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Molla E. Majid

Curtin University of Technology, mollamajid@gmail.com

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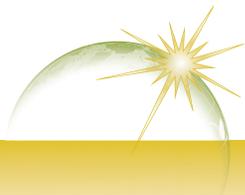
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Role of ICT in promoting sustainable consumption and production patterns – a guideline in the context of Bangladesh

Molla E Majid
Curtin University
mollamajid@gmail.com

ABSTRACT: Sustainable development is of much focus now-a-days due to global warming and continuing depletion of natural resources. Implementation of sustainable consumption and production patterns is central to achieving sustainable development. Many countries along with the United Nations have reiterated this fact in multiple global platforms. Growing industrialisation and population growth are gradually making developing countries more and more susceptible to unsustainable patterns of production and consumption. Many governments are taking strategies to change this situation. Science and technology have been proven to be effective in fighting poverty and unsustainability in many cases previously, and have the potential to be helpful in the implementation of sustainable patterns of consumption and production. This paper, therefore, focuses on the use of technology, in the form of Information and Communication Technology, in changing unsustainable patterns of consumption and production in the context of Bangladesh.

KEYWORDS

Sustainable Consumption and Production; Sustainable development; Bangladesh; ICT

I. INTRODUCTION

On the 25th of September 2015, a resolution was adopted by the UN general assembly known as ‘2030 agenda for sustainable development’. The resolution included 17 goals and 169 targets – the purpose was to foster sustainable development in the areas of economy, society and environment by the year 2030 (UN General Assembly, 2015). These goals and targets are known as Sustainable Development Goals (SDGs)-2030. This paper focuses on the target 12.a of SDGs-2030, that states: “support

developing countries to strengthen their scientific and technological capacities to move towards more sustainable patterns of consumption and production” assuming that developing countries lack scientific and technological capacities with respect to attaining sustainable patterns of consumption and production. This assumption is applicable for Bangladesh. The major reasons are growing demand for unhealthy food, luxurious commodities, gradual depletion of natural gas, unplanned urbanization and industrialization, and increasing levels of pollution and emission. Thus, the paper aims to promote con-

sumption and production processes in Bangladesh in a sustainable pattern by way of strengthening the current state of scientific and technological capacities in terms of ICT.

The paper analyses current practices of consumption, production and underlying supply chain issues in Bangladesh and identifies challenges and obstacles that need to be overcome in order to ensure sustainable patterns of consumption and production in the country. This paper also highlights some of the latest development in ICT for sustainability purposes and provides guidelines on how these can be applied in the context of Bangladesh. Thus, the objectives of this paper are to:

- 1) Analyse current practices of consumption, production and supply chain issues in Bangladesh, and identify challenges that need to be overcome in order to make them sustainable
- 2) Provide guidelines on the applications of ICT in overcoming these challenges

II. METHODS AND LIMITATIONS:

This paper uses data and information from various secondary sources including research journals, book chapters, thesis papers, newspaper articles, government websites and United Nations bodies. Observation over a long period of time has contributed significantly towards the sources of information. In the future more research may be conducted in this area collecting data directly from various sources.

III. SUSTAINABLE CONSUMPTION AND PRODUCTION PATTERNS:

Sustainable Consumption and Production is defined as “the use of services and related products, which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations” (Oslo Symposium, 1994). Ensuring sustainable consumption and production patterns is a prerequisite to sustainable development. Sustainable development means “development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development includes economic, environmental and social sustainability, which are independent and mutually reinforcing pillars, and can be achieved by rationally managing physical, natural and human capital. Poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base of economic and social development are overarching objectives of, and essential requirements for, sustainable development” (UNEP, 2010).

Sustainable consumption is generally tied to the retailer and consumer end of the supply chain and aims at more efficient distribution and consumption of food rather than ‘eating less’. Sustainable consumption deals with food consumption and purchasing behaviour as well as other activities related to housing, leisure and mobility that contribute towards lifestyles and livelihood. Human values, awareness and willingness, policy-making and enforcement are all equally necessary to implement sustainable consumption patterns. Sustainable consumption cannot be achieved by only targeting food consumption patterns in the developed countries; 842 million of undernourished people around the

world needs to be included in the process. Half of the total food wasted in the world is enough to feed all these undernourished people to whom food is the primary concern. Sustainable consumption is, thus, key to eliminating poverty, under-nourishment and promoting social inclusion. (UNEP, 2015)

Sustainable production, on the other hand, is associated with producers and suppliers in the supply chain. Objectives of sustainable production patterns include responsible and sustained use of natural resources and factors of production along with waste minimisation and reduction of pollution. 'Sustained use of natural resources' includes usage of water, air, energy and land for production purposes. Science and technology may be used to produce high-growth water efficient seeds. Green agriculture may be implemented to reduce energy usage by substituting machines with human, which, in turn, will boost employment. 'Sustained use of factors of production' implies to choice between renewable (solar, wind and hydro) and non-renewable (fossil fuel and nuclear energy) sources of energy for production purposes. 'Pollution reduction' implies to reduction of industrial toxic gases and chemicals, greenhouse gas emissions and use of excess nutrients resulting from unsustainable production patterns. (UNEP, 2015)

In order to achieve sustainable development goals, it is important to analyse and act on production and consumption ends of the supply-chain together (convergence) rather than separating them. Previously Sector-, place-, product- and consumer-oriented approaches had been adapted in order to achieve sustainability (Princen et al., 2002; Lebel, 2004). Limitations of these approaches include narrow range of focus leading to imbalance, confusion and shifting unsustainable practices from one area to another rather than combating them altogether. Production-consumption systems (PCS) address

these limitations by linking environment, human, organisation and state through flow of energy, materials and relationships with the use of money, information, power, influence and negotiation (Lebel and Lorek, 2008). Lebel and Lorek (2008) mention 11 (eleven) enabling mechanisms for sustainable production-consumption systems, these are:

- efficient production using lesser raw materials
- implementation of green supply chain by imposing environmental standards on suppliers
- co-design of products by involving consumers in the design process
- producing responsibly by making producers liable for waste management
- being service-oriented rather than being product-oriented
- certification and labelling products using environmental standards
- fair trading to ensure both customers and producers get a better deal through agreement
- ethical marketing to reduce wasteful and over-consumption practices
- campaigns to educate consumers about responsible purchase leading to change in overall behaviour
- using less and responsibly, and
- increasing consumption wisely.

A major challenge to these mechanisms in ensuring sustainable PCS practices is the gap between knowledge and practice. Lebel and Lorek (2010) identify three major reasons for this gap. These are:

- firstly, relevant actor does not know what to do due to relevant knowledge not available to him or does not exist at all
- secondly, relevant actor does not have power to peruse the knowledge even though he knows what to do
- thirdly, factors other than available knowledge of sustainability is more influential in the decision-making process.

Effective communication is suggested to have this gap minimised. Others suggest that differences in interest-based priorities, political agendas, corruption and other factors are responsible for the maintenance of these gaps; therefore, these factors need to be eliminated in order to ensure sustainable patterns of consumption and production. (van Kerkhoff and Lebel, 2006; Lebel and Lorek, 2010)

IV. CURRENT PRACTICES OF CONSUMPTION AND PRODUCTION IN BANGLADESH:

In the developed countries wastage of food and consumables in the consumer-end and excessive carbon emission in the producer-end are major concerns towards achieving sustainable consumption and production patterns. Many of the developed countries are trying to shift this 'burden of carbon' towards developing countries by moving production units, and this, in turn, is gradually triggering unsustainable production patterns in the developing countries. Bangladesh, being a developing nation, is suffering unsustainable production patterns triggered both by increasing internal demand of food and energy, and 'shifted' external demand of commodities.

Although approximately 43% of the population in Bangladesh are living under \$1 a day (UNDP, 2015), growth of the middle-class income earners over the past couple of decades has increased the overall level of consumption of food, clothing, energy and other primary as well as secondary necessities of life. A greater number of people are now moving towards increasing their quality of lives through satisfaction from over-consumption of food and other commodities, which is triggering unsustainable production demand in the country. With the growth of the economy, rich are becoming richer and poor are becoming poorer creating an imbalance

in the economy. Open-market strategies taken by the government in the early 1990s and the emergence of ready-made garments (RMG) manufacturing sector have made a huge quantity of wealth available to a smaller group of population whose purchasing behaviour are also imposing challenge to sustainable consumption and production patterns in the country.

Bangladesh has one of the highest density of population in the world. Current population is over 160 million and it is increasing at a rate of 1.6% p.a. (CIA, 2015) The size of the land, being smaller than the Australian state of Victoria, there has been an enormous pressure on increasing food production in order to meet the consumption needs of this huge population. Excessive use of chemical fertilizers along with invention of high-growth hybrid rice seeds and deforestation has helped Bangladesh becoming almost a self-sufficient food producing country over the past couple of decades. Although chemical fertilizers are helping to meet the current demand of crop production, long-term effect on pertaining land's productivity may be adverse. Depletion of soil nutrients may reduce food production in the near future. Chemical fertilisers, after rain-washed, are causing river-water and lake-water to change ph. value and thus harming their ecosystems. For generations, fish and rice have been the most popular foods in Bangladesh due to their abundance. However, due to increased level of water pollution, resulting from unsustainable production patterns, the situation has changed. Now-a-days fish are not so easily available in the ponds, rivers and lakes the way they used to be available 50 years ago. The sizes of common local fish, such as, 'Ruhu', 'Katla', 'Boal' etc. have been greatly reduced over the past 40 years or so. Deforestation, destruction of wetlands and hill tracts in order to accommodate the increased population and food production, are causing increased rates of natural calamities such as flood, cyclones, tidal-bores, landslides and salinity of the land in the area, and thus adding to unsustainable consumption practices. (Ahmed, 2011)

Along with food production, food conservation and supply chain are other areas contributing to the unsustainability of consumption and production practices in Bangladesh. Most of the fruits and vegetables are traditionally grown and supplied from the villages of North-Bengal (districts in the Rajshahi and Rangpur division) and Jessore-Khulna area. Root level farmers being extremely poor are forced to sell their products to tier-1 middlemen or 'dalals'. These tier-1 middlemen then supply these products to the tier-2 middlemen in the wholesale markets of large cities, such as Dhaka and Chittagong. Products are then distributed to retail shops and markets for consumers to buy. This multi-level supply chain is very slow due to the lack of proper management and poor-quality roads, highways and transportations. Rickshaw-vans and normal trucks, without any sort of freezer, are used to carry these products for over 1 to 3 days before reaching consumers. Therefore, in order to keep them fresh, wholesalers and shopkeepers often use chemical preservatives, such as formalin, that artificially keep fruits, vegetables, fish and meat look fresh over a prolonged period of time. Excessive formalin is extremely harmful for human body and is suspected to cause cancers, lungs and kidney dysfunctions. Raw food products treated with formalin are not easily decayed in soil causing serious threat to the environment and sustainability of consumption and production patterns.

Current population of Dhaka, the capital of Bangladesh, is over 15 million (CIA, 2015) making it one of the most densely populated mega-cities on earth. With the growth of the economy, greater number of population are gradually migrating to the large cities from other parts of the country. 'Vision 2021' goal of Bangladesh government targets the country to become middle-income earner by 2021. With a DGP growth of around 6.5 - 7 Bangladesh is undergoing massive construction and development work requiring thousands of day-labourers and workers.

People migrating from villages and other parts of the country are working in these sectors for an average daily wage of around \$5-\$8. Majority of these people live in the slums lacking adequate provision of toilets or fresh water. Environments of these slums are extremely poor where contagious diseases often break out. Although a number of NGOs are working towards resolving the problems of toilets and fresh water across the country, liveability of the large cities is getting worse due to unhealthy living environment resulting from unsustainable production patterns. General household or domestic waste management system is another area of concern resulting from unsustainable consumption patterns in the country, especially in the large cities. Majority of the times city corporation bins are overflowed with rubbish clogging sewerage lines and extreme level of air-pollution in the surrounding neighbourhood.

Growth of population and industrialisation is causing energy demand and production to rise in Bangladesh. Currently, internal electricity demand in the country is around 8500-10000 MW. By 2021 this demand will be increased to 19000 MW per day. Current electricity production capacity is approximately 7000 MW per day (World Nuclear Association, 2015). Major sources of electricity production in the country are hydroelectric, gas-, coal- and oil-based power plants. Bangladesh, being a coastal country, sources of hydroelectricity is limited. Current gas reserve is not adequate to meet country's demand after 2030 if large-scale gas fields are not discovered. Most of the gas-fields are experiencing over-extraction, increasing the potential of landslide and gas-fled accidents; Niko gas field explosion in 2005 being an example of it. Total damage of Niko gas-field explosion was around \$106 millions. In order to meet the increasing demand of energy Bangladesh is gradually shifting towards coal-based power plants along with planning for large-scale nuclear power plants. Rampal coal-based power plant

near the Sundarbans (one of the largest mangrove forests on earth) and Rooppur nuclear reactors are two major power plants that are facing lot of protests and criticism both from inside and outside the country due to their potential harmful effects towards the environment and unsustainable production practices. Additionally, increase of population and unsustainable pattern of lifestyle has increased mobility of people inside the country, increasing motorised vehicles and unsustainable consumption of fuel. Although majority of the vehicles are using environment-friendly Compressed Natural Gas (CNG), outdated vehicles on the streets of Dhaka and Chittagong still remain a threat to the environment and sustainability.

80% of the export earning in Bangladesh comes from ready-made garments (RMG) sector. Approximately 3.6 million of workers are dependent on this sector. Major importers of Bangladeshi RMG products are North America and the EU countries. Global demand of these products is increasing due to low production costs resulted from extremely low labour costs. Currently there are over 3700 RMG factories operating in Bangladesh (Department of Inspection for Factories and Establishments, 2015). Majority of these factories have been built in and around Dhaka and Chittagong cities and are situated in high-rise buildings. This huge number of factories is degrading the liveability of these already over-crowded cities. Most of these buildings were originally built for residential purposes, now converted to RMG factories. Most of these buildings have inadequate facilities to survive an emergency. Although strict environmental and social compliance requirements have been placed on the RMG sector from many of the western importers, majority of the factories are not complying with these rules due to lack of enforcement from the government agencies. Collapse of Rana Plaza in 2013 and thousands of other accidents and

burnouts in the RMG sector, thus, impose serious threat towards sustainable production practises in the country. (Westervelt, 2015)

Industrial waste is another area in Bangladesh imposing threat to sustainable production-consumption systems in the country. Along with RMG factories there are tanneries, pharmaceuticals, dying, cement, steel, paper, plastic and thousands of other types of small to large scale industrial units situated mainly in Dhaka, Narayangang, Chittagong, Bogra, Khulna and Rajshahi areas. Most of these industries do not have any ETP (Effluent Treatment Plant). Rather wastes are directly thrown in the rivers or sewerage lines. Pollution level in the rivers around Dhaka city, such as Buriganga and Shitalokkha, is extremely high. Drinking water in Dhaka and Narayangang contains alarming levels of harmful chemicals contaminated from industrial wastes. Aquatic sustainability is thus being damaged in many parts of the country. Level of carbon emission is gradually increasing due to untreated industrial smoke and toxic gases. Thousands of clinics, health centres and hospitals around the country are also adding to unsustainable production-consumption practices by dumping wastes directly in open areas or rivers. (Miti et al., 2009)

Newly emerging tourism industry in Bangladesh is also becoming a challenge in ensuring sustainable consumption and production patterns in the country. Many new multi-storied hotels and resorts are being built around Cox's bazar, Teknaf and Saint Martin's island - the major tourism hubs of Bangladesh. 10-15 years ago, Cox's bazar had plenty of greeneries along the sea beach. Most of these are gradually being cleared up in order to accommodate for new hotels and resorts. Poor waste management, resulting from growing number of tourists, is increasing pollution level of the Bay of Bengal. Saint Martin's Island, the only coral

island of Bangladesh, is already facing a fragile ecosystem due to removal of corals from around the island and over-fishing by increasing number of tourists and local people. (Khan, 2013)

Some of the major obstacles in ensuring sustainable consumption and production patterns in Bangladesh are over-population, poverty, corruption, unfair trading, ignorance & lack of awareness of the knowledge of sustainability, and lack of enforcement of environmental policies, rules and regulations by appropriate authority. In order to overcome these barriers, it is important for the country to have a clear vision and framework along with necessary scientific and technological knowledge and capacity. The following sections focus on technological aspects of mitigating some of these challenges from ICT point of view.

V. STRATEGIES AND APPLICATIONS OF ICT USED IN PROMOTING SUSTAINABLE PRODUCTION AND CONSUMPTION PATTERNS:

ICT is commonly known as Information and Communication Technology. Any technology that uses information or communication in the form of coding, oral or writing can be regarded as ICT. In this paper, any medium that directly or indirectly uses and transfers information has been put under the umbrella of Information and Communication Technology.

Role of ICT in the areas of sustainability is an emerging area of research. ICT plays role in sustainability in two different ways, these are:

- a) Sustainable ICT, and
- b) ICT for sustainability

The first category implies how ICT and relevant technology can be made sustainable by reducing their harmful effect on the environment and society. Strategies include, reducing emission of computers and electronic devices, greening data centers, energy efficiency of electronic products, turning monitor and computer sleep when not in use etc. The second category discusses how ICT and relevant technology can be used to promote sustainability. Strategies include use of software, computer systems and technology-based tools to replace any physical forms of communication or operation that directly or indirectly causes emission, pollution and unsustainable patterns of consumption and production. Hilty and Abeischer (2015) mention five major areas of interest that interact ICT with sustainability and contribute positively towards sustainable development. Following are a brief outline of these areas:

Environmental Informatics and Environmental Information Systems (EIS):

Environmental informatics or Environmental Information Systems (EIS) collect, gather, sort and analyze data and information related to environment. Main methods of operations of these systems include Modeling and Simulation of environment related issues, and Spatial data processing. EIS can contribute to sustainable development by monitoring the environmental changes, understanding complex systems, sharing data and building consensus among stakeholders.

Computational Sustainability (CompSust):

Computational sustainability applies techniques from computer science, mathematics, statistics, information science and operations science to provide support for management of resources and balancing conflicting goals related to environmental, economic, and societal needs for sustainable development. Methods used by CompSust systems include modeling, optimization, constraint reasoning, machine learning etc.

Sustainable Human Computer Interaction (HCI):
Sustainable HCI has been defined as a sub-category of Human Computer Interaction (HCI). Sustainable HCI deals with human interaction and behavior with computer and technology from sustainability point of view. Sustainable HCI contributes to sustainable development by increasing longevity of devices and modifying devices so that their usage promotes sustainable consumption patterns.

Green IT and Green ICT: ^[11]_[SEP]
Green IT/ICT is defined as the area of technology-sustainability interaction that deals with usage and disposal of computers and related products in a sustainable way so that it leaves minimum effect on the society and environment. Green IT/ICT also deals with how technology can be used to promote sustainability. It encourages people to change their lifestyle and behavior to support sustainable development through online tools, websites and portals. (Murugesan, 2008)

ICT for Sustainability (ICT4S):
The concept of ICT for Sustainability came into much focus since ICT4S conference held in Zurich during 2013 and 2014. The preamble of the conference suggests that ICT can be applied to promote sustainable consumption and production patterns in ensuring sustainable development. ICT4S therefore emphasizes on dematerialization instead of simply making devices and products energy efficient. Energy efficient products and devices increase total consumption due to rebound effect just because they cost less to produce. Rather, if a system replaces an activity or device whose Life Cycle Assessment reveals greater environmental effect compared to the system, then this system is capable of helping people change their unsustainable pattern of production and consumption. As an example, energy efficient transport would increase product sell due to lower distribution costs. However, if a product, such as a music

CD, is made available to be purchased and downloaded online this would help change the production and consumption pattern sustainably. (ICT4S, n.d.)

'Substitution of resources' helps achieve sustainable consumption and production patterns. It refers to substituting a material or immaterial resource with another. Following are some of the strategies where resource can be substituted in order to achieve sustainable patterns of production and consumption. (Hilty and Abeischer, 2015)

Process optimization: Process optimization targets an input material resource, such as labor, natural resource or capital - optimized with the help of an immaterial resource, such as information. This can be applied to both production and consumption sides. For example, a driver can use a GPS to optimize the route and thus reduce fuel consumption, or a person can perform online research to optimize amount of food needed for a healthy living.

Media substitution: Media substitution implies replacing one material media by another and, thus, promotes sustainable consumption and production. For example, printed invoices may be replaced by emailed invoices, online version instead of printed newspapers.

Externalization of control: Externalization of control implies substituting an immaterial resource by another. For example, a web or mobile application to control light globes or heating devices from remote, and thus optimize consumption patterns.

Sustainable Supply Chain helps promote sustainable production patterns by sourcing raw materials responsibly. This encourages companies undergo a commitment with suppliers that any raw material sourced should be done considering their societal and environmental effects. Companies may encour-

age or enforce suppliers to use green fuel when supplying raw materials. Buyers may impose environmental obligations on producers on ensuring healthy work environment and proper waste management. (UNEP, 2010)

Maranghino-Singer et al. (2015) propose a 'Cap and Trade' system that can be used in private or public organizations to promote sustainable fuel consumption. Cap and trade was originally implemented by EU Emissions Trading System (EU ETS). The goal was to reduce carbon emission by setting a cap on emission level and then trading permits to different companies so that total emission does not exceed the predefined cap limit. Similar computer software may help organizations 'cap and trade' emission level incurred from internal business trips. Each employee will be given a capped permit of emission that encourage them to take trips using greener transport that causes less emission.

Gomez and Teuteberg (2015) come up with the concept of a Corporate Environmental Information Management System (CEMIS). Significance of this system is that along with collecting, storing, integrating and disseminating environment related data, it helps the company to implement environment-related workflows, such as, life cycle assessment (LCA), environmental monitoring, and Sustainability Reporting (SR), and thus helps implement sustainable patterns of consumption and production. This system, unlike other Environmental Management Systems, is able to calculate KPI, economic, social, environmental advantages and interact with other business software or systems the company runs.

Hojer and Wangel (2015) propose the concept of a Smart Sustainable City. A Smart Sustainable city can be defined as a city that is supported by ICT and is able to meet the needs of its residents without any compromise of the environment. The concept of Sus-

tainable City may not be practical in the context of a developing country due to lack of resources and other priorities. Smart grids and micro-production of electricity (Katzeff and Wangel, 2015) may be implemented to supply electricity from home-based solar/wind systems to national grid. Persuasive Technology (PT) can be used to change people's unsustainable behavior with the help of interactive systems. For example, electronic speed sensors are used to warn people of their driving speed. In the same way real-time electricity consumption display system can be used to monitor electricity usage in real-time and thus help people change unsustainable energy consumption pattern. (Huber and Hilty, 2015)

Other applications of ICT to promote sustainable consumption and production patterns include use of social media and e-learning in creating public awareness; use of Knowledge Management Systems (KMS) in sustainability-knowledge sharing; promoting e-business (online buying, selling and payment), virtual mobility (telework, teleshopping, virtual meetings) and virtual goods (services replacing goods); and in waste-management and production process management. (Hilty and Aebischer, 2015). Each of these methods has its own advantages and disadvantages and needs to be implemented after careful assessment of the circumstances.

VI. POLICY IMPLEMENTATIONS

Some of the obstacles that make Bangladesh unique from other countries in implementing sustainable consumption and production patterns are poverty; lack of proper initiative; poor law enforcement; corruption; lack of education; and lack of knowledge and awareness of sustainability (Bangladesh National Sustainability Development Strategy, NSDS-2013). ICT can be used to overcome some of these barriers in order to implement sustainable patterns of production and consumption. National ICT Policy of Bangla-

desh-2015 briefly mentions few action plans of using ICT in the strategic areas of environmental preservation, green technology, disaster warning and management, disposal of e-wastes as well as agriculture and production (National ICT Policy-2015). However, this policy does not provide any indication on how sustainable consumption and production patterns can be promoted. Although strategic objective-10.5, in this policy, indicates using MIS (Management Information Systems) models in ensuring 'sustainable productivity' in the service sector through 'increased automation', it is not clear whether this type of 'sustainable productivity' goal is in line with SDGs 2030. No other literature has been identified that provides implementation guideline on this matter from ICT point of view. Therefore, this paper proposes a three-phase strategy that may be undertaken in Bangladesh in promoting sustainable consumption and production patterns; these are:

Phase-1: Social awareness

This phase targets to make people aware of the consequences of unsustainable consumption and production patterns and thus targets to change individual lifestyle and consumption pattern sustainably. This phase also prepares the society psychologically to embrace the changes to be implemented in the next phase. Strategies in this phase may include the following:

a. Government needs to setup goals and targets regarding sustainable consumption and production patterns, and develop strategies to implement them. Data from statistical organisations needs to be analysed, simulated and projected for this purpose. Environmental Management Information Systems (EMIS) or Business Intelligence (BI) systems may be helpful in this regard.

b. Social media, such as Facebook, is very popular in Bangladesh. As of 2012, some 3.3 million of people in Bangladesh use Facebook, ranking 51st amongst 213 countries globally (Kabir, 2012). Social media may be used to run campaigns in order to aware people of unsustainable consumption and production patterns.

c. As of Bangladesh Telecom Regulatory Commission (BTRC) there are 115.6 million mobile phone subscribers and 44.6 million internet users in Bangladesh (BTRC, 2015). Automated messaging, voice campaigns and mobile internet may help to aware this huge population of how to change their consumption pattern sustainably.

d. Electronic media such as television and radio reach most parts of Bangladesh. Campaigns through these media may also be helpful in raising people's awareness.

e. NGO's working in the rural areas may use video-media to raise awareness amongst people in those areas. Micro-credit organizations such as Grameen bank may also be included in this process due to their reach in the root level.

f. Evaluation of the success of Phase-1 needs to be conducted through data collection, analysis and research. Without successful social response and preparedness achieving sustainable consumption and production goals would not be successful.

Phase-2: Education, training and implementation

In this phase education and training are provided to stakeholders in order to implement changes as per government strategies and directions. Government may need to revise and amend rules and regulations in order to foster implementation of sustainable consumption and production patterns. Strategies may include the following:

a. Changing government policy and rules as per sustainability strategies and goals developed in phase -1. Such as:

- Implement online bill payment systems and e-governance. This would help reduce unsustainable mobilization decreasing fuel consumption.
- Rebate for use of renewable sources of energy
- Emission, waste and pollution management and reduction target for organisations through implementation of EMIS
- Encourage online shopping and service-oriented industry through rebate and tax-cuts etc.

b. Education and training of the stakeholders is compulsory for successful implementation of any project. Knowledge Management Systems (KMS) and E-learning systems can be used to educate and train all government and non-government employees in all organisations on implementation strategies, guidelines and targets.

c. School curriculum may be modified to include sustainability and government strategies on sustainable consumption and production patterns. This may provide direction to future generations on what to do and what not to regarding sustainable consumption and production patterns.

d. Government website and centralised call centre need to be established in order to help organisations throughout the implement process. Website may be linked to E-learning and Knowledge Management Systems (KMS) that contain related research work and implementation guidelines. Guidance may be provided through experts in the following areas:

- Optimizing supply chain through implementation of Green Supply Chain Management (SCM) Systems
- Waste management strategies and implementation of waste and pollution management systems, use of EMIS
- Ethical marketing promoting sustainable consumption and production patterns
- Online shopping and bill payment systems
- ‘Cap and trade’ strategy
- Resource substitution

Phase-3: Evaluation, Monitoring and Enforcement

This phase emphasises on evaluation of phase-2 and follow-ups accordingly. Evaluation may be conducted by expert panels of researchers, through data collection, analysis and inspection. Maintenance of database and use of Business Intelligence (BI) systems may be helpful in this regard. Follow-ups need to be supported by government actions and consequences.

VII. IMPORTANCE AND SIGNIFICANCE

The world we live in has limited natural resources in the form of food, water, and finite renewable & non-renewable sources. But the demand and usage of these resources are increasing day by day, increasing the risk of placing us in a position with no resources left in the near future. A large portion of these resources is being wasted due to our current consumption and production patterns (UNEP, 2015). Therefore, it is important for us to opti-

mize our consumption and production patterns so that these resources are able to sustain for our future generations and help us address diverse types of poverty. Since the formulation of Agenda 21 at the World Summit in Rio de Janeiro (UN, 1992) global leaders have already recognized sustainability of production and consumption as key to achieving sustainable development (Manoochehri, 2002). High Level Panel (HLP) of experts on post-2015 development agenda and many other governments suggested that sustainable patterns of consumption and production should be embedded in the Sustainable Development Goals (SDGs). Bangladesh is also working towards achieving SDGs 2030. Bangladesh government's 'Vision-2021' goals (Perspective Plan of Bangladesh 2010-2021) and National Sustainability Development Strategy (NSDS-2013) emphasise on achieving sustainable development in line with SDGs 2030. National ICT Policy-2015 also emphasizes on using ICT resources in some of these aspects. Therefore, this paper is of great importance due to its objective of analysis of consumption and production patterns in the context of Bangladesh and guidelines on how to make them sustainable with the help of ICT.

VIII. CONCLUSION

Achieving sustainable patterns of consumption and production is not a straightforward process and requires determination and cooperation of the government bodies, stakeholders and citizens. Lack of proper education, poverty, corruption and unsustainability may be interlinked and needs to be addressed altogether rather than a stand-alone process. Innovations in science and technology always need to be appreciated in order to implement this, and research needs to be conducted in an ongoing basis in order to succeed in this regard.

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