Technology Integration in the Mobile Communication Industry : A Review

** Vishal Kulshrestha*
*** Kokil Jain*

Abstract

The human society has been witnessing major changes in the economic, consumer, and the social behavior context brought about by the growth in mobile communication and mobile broadband and its increased adoption in all parts of the world. This paper analyzed these specific dimensions together and identified the relationship between them. Since the changes have been brought about by the advancement of mobile communication technology, the paper defined the nature of mobile technology and its components. Also, the paper defined how the technology in mobile was related to changes in human society. Finally, the paper outlined the reasons for the rapid growth in mobile technology and its ever accelerated adoption all over the world. The methodology used was a review of existing literature related to development in mobile technology and changes in social, economic, and consumer behavior due to expansion in mobile technology. The findings of the study showed that the mobile technology today stands for technology integration between technologies namely mobile network and infrastructure technology, mobile broadband and computing technology, and smartphone devices. Its development has impacted social, economic, and consumer behavior of the human society. The changes and development in human society have served as fuel for further progress in mobile technology. Therefore, it can be concluded that the development has been interrelated and has supported each other. This study will give a thorough understanding to managers of the influencing factors of service adoption and create an appreciation for investment in technology as an important strategic tool which will define the future competitive advantage.

Keywords : **mobile technology, technology integration, mobile broadband, smartphones, M2M, ICT, M - banking**

JEL Classification : L96, L86, M15, M31, O32, O33, O35

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As per Huawei (2016), the mobile communication transition has been driven by innovation and technological development taking place in mobile technology, including the Internet and broadband technology. Gerpott, May, and Nas (2017) established that the telecommunication industry is no longer providing only voice connectivity, but has a much broader role to play. Mobile services have become more popular than fixed line services. UNESCO (2016) reported that people accessing broadband services have increased at a very high rate with some countries like Finland reaching a subscription rate of 144 per 100 people followed by Singapore (142) and Kuwait (139). The 4G technology has increased in big leaps internationally.

The future development in 5G technology, cloud computing, and Internet of Things is making everyone connected with telecommunication very positive about the probable defining outcomes. It may not be far from truth if the transformation may be termed as the "Industrial Revolution" of the 21st century. It is only reasonable at

* *PhD Scholar,* Amity International Business School, I-3 Block, Amity University, Sector 125, Noida - 201 303, Uttar Pradesh. E-mail: kulshrestha.vishal@yahoo.in
** *Associate Professor,* Amity International Business School, I-3 Block, Amity University, Sector 125, Noida - 201 303, Uttar Pradesh. E-mail: kjain@amity.edu

this stage to ask the underlying reasons for this phenomenal popularity of the mobile broadband services. It is evident that this is not a short-lived fad or effect of a very efficient marketing program. The popularity is worldwide and cannot be merely credited to superficial factors alone. A critical examination of the role of technology in this outstanding growth concludes that technology alone cannot be credited as technology takes time to diffuse ; whereas, the growth in mobile broadband has been too rapid and is a global phenomenon. Social and economic reasons can also not be the sole reasons because the growth in developed and developing countries is happening at a very competitive rate, overriding differences across the border. According to Singhal (2016), India is emerging as one of the largest contributors to the growth and is amongst the largest smartphone markets of the world. As cited by Singhal (2016), Nokia Mobile Broadband Index showed that the overall data traffic grew by 50%, with a 85% surge in 3G data traffic in 2015. GSMA Intelligence (2016) cited research company IDC to show that Indian mobile service market revenue was expected to touch US$ 37 billion by 2017. The report further established that India is expected to have 180 million subscribers and will contribute 13.5 % to the global smartphone market. The *Ericsson Mobility Report India* (Ericsson, 2015) stated that smartphone subscription will grow to 810 million and smartphone traffic by 17 times to 4.2 exabyte per month by 2021. GSMA Intelligence (2016) also mentioned that to establish that, smartphones are expected to account for two out of three mobile connections by 2020.

There have been many research studies in the field of telecommunication and mobile services but the studies have been done in isolation, failing to provide a comprehensive and holistic understanding. Some have focused on technology adoption process and consumer behavior, some on technology development in the industry, while others have stressed on social and economic importance of mobile services or on understanding consumer acceptance of mobile technology. Very little research, especially in India, has been on the interrelation between the development happening in the technical, marketing, social, and economic aspects, and how it is resulting in high degree of consumer acceptance and rapid growth in mobile penetration. The Indian telecom industry is one of the largest players globally, therefore, it is a very important phenomenon for the Indian industry to understand and acknowledge.

The aim of this study is to identify the common elements affecting the different aspects of development in the mobile industry and to identify future possible strategic insights for Indian mobile service operators.

Research Objective

The use of mobile broadband is growing globally and India is a part of it, infact, one of the leading players. But the reason for the growth is not very evident. Existing research has focused on only one factor rather than studying them together. Based on the study of extant literature, the existing research can be divided into four categories as given in Table 1 in the annexure. The four categories are (a) technology development in mobile communication and broadband services, (b) consumer behavior in mobile service adoption, (c) social impact of mobile services, and (d) economic importance of mobile services.

Therefore, the aim of the study is to identify if :

(i) All the developments in mobile communication are interrelated.

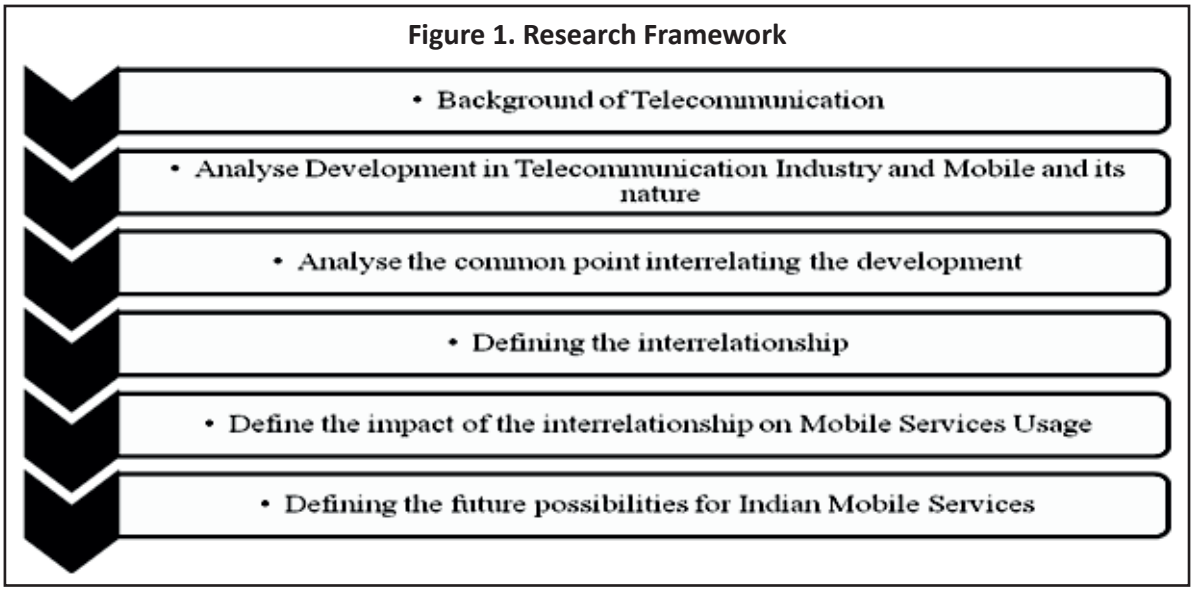
(ii) Define the interrelationship between all defining factors.

(iii) Define how the interrelationship is creating an impact on mobile usage.

(iv) Define future possibilities for the Indian mobile market.

The study intends to approach the research in the manner as described in the Figure 1.

Figure 1. Research Framework



Research Methodology

The research reviews secondary data. For the purpose of the study, the following sources of secondary information were reviewed :

(i) The available research related to development of mobile services involving management, technical, social, or economic aspects from 2010 are considered since that is the period when mobile services started evolving from purely voice services to VAS services in India.

(ii) All reports and statistics available on mobile service growth, development, and transformation.

(iii) Articles and corporate studies done in the related field.

Perusal of available research through the Internet concluded that the results generated revolved around technological, social, economic, and business development as described in Table 1 in the Annexure. Therefore, it was logical to divide the literature review into four parts, that is, review research papers by technology, social, economic, and business studies categories. The rest of the paper is divided into the following sections : The first part defines the variables studied. The second part focuses on the literature review. In the third part, the findings of the review are presented. The fourth, fifth, and sixth parts are for Discussion, Recommendations, and Limitations, respectively.

Development in the Mobile Communication Industry

The perusal of various articles and papers has shown that the development in the mobile industry has been mainly around mobile technology and has resulted in developments in other areas. Therefore, it is important to understand 'Mobile Technology'.

↳ **Mobile Technology :** Sheng, Nah, and Siau (2005) cited Varshney and Vetter to establish that mobile technology can support computing on the move using portable devices through a wireless network. Sheng et al.

(2005) also stated that mobile technology is the next wave in IT development and includes infrastructure for connectivity such as Bluetooth, 3G, GPRS, etc. and mobile information appliances such as mobile phones. Extending computing and the Internet into the wireless medium, mobile technology has enabled users to access information and applications anywhere, anytime. According to Kumar, Liu, and Sengupta (2010), wireless access technology has evolved from 1G, which provided basic mobile voice to 3G, which brought in mobile broadband and provided the foundation for 4G. The study also established that 4G will provide access to a wide range of advanced mobile services and will be supported by mobile and fixed networks. According to Kumar et al. (2010), 4G in contrast to 3G will enhance user experience and multi-service capacity by integrating all the mobile technologies which exist such as GSM, GPRS, Wi-Fi, etc. A study by Frattasi, Fathi, Fitzek, Prasad, and Katz (2006) concluded that 4G can be defined as integration of already existing and new network, services, and terminals.

Johnson and Maltz (1996) defined mobile computing as the use of transportable computing devices with mobile communication technologies, which allows for transmission of data, voice, and video through any wireless devices. The devices identified for the purpose were smartphones, laptops, tablets, PDAs, etc. A paper by Sturgeon and Zylberberg (2016) also concluded that the ICT sector is a rapidly changing and broadening mix of electronic hardware and ICT related services, including telecommunication, software, IT, cloud based services and platforms.

Thus, mobile technology means:

(i) Technology for transmission of voice, data, and video.

(ii) It includes ad hoc and infrastructure network.

(iii) It is now a fusion of mobile and computer mechanisms through the Internet.

(iv) Mobile devices are also an integral part of this technology.

(v) This includes different applications on mobile.

Literature Review

Background

According to Bock, Field, Zwillenberg, and Rogers (2015), the world is changing due to a small device in the hands of common people. The small device is the 'mobile' and its cousin the 'tablet'. Other than the tablet, the expanding family of "wearable" and "smart devices" is transforming the way people live, work, communicate, and interact with each other. The digital revolution has changed into a mobile communication revolution. In addition, Bock et al. (2015) also reported that competition and innovations have been creating development in other areas as well. Consumers are adopting new behavior and businesses are trying to improve efficiency and develop new products and services. The mobile internet has also created many new jobs. Bock et al. (2015) also informed that mobile penetration has increased and the cost of services and devices is also coming down. The result is that the mobile internet has increasingly become the first choice of going online for people from both the developing and developed worlds.

According to the *Global Mobile Consumer Survey* cited in a report by Deloitte U.S. (2017), the consumers in USA were looking at their devices more than 9 billion times a day which was 13% more than the figures reported for last year (2016). The survey informed that smartphone sale was strong with a 10% yearly growth, and so was for wearables such as smart watches. Globally, the world is getting connected to the Internet through smartphones. Ernst and Young (2015) reasoned that due to increase in high demands, companies are investing in faster

networks and Internet capabilities. Markets have shifted to usage based data plans, and innovating data share models are being offered for household needs. The European operators have been using M&As to consolidate their markets. The Russian and Latin American operators have been facing macroeconomic pressure. North Americans have introduced many service innovations. African and Asian operators have been growing at a very high rate with an increasing use of mobile data. The biggest challenge globally will be from the over the top (OTT) content providers who are diversifying their value proposition and increasing their share of revenue. The report by Ernst and Young (2015) also established that telecom operators globally have realized the importance of enhancing customer usage experience. To benefit from 4G technology and the future expansion with 5G and internet of things (IOT), operators have focused on increasing investment in network quality, especially in the developing countries. Simultaneously, the developed market has also been focusing on modernization of the network.

The data by ITU (2016) showed that global penetration of mobile subscription has neared 100 subscriptions per 100 inhabitants and fixed line penetration has declined. According to The Statistics Portal (2016), the unique mobile subscriber base worldwide is expected to reach 4.6 billion by 2020.The mobile subscription growth is being led by the Asia Pacific Region in which China and India have contributed the highest number of subscriptions. ICT Data and Statistics Division, International Telecommunication Union (2015) brought out that the mobile broadband market segment had reached 47% in 2015, increasing 12 times from 2007. The data report of ITU (2016) gave the information that the advanced mobile broadband network (long term evolution - LTE) had reached almost 4 billion people corresponding to 53% of the global population. The number of mobile broadband subscriptions was growing at double digit in developing countries but had slowed down globally. The data presented by The Statistics Portal (2016) also showed that the Asia Pacific region has the highest number of mobile broadband subscribers, and Europe and USA have the highest number of mobile broadband subscribers per 100 inhabitants.

The Statistics Portal (2016) also predicted that LTE and HSPA technologies will hold 80% of the global market by 2020. LTE was dominant in USA and will cover nearly 90% of the markets by 2020. In 2015, China had the highest LTE subscriber base followed by USA. Advances in mobile network technology have helped the customers to access multimedia applications that were not possible earlier.

According to a report by GSMA Spectrum 4 All (2015), Vodafone reported a 80% jump in their data traffic in 2014. China Mobile, the largest Chinese mobile operator, reported a 158% growth in data traffic in the 1st quarter of 2015. The growth rate of mobile data traffic has been different after the introduction of 4G. South Korea was the best example with 100% 4G population with LTE accounting for more than 50%. The average monthly data usage in South Korea is 3GB compared to 819MB globally.4G has become so popular that people continue to use it even when public Wi-Fi is available. The U.S. is also seeing the same pattern where 4G network accounts for 84% of its data traffic. According to GSMA Intelligence, the 4G consumers typically use twice as much data as other users (GSMA, 2016).

As per the report by GSMA (2016), the emergence of smartphones has enabled customers to use their mobile services for more than making calls. Technology and smartphones are replacing computers. A study by Ericsson (2015) analyzed that mobile technology and its Internet capabilities have made it the perhaps the most important development of the 20th and 21st centuries. The future is 5G deployment creating a platform for internet of things, including machine to machine (M2M) and massive machine - type communication (MTC).

India is catching up fast. According to a Morgan Stanley report ("India to become second largest smartphone market by 2017," 2016), India will overtake the U.S. to become the second largest smartphone market by 2018 with a CAGR of 23% and account for 30% global growth ; 75% of the total smartphones sold in the country will be 4G enabled. India's internet penetration is also expected to reach 50%, driven by smartphone availability and affordability, online content, and changing user behavior ("India to Become Second Largest Smartphone Market by 2017," 2016).

It is evident that the mobile broadband is progressing at a very rapid rate and is covering all the parts of the world, something that has never happened before in any other industry. Therefore, it is important to understand the reasons for rapid growth of mobile broadband services. The rapid growth in the industry has naturally attracted attention of experts, researchers, and academicians attempting to understand the nature and reasons for the unprecedented growth.

A search of research papers on the Internet produced huge results, but for the purpose of the present study, only the studies from 2010 and afterwards were considered. The resulting papers and reports were selected on the basis of quality of paper and the publishing journal. Finally, all the papers, corporate studies, and articles were divided into groups based on the topic under study. As such, four main groups were formed, which are discussed in detail.

(1) Technical Development : A study by Wu, Talwar, Johnsson, Himayat, and Johnson (2011) established that mobile broadband technology was evolving towards embedded Internet. Machine to Machine Internet would present both opportunity and challenge to the industry. The growing market of M2M would require faster and improved technology and infrastructure. Fehske, Fettweis, Malmodin, and Biczok (2011) also concluded that the usage demand was leading to use of better and faster technology, which was again leading to more demand. A study by Reddy (2016) established that e-banking, e-learning, and e-health would drive use of mobiles. Interactive TV and video on demand applications will increase mobile and wireless traffic and that 5G technology will fulfill the increasing requirements.

Osseiran, Boccardi, Braun, Kusume, Marsch, Maternia, and Tullberg (2014) concluded that 5G technologies will experience challenges from end user perspective in areas of fast service, experience, real time reliability, connectivity, and M2M communication. By 2020, mobile and wireless traffic volume will increase thousand fold from 2010, and wireless connected devices will count to billions and profoundly impact on society. Osseiran, Braun, Hidekazu, Marsch, Schotten, Tullberg, and Schellman (2013) said that everyday life will be more efficient, comfortable, and safe with massive machine to machine communication and the internet of things. Qi and Gani (2012) commented that larger data traffic will result in wider requirements in services, devices, and networks. The combination of ubiquitous mobile network and cloud computing has generated mobile cloud computing resulting in various applications for mobiles. Qi and Gani (2012) also cited Juniper to establish that the applications based on MCC created revenue worth U.S.$ 9.5 billion in 2014.

Wynn (2016) cited Gartner to establish that 2019 would see a $ 3.8 trillion global spending on cloud, mobile, social, and big data technologies. Wynn (2016) again cited a report from Mckinsey and informed that cloud computing will be the most influential technology. It is because the cloud enables the use of all web based tools and applications, smartphone apps to business basics such as video conferencing. The massive storage and processing capability of cloud computing has made it the principal enabler for internet of things (IoT). IoT creates a ubiquitous network of connected devices which not only communicate with each other, but also provide 'anywhere/anytime' access of complex data and applications. A review study by Gawas (2015) predicted availability of 5G or world wide wireless web (wwww). The 5G.IPv6.5G technology will have no limitation and will provide unlimited access to information and share data anywhere, anytime. The 6G technology would integrate satellite communication.

Chen and Zhao (2014) found that the dramatic growth driven by wireless internet and smart devices has compelled the development of 5G technology for next generation of mobile communication. Further, the increased mobile traffic requirement will impact mobile system architecture and technology evolution. A ZTE study by Jun (2013) reported that mobile Internet has become a lifestyle, and terminal and cloud have further accelerated the development of mobile broadband. Availability of smart terminals, mobile broadband networks, and cloud technology has given a great boost to use of mobile internet. According to Fehske et al. (2011), mobile serves as a tool which combines cloud computing and data output. LTE-Advance would push mobile broadband

and usage would be counted in gigabits. Increasing use of data will lead to better and faster technology, which would further fuel demand.

According to Sutton and Tafazolli (2015), the 5G technology will be a flexible infrastructure capable of handling the constantly increasing demand for mobile data and provide connectivity to future technology such as IoT. The 5G technology will be a holistic framework and flexible to adopt, evolve, and grow. It will need to provide ultra high capacity and ultra reliable & dense network. Greater capacity, devices and application, cost effectiveness, energy efficiency, and business model will be its main characteristics. Neira (2015) predicted 5G, fiber, IoT and IoE, big data, cyber security, green communication, smarter smartphones, and network neutrality as some major technology trends of the future.

A critical analysis of the above shows that 4G, 5G, LTE, cloud computing, IoT, and smarter devices will be the major technology development aspects in mobile communication. Rising data demand is fueling requirement of better and faster technology with better infrastructure. Improved technology and smartphones are in turn fueling data demand. Organization efficiency is improving due to creation of better network and mobile system architecture.

(2) Social Development and Changes : The main areas affected by the development in mobile communication are education, health, and social life. Sarwar and Soomro (2013) showed that the cultural norms and behavior of individuals changed drastically due to advancement in mobile technology. Haenssgen and Ariana (2017) concluded that technology diffusion is an interaction of society and technology innovation, and would result in unexpected use of technology. Anthropological, sociological, and economic studies have showed that mobile communication diffusion takes place as information and communication technologies (ICT) interact with social change.

A UNDP report cited in Malaquias, de Oliveira Malaquias, and Hwang (2017) stressed upon the importance of three dimensions to human development: long and healthy life, knowledge (education), and a decent standard of living. Malaquias et al. (2017) also cited Bada and Madon to show that ICT contributed to the building of effective human capital in developed and developing economies. According to Malaquias et al. (2017), mobile phones are innovative tools, which help the poor to connect and receive information. Campbell and Kwak (2010) identified that people who were comfortable with mobile technology and used it for exchanges of information were civically and politically more active. In a paper by Chatterjee, Sarker, and Siponen (2016), it was established that mobile ICT makes the organizations more flexible, agile, and efficient.

Singh, Saxena, Roy, and Kim (2016) explained that development in mobile technology, especially 5G would have many positive social impacts through the application of technology in (a) Internet of vehicles could solve problems of road safety, traffic management, etc., (b) Internet of things provides self operation, security and trustworthiness, device discovery & interaction, and data management, etc., (c) Mobile cloud computing facilitates social sharing of data, (d) Smart grid helps in management of large data and demand response, (e) Big data can provide collective analysis of interconnected data from different sources rather than individual analysis and support privacy and data integrity, knowledge sharing, handling online data, etc., (f) Device to device communication will be the next generation of communication where devices will communicate with other devices, and transmit data to each other.

According to a study by Gupta and Arora (2017), reason and value serve as important antecedents to mobile shopping adoption and that customers do not adopt mobile shopping due to reasons of (a) self-efficacy, (b) anxiety, and (c) relative advantage. Koenig-Lewis, Palmer, and Moll (2010) reported that the mobile phones were being increasingly used to undertake commercial transactions and the range of services which can be undertaken from mobiles are only going to increase, and mobile phones will emerge as ubiquitous payment devices. Zhang, Zhu, and Liu (2012) observed that subjective norms had more influence in Eastern cultures compared to Western

cultures on perception of usefulness of mobile commerce. Aguiléra, Guillot, and Rallet (2012) found that mobile ICT and physical mobility are related as those who interact online would have more face to face interaction and also stimulate travel demand.

A study in Malaysia by Balakrishnan and Raj (2012) found that among the youngsters and university students, socializing and privacy were the most important reasons for use of mobile phones. Behavioral issues were also observed to be related to addiction and inappropriate use of mobiles. Women used the phones to socialize, gossip, and as a safety device. Plaza, Martín, Martin, and Medrano (2011) studied mobile adoption by older people and found that they used it in both leisure and work contexts. Mobile phones were considered important to improve the quality of life of elders. The applications were mostly related to health, wellness, homecare, safety, security, and to help the elderly to keep in touch with the family and dear ones. All these reasons made the mobile usage among the elders high. A study by Liébana-Cabanillas, Sánchez-Fernández, and Muñoz-Leiva (2014) proved that the younger generation was quicker to adopt while the older users of age greater than 35 years were influenced by their social network for involvement and ease of use. According to another study by Salehan and Negahban (2013), there is a large growth of mobile usage among youth which has led to fast growth of online social networking sites (SNS). However,the extensive use of technology has also led to addiction and has impacted the use of mobile services.

Vannoy and Palvia (2010) made an important study on the adoption of technology in the context of social computing and concluded that technology influences society and society exerts pressure on technology. The study defined social computing as formation of community as a result of combination of the Internet, networking, and communication technologies and group interaction causes the members to confirm and influence others to join the group. Due to social computing, technology is embraced rather than simply accepted. Forrester and Jupiter were cited by Vannoy and Palvia (2010) to show that users play an increasing role in design, development, and marketing of technology.

The above analysis of social development and changes shows clearly that the development of mobile technology and availability of smartphones is influencing the society in many ways. Demographically, there is acceptance of mobile technology. While the technology is influencing society and creating new requirements, the use of technology itself is creating more demand. This resulting social action is influencing the development of technology.

(3) Economic Development : Gruber and Koutroumpis (2011) found that mobile adoption and its contribution to GDP were directly related. Low-income countries had low contribution in GDP compared to developed nations. High mobile penetration yielded incentive for further investment following the adage "success breeds success." The returns from network increased with usage base increase, leading to the emergence of a concept called network externality. The telecommunication industry is affected by infrastructure investment, but there are important spillovers of mobile network externalities in other sectors of the economy. The benefits to other parts of the economy further create new demands for services and thus further drive more investment into networks and other mobile infrastructure. Donner and Escobari (2010) said that adoption of mobiles was high in small and medium entrepreneurs who got many benefits from mobile broadband. Real time access to prices and markets ; instant availability of information on markets, customers, and suppliers helped the entrepreneur to function more efficiently at lower cost. Mobility features have made mobiles more popular than landline. As a result, the MSEs are playing an important role in global development. Another study by Ongori (2008) found that due to lack of ICT, the SMEs were not able to compete with large organizations.

As per GSMA Intelligence (2017), the mobile ecosystem has created a digital platform that is connecting everyone and everything. It was being increasingly felt as companies are reinventing themselves to provide innovative services. It has already generated 28 million jobs. The report by GSMA Intelligence (2017) cited UN Sustainable Development Goals to establish that mobile technology and innovation are helping in building

efficient and environmentally sustainable societies. It will also lead to financial inclusion of communities. According to GSMA Intelligence (2016), the Indian smartphone market was already the second largest in the world overtaking the U.S. The Indian mobile broadband base is expected to touch 670 million by 2020, and 4G connections will reach 280 million by 2020. The mobile ecosystem has created 2.2 million direct jobs and 1.8 million indirect jobs. The Indian government's 'Digital India' initiative aims to use the potential of digital technologies to address socioeconomic challenges of the country and mobile broadband will help the Digital India vision of making broadband a utility for every citizen. According to Singh (2013), citing a study by Vodafone, mobile technology has a strong impact on economic systems in developing countries as mobile phones allow people to communicate and do business across long distances. Access to information due to mobile phones has a positive impact on economic growth. Mobile phones support democratic participation, increase gender equality, and improve education. The report presented that mobile phones will spur social and economic development in India.

Piotrowicz and Cuthbertson (2014) reported that changes have been brought by diffusion of mobile devices and social networks. As a result, the retail network has evolved into an Omni channel, which is an integration of online and physical channels and provides seamless customer experience. Future technologies like Google Glass and 3D printing are going to drive more changes. The mobile phone diffusion has generated hope to raise incomes and provide opportunities to people. Wallis (2011) found that mobile phones are considered as libratory and equalizing technology. Tomlin (2016) described that mobile communication and productivity tools have been integrated, and as a result, emails, meetings, CRM, etc. are available to employees through company apps. According to Hunt (2014), mobile phones are revolutionizing the way we conduct business, interact with those around us, and keep track of all the issues. Picoto, Palma-dos-Reis, and Bélanger (2010) explained that m-business applications are useful for managing internal operations of a business and make them more efficient.

Azim and Hassan (2013) established that the mobile devices allow companies to access huge customer databases for digital advertising. More companies are getting wirelessly connected. Social media has helped companies to build relationships and talk with the customers in real time. Information is readily available on fluctuations in market demands, etc. Globalization and electronic commerce are becoming wirelessly connected through the Internet environments. Azim and Hassan (2013) cited Rackley to define digital convergence as the ability of network platforms to carry out services which take place at different levels between technology, regulatory, and economic convergence. Kramer was also cited by Azim and Hassan (2013) to show that ICT has driven business growth in today's digital environment. Therefore, today, the digital convergence has emerged due to integrated broadband network. Mobile platform based growth opportunities have driven organizations to adopt more mobile strategy to leverage existing and future opportunities.

A study by Sarda, Kumar, Chetia, Gangapuram, Sippy, and Jayaraman (2013) suggested that the way forward for service providers is to focus on VAS, 3G, and 4G application development and new product development. Felicita and Jayanthi (2012) found that the growth in the wireless technology has changed the way of business. M-commerce is enabling consumers to buy and use services via their mobiles, wearable PCs, and handheld devices, and thus bring change in both the individual and the society.

The understanding of economic development review shows that mobile communication technology development can be viewed as direct consequence of increased usage (network externalities) and digital convergence is being created due to integrated broadband networks. Development in broadband is creating economic growth and change in business methodologies. Higher economic growth will result in higher mobile penetration.

(4) Consumer Behavior : A great number of studies on consumer behavior in mobile telecommunication such as the ones conducted by Lin, Lin, Chen, and Liu (2015) ; Zarmpou, Saprikis, Markos, and Vlachopoulou (2012); Koenig-Lewis et al. (2010) ; Chen and Chang (2013) ; Park and Kim Joon (2013) just to name a few focused on

technology adoption and acceptance model (TAM). They analyzed variables of TAM such as perceived ease of use, perceived usefulness, perceived risk, and social norms for mobile adoption. Some like Liu and Li (2010) used the innovation diffusion theory to analyze mobile adoption. Theory of planned behavior was used by Kim (2010) and Aboelmaged and Gebba (2013) to explain user acceptance. Using UTAUT (unified theory of acceptance and use of technology), Kim and Han (2011) and Kim and Hwang (2012) also included hedonic and utilitarian values as the influencing variables affecting usage of mobile internet technology.

Lin and Chang (2011) introduced technology readiness and explained adoption of self service technologies. The TR influences PU, PEOU, attitude, and intention to use. Gummerus and Pihlstrom (2011) established that the activities in which customers engage, environment factors which surround them, and the cultural background underlying the situation would all impact the users' experiences.

A study by Jun (2013) for ZTE analyzed future developments in mobile telecommunication. The mobile devices are now being used for data rather than voice. Mobile internet has turned into a lifestyle. Smart terminals and cloud computing have accelerated the development of mobile internet. The three technologies, that is, smart terminals, mobile broadband, and cloud computing have contributed to the rapid growth of mobile broadband. The growth in mobile broadband has encouraged investment in network upgradation to long term evaluation (LTE). LTE (advance) usage will be measured in gigabytes and will push mobile broadband to a new level. According to Reddy (2016), mobile applications will be driven by e-banking, e-learning, and e-health. These usages will demand development of faster and more dependable e - technologies.

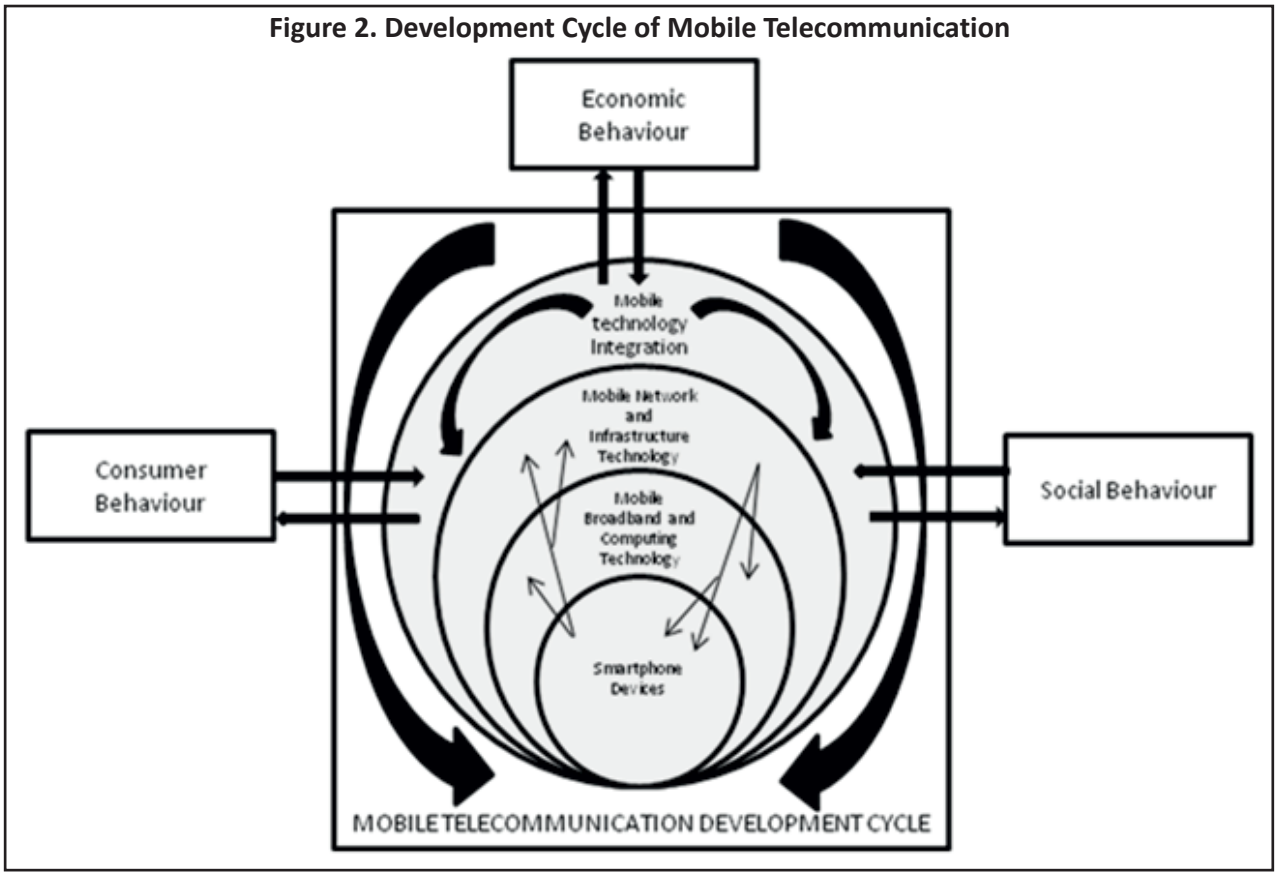
The consumer behavior review analysis brings out that the mobile broadband has been accepted as a result of influence of PEOU, PU, system anxiety, and self efficacy on intention to use. Perceived enjoyment, ease of use, and compatibility with user's life will create diffusion among all sections. Subjective norms, hedonic values, and utility will also create adoption. The popularity of mobile broadband has been facilitated by convergence of smart terminals, cloud computing, and mobile broadband. The growing demand will encourage more investment in faster and more efficient technologies such as LTE and better technologies will create further growth with use of more applications.

Findings and Discussion

From the four sections reviewed, it can be concluded that mobile technology covers three aspects, which are : (a) mobile network and infrastructure technology, (b) mobile broadband and computing technology, and (c) smartphone technology.

The first finding is that the development in mobile telecommunication is a result of fusion of mobile network and infrastructure, mobile broadband and computing technology, and smartphone technologies. The availability of faster and more efficient broadband technologies has resulted in development in network and infrastructure technologies. Better network and infrastructure are facilitating the use of faster and more efficient mobile broadband and computing technologies. Development of smartphone devices and its technologies has made it possible to provide faster and efficient mobile broadband services supported by improved infrastructure and network. The second finding is that technology integration alone is not responsible for development of mobile telecommunication. The users have been positively affected by the technology integration and are willing to use it in all aspects of their lives. The acceptance has resulted in a direct and ever increasing impact on social, economic, and consumer behavioral aspects. It has resulted in more increase in use and demand of improved mobile technologies. The increasing demand and use are resulting in further investment in mobile network and infrastructure. Faster and more efficient broadband technologies are also being developed to fulfill rising demands for applications and other broadband based services. Based on the above findings, a model is proposed in Figure 2 to illustrate the integration of technology, its interaction with the environment, and the resulting development.

Figure 2. Development Cycle of Mobile Telecommunication



Managerial Implications

The model given in Figure 2 is useful for mobile services operators, especially in India. A large market is yet to be tapped in India for both smartphone penetration and mobile broadband coverage (particularly 4G). To convert this market, operators who can offer different applications in the area of social networking, e-learning, mobile payment, e-health, and entertainment backed by faster and efficient broadband, economical, and dependable network & infrastructure are more likely to attract customers and increase data usage. It is important to realize that investment in better network and infrastructure is likely to give more returns. Using only broadband (4G) as a marketing tool is not likely to give results unless combined with apps and network features. Therefore, it is recommended to offer apps backed by faster broadband and an efficient, dependable network as a service USP. Mobile service providers can become active channel partners to OTT app providers and offer innovative apps.

Originality of the Study and Gaps Identified

The paper is original in nature as so far, no attempt has been made to analyze the nature of technology integration in mobile telecommunication. The study provides a holistic view of evolution of technical development, which has been missing so far in all the research being done on development in the mobile industry. It defines the concept that all technologies, that is, the network and the infrastructure, the broadband and cloud, and the devices have all integrated together to form a singular technology, which is the mobile technology. This is of particular interest to the service operators as it can help them to identify the way forward and identify new target segments such as B2B services.

Limitations of the Study and Future Research Directions

The limitation of this research is that it is purely exploratory in nature. The study is not based on any quantitative findings. The paper is based on inferences drawn from the study of various research studies done in the field of mobile telecommunication development. This limitation can also act as a future research direction, wherein authors can examine and verify the findings quantitatively.

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ANNEXURE

Table 1. Research in Mobile Communication Development

S. No.	Article	Author	Publication	Date	Nature of Study
1	Using Mobile Technology for Cardiac Rehabilitation: A Review and Framework for Development and Evaluation	Beatty, Fukuoka, & Whooley	*Journal of the American Heart Association*	2013	Social Behavior
2	Here and Now Mobile Learning: An Experimental Study on the Use of Mobile Technology	Martin & Ertzberger	*Computers & Education*	2013	Social Behavior
3	The iPad and Mobile Technology Revolution: Benefits and Challenges for Individuals who Require Augmentative and Alternative Communication	McNaughton & Light	*Augmentative and Alternative Communication*	2013	Social Behavior
4	Mobile Phones and Economic Development in Africa	Aker & Mbiti	Center for Global Development	2010	Economical/ Social
5	Reducing the Spatial Distance Between Printed and Online Information Sources by Means of Mobile Technology Enhances Learning: Using 2D Barcodes	Ozcelik & Acarturk	*Computers & Education*	2011	Social Behavior
6	A Theory of Learning for the Mobile Age	Sharples, Taylor, & Vavoula	Medienbildung in neuen Kulturräumen	2011	Social Behavior
7	Mobile Application Development: Web vs. Native	Charland & LeRoux	*Communications of the ACM*	2011	Technology
8	Evaluating Cross-Platform Development Approaches for Mobile Applications	Heitkötter, Hanschke, & Majchrzak	Springer Berlin Heidelberg	2012	Technology
9	Millimeter Wave Mobile Communications for 5G Cellular : It Will Work!	Rappaport et al.	*IEEE Access*	2013	Technology
10	The Requirements, Challenges, and Technologies for 5G of Terrestrial Mobile Telecommunication	Chen & Zhao	*IEEE Communications Magazine*	2014	Technology
11	From 3G to 4G: Standards and the Development of Mobile Broadband in China	Stewart, Shen, Wang, & Graham	*Technology Analysis & Strategic Management*	2011	Technology
12	Mobile Telecommunications and the Impact on Economic Development	Gruber & Koutroumpis	*Economic Policy*	2011	Economical
13	Determinants of Users' Choice of Mobile Service Providers in the Nigerian Telecommunications Market	Olatokun & Nwonne	*African Journal of Computing & ICT*	2012	Consumer Behavior
14	The Potential of Converged Mobile Telecommunication Services: A Conjoint Analysis	Nikou, Bouwman, & Reuver	*Info*	2012	Technology/ Consumer Behavior
15	Dynamic Energy-Aware Cloudlet-Based Mobile Cloud Computing Model for Green Computing	Gai, Qiu, Zhao, Tao, & Zong	*Journal of Network and Computer Applications*	2016	Technology
16	5G Ultra-Dense Cellular Networks	Ge, Tu, Mao, Wang, & Han	*IEEE Wireless Communications*	2016	Technology
17	Living in a Big Data World: Predicting Mobile Commerce Activity Through Privacy Concerns	Eastin, Brinson, Doorey, & Wilcox	*Computers in Human Behavior*	2016	Consumer Behavior
18	Smartphone Use in Everyday Life and Travel	Wang, Xiang, & Fesenmaier	*Journal of Travel Research*	2016	Social/Consumer Behavior

19	A Multi-Analytical Approach to Understand and Predict the Mobile Commerce Adoption	Yadav , Sharma, & Tarhini	*Journal of Enterprise Information Management*	2016	Consumer Behaviour
20	Consumer Adoption of Mobile Banking in Jordan: Examining the Role of Usefulness, Ease of Use, Perceived Risk and Self-Efficacy	Alalwan, Dwivedi, Rana, & Williams	*Journal of Enterprise Information Management*	2016	Consumer Behavior

About the Authors

Vishal Kulshrestha is an Assistant Professor at RGGI, Meerut. He is pursuing PhD from Amity International Business School, Amity University, Noida with Consumer Behavior as an area of interest. An NMIMS alumnus, he has over 5 years of teaching experience backed by strong industry exposure.

Dr. Kokil Jain is an Associate Professor in Marketing, Amity International Business School, Amity University, Noida. She is a Doctorate in Management and has over 15 years of teaching and research experience. Brand Management and Consumer Behavior are her main areas of teaching and research.