role in fulfilling our needs, countries, states which have used technology have achieved a higher growth rate. The factors like awareness level, interest, trial, consumer perception, knowledge level, advice from peer, cost, role of opinion leaders, payback period, distribution channels, communication process and learning, performance of the product, affordability, reliability, good services, financially viable, repair and maintenance are affecting technology diffusion of various products. Some researchers have also given age, gender, education



level, occupation, skill, govt regulations, subsidy, income level do also affect diffusion process. Other researchers have highlight factors like advertising, brand image, price of the product and competition, demand and supply chain, motive to buy the product, taking its ownership, buying attitude, beliefs, life style of adopter and norms and culture do also affects the innovation adoption. Maximum of the these factors are pertaining to US or European context specific, here the current researcher believe that few studies has been made on technology diffusion pertaining to renewable energy products, that too in rural tribal dominated areas of South Odisha and moreover may be a large number of possible factors hidden in this aspect.

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