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Modeling the factors and their inter-dependencies for investment decision in Indian mobile service sector

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1 Introduction

Mobile computing is an integral and core component of ubiquitous computing environments that encompass a spectrum of computation and communication devices that seamlessly augment human perception processing and decision making in a networked environment. Mobile computing and services have become the mainstay to support todays fast growing businesses demanding feature rich flexible applications that aid in electronic transactions and informed decision making for mobile users.

Mobile services are considered to be one such area which are considered as the next wave of hope for the Telecom Service Providers (TSP) that can bring relief from continuously falling Average Revenue Per User (ARPU). Spohrer et al. (2007), define services as a "kind of action, performance, or promise to exchange for value between provider and client".

Short Message Service (SMS), started in 1984, is the most popular mobile service; however, the expectations of users have surpassed far beyond SMS with the availability of smartphones that support rich text, images, videos and many more. There are certain applications such as WhatsApp that come with many additional features like group chat, community, and photo sharing offering cost effective solution for the users who earlier used SMS (Gayomali, 2012). India, being the most competitive telecom market with twelve operators working simultaneously throughout the country, is ranked second in terms of a number of mobile phone subscribers (TRAI, 2014). This competition creates a price war over voice services. So, it becomes highly commoditized leaving the very narrow scope of making profits. With the launch of smartphones from big players like Amazon, Apple, Facebook, Google and Microsoft, TSPs have started facing additional challenges from free application developers and third-party sellers.

Mobile services are mainly developed using two approaches: a) making services available through telecom channels without The internet, and b) making services with Internet or data services. Most of the telecom services being accessed from smartphones are primarily dependent on the Internet. This means the application would require considerable data speed apart from being competent enough to use the device along with the application programs. Access to good Internet connection is still a distant dream in many parts of the country prohibiting usage of these services.

India is a vast country with multiple languages, different cultures, and religions. People have different preferences depending on their local needs and occupation, cultural and linguistic backgrounds. More than 22 languages are being used in different parts of the country. Delivering services in user's preferred language are likely to enhance the adoption of different mobile services and enhance customer experiences. English, being the primary language in the devices and the incompatibility with Indian languages, creates a problem for adoption among the masses. It is evident that with a vast number of mobile users in India, there is a huge opportunity to cater mobile services in local languages to meet their demand and tap the bottom of the pyramid in the growth process. The future of telecom networks is being seen as a new revenue stream from its prospects of expanded service offerings. However, the future service array is not yet clear, and a killer application still remains to appear (Iden and Methlie, 2010; Yelmo et al., 2008). Furthermore, there is still a lot of uncertainty as to what will influence the development of mobile services or independent applications. The huge Capital Expenditure (CapEx) invested on upgrading telecom infrastructure and high license fees for spectrum can only be recovered with systematic planning and harnessing the capability of mobile phones to a maximum possible extent. It becomes important for TSPs to understand, develop, and innovate services that can bring them back on the profit-making business unit.

Mobile services are considered to be one of the areas in telecom domain which can bring a massive change in the way mobile phones are being used today. Many researchers (Carlsson et al., 2005; Constantiou, 2009; Verkasalo et al., 2010; Yang and Laura, 2006) studied extensively to understand the adoption factors of different mobile services in varied context.

The initial study towards understanding the factors for poor usage of mobile services factors such as usability, features and functionality of network and devices, security risks, financial costs, and differences in offerings of useful mobile services were considered (Carlsson et al., 2005). This study highlights the importance of abstract modeling and its usefulness in understanding problems that are not easily interpretable or comprehensible as is the case with mobile services adoption factors.

In a study by Yang and Laura (2006) on the usage of mobile data service, it was found that functional value, emotional value, social value, monetary value, and attitude played a significant role in predicting the behavioral intent. Similarly, Verkasalo et al. (2010), tried to understand factors that drive the adoption intent among the users of smartphone applications. It was found that technical barriers, behavioral control, social norms, enjoyment, and usefulness were the most important factors. Service initiatives, customer loyalty, and retention were considered as important factors for engaging the customers in top performing telecom companies (Ferguson and Brohaugh, 2008). The study showed that companies with aggressive customer strategies can use this diversified service offerings as a key differentiating factor in a highly competitive market. Customer loyalty efforts could play an important criterion in attracting new customers and retaining current ones. Utility based on experienced usefulness and experienced value plays a significant role in the adoption of a service in innovative mobile service adoption (Constantiou, 2009). Usage context, innovativeness in services, efforts required by users for using the service, and the usefulness of the service were considered as important factors for evaluating the success of a mobile service (Bouwman et al., 2012). Mobile network functionality can be uncovered by offering cloud-based services to attract mobile users to use this kind of sophisticated services over their hand-held devices as it would provide more capability if the services are offered on Platform-as-a-Service model rather than just relying on Software-as-a-Service (Goncalves and Ballon, 2011). Iden and Methlie (2012) identified the challenges for service deployment on future telecommunication networks using Political, Economic, Social and Technological analysis to understand the driving forces based on demand factors like customer values, service quality, and user readiness. To incorporate customers' point of view to select a particular mobile service, Nikou and Mezei (2013) identified relevant mobile services and factors driving their adoption (consumers' preferences) using Analytic Hierarchy Process (AHP).

Previous studies were primarily carried out in developed nations, so the generalization is questionable in the Indian context. There are many differences from every aspect ranging from culture, language, economy, literacy, and infrastructure. Only limited literature gives a holistic view of Indian telecom scenario from mobile-based additional services applicability and adoption factors focusing towards holistic development of telecom sector in India. There lies a huge perception gap about the adoption of mobile services by both telecom operators and the consumers in totality. However, studies pertaining to Indian context have not been dealt adequately that try to understand the crucial factors for telecom companies to invest in mobile services and consider it as an independent profit-making business unit.

With the help of extensive review of the literature covering recent research articles, government reports and organizational reports important factors in the Indian market context have been identified which are explained in section 2 and are validated with the help of experts through a questionnaire-based survey. In order to understand the impact of underlying dependencies among various factors influencing investment decisions in mobile services, the telecom managers, and the policymakers need to identify both internal as well as external factors that affect the investment decisions and exploring mobile services as a viable business solution to check and control the falling ARPU in India. The objectives of this paper are:

- identify the critical factors influencing the investment decision in mobile services and adoption concerns in India;
- establish the hierarchical relationship among identified critical factors; and
- understand the managerial implications of this research.

2 Identification of factors critical to investment decision on Mobile Services

2.1 Conducive Policy

The planning commission of India has given utmost importance to foster inclusive growth by bringing user-friendly policies to promote high-quality telecom services and affordable mobile services. The focus of the government is "to provide secure, reliable, affordable and high quality converged telecommunication services anytime, anywhere for an accelerated inclusive socio-economic development" (NTP, 2012). The number of telecom (wired and wireless) users at the end of December 2013 reached 915 million as compared to 41 million in 2001 (TRAI, 2014). The growth in Indian telecom industry soared up with the release of National Telecom Policy (NTP) in 1999. Efforts have been made in NTP 2012 to promote mobile services and development of indigenous technologies within India to connect multiple isolated services through mobile phones at an affordable price with better Quality of Service (QoS). It also promotes collaboration with foreign companies and attract investment from private companies to touch lives of all citizens and transform India apart from generating employment opportunities in the telecom sector. As a result, it is expected to prompt the application developers to take a lead role in customizing to local needs apart from catering to the global market. The financial incentives from the government have encouraged several multinationals corporations to collaborate with their Indian counterparts thus increasing foreign investment in the mobile service market. For example, MediaTek, a Mobile chip maker collaborated with Indian smartphone makers like Intex, Micromax, Spice and Lava to bring 4G-capable chipsets in the future to meet the needs of Indian consumers (Telecom-Snapshot, 2013).

2.2 Context-aware Services

On a conceptual level, mobile services add value to the standard service offerings and allow operators to expand their customer base and drive up the ARPU. The services that are designed to serve either in terms of saving time, money and increasing the comfort levels of customers are likely to be more effective. Context-based services are considered to be the key factor for service differentiation in the market to attract more customers and retain existing ones. If mobile services come with pragmatic added value to the user experience, service providers must have to should explore the concept of mobility, as well as the context of its usage (Bouwman et al., 2012; de Reuver and Haaker, 2009). Location-based services, traffic alerts, m-payments and improving healthcare monitoring could be applications which might be used by the consumers irrespective of their social status.

2.3 Convergent Services

The development from analog to digital technology has expedited the transmutation of data, voice, and video to the digital form. With the increase in competition and market getting mature, traditional ways of earning profits inevitably have started declining. Increasingly, these are now being manifested through single networks bringing about a convergence in networks, devices, and services using Service Oriented Architecture (SOA) and Cloud (Pruthi et al., 2013). Most of the devices used for day-to-day communication have some or the other limitations in their functionality or the network they access. Customers' eagerness for reduced costs and high quality, reliable and enabling services make customer retention one of the toughest challenges. Broadband has enabled users to make calls with IP-telephony at a low cost and empowers users with advanced features like video calling, video on demand (VoD) and Internet Protocol TV (IPTV). Convergence between the fixed and mobile telecommunication industries is the next big thing that is being expected in the mobile space. Device convergence, service convergence, and network convergence are thought as the current focus area for the telecom companies (Ivanek, 2008; Jiang and Gille, 2006). It is considered to be a challenging activity for the content aggregator, content provider and mobile service or application developers for content dissemination with the help of TSPs over telecom infrastructure. It would promote fair and efficient usage of spectrum and making services accessible on different platforms or devices irrespective of location.

2.4 Global MVAS Leader

Mobile services bridge the digital divide and empower people through mobile phones. It provides an opportunity for the TSPs to earn without investing much for the development of additional infrastructure to float mobile services. With a strong commitment from the government, telecommunication is considered as an independent infrastructure sector. The focus is to *"promote innovation, indigenous R&D and manufacturing to serve domestic and global markets, by increasing skills and competencies"* (NTP, 2012). Investment in mobile services is likely to increase job avenues for thousands of mobile application developers, content providers, aggregators and telecom companies altogether towards achieving innovation leading to a world-class mobile service provider.

2.5 Community Identification

To promote any service, it is important to identify and classify different segments of users based on various attributes like income, education, place of residence, friend circles, activity on social networks and many other hidden factors. Some of the recent studies have addressed the issue of identifying social division (Bucicovschi et al., 2013), identifying virtual city structure (Caceres et al., 2007; Ge et al., 2014; Ratti et al., 2006) using mobile phone traces. It becomes important for the telecom companies to promote research for a better understanding of their customers by identifying the influencers, social community and structure for designing products to meet users requirements and develop services that are useful in real-life. Data mining and machine learning techniques have helped a lot in this direction (Bhadani et al., 2013).

2.6 Quality of Service

With the introduction of Mobile Number Portability (MNP), the Quality of Service (QoS) has improved due to high competition and fear of churn. It is considered to be an important parameter to build confidence among the customers. With the launch of 3G services and upcoming 4G/LTE services, it is expected to play a crucial role in determining the adoption of different mobile services in India as it provides high-speed data services and support for integrating convergent services over mobile phone devices (Jain and Banwet, 2013).

2.7 Indian Language Support

India is a land of heterogeneous culture with around 22 major languages and 1,652 dialects from six different language families (Kamthania, 2014). Each civilization and community have their own language. The larger sections of Indian population find it impractical to navigate interfaces in these electronic gadgets. In reality, this leaves the potential of various features of these mobile devices unexplored. Mobile handsets as a portable and pocket-sized communication device are one of the driving factors for offering differentiated services over this ubiquitous platform, which has diffused so well. Local innovations and incentives can catalyze service development in local language. It provides an opportunity for the TSPs to integrate services including m-government, m-ticketing, m-health, and social networks to bridge gap between government and the rest of the world in local languages (Nikou and Bouwman, 2013). However, in order to mark their presence in rural or semi-urban areas it is important to offer services in local languages to meet local needs such that it can be used with ease irrespective of various education levels or economic conditions. One way to achieve this would be to support Indian languages (Kamthania, 2014; Mistry, 2007).

2.8 Information Security Concerns

It is important the address the concern and apprehensions of using mobile phones for high-valued transactions. The concerns vary from losing of the mobile phone to losing money while doing any transaction. The fear of data misuse, data theft and ease of misuse result in creating fear for using mobile phones. The fear of virus attacks and hacking of mobile phone data leads to nervousness among the users. If m-government is to encompass m-payment systems or any other transactional services, then security must be ensured to gain the trust of users. As of now, credibility gap still lies to be crossed for many mobile device users (Kailasam, 2014).

2.9 Value Added Service Usage

Services that add value to the users in some sense with their mobile device is called as value added services. Though, India is ranked second in terms of mobile phone users, the country is ranked far behind in terms of mobile service usage (de Leon and Adhikari, 2010; Djamal-Eddine et al., 2011). The focus should be on making mobile services available at an affordable price so as to fuel growth in entrepreneurship, innovation and provision of region-specific content in regional languages. There is a strong need to motivate the developers, content providers, content aggregators so as to make them a channel partner for developing mobile services along with TSPs, such that everyone gets equally benefited, in turn, promoting the adoption among the mobile users.

2.10 Mobile Service R&D

The need for keeping operating costs low has always been a challenging activity. People adopt any service or product only if it is better than the existing products, it is cheaper and it is easy to use. Research in mobile services can help in developing applications or services that can replace existing way of utilizing several services. For instance, m-health applications can alert an individual about blood pressure, how many calories to consume and aid in checking glucose level. Similarly, m-ticketing can assist in booking tickets from their mobile devices thus saving a huge amount of time for standing in long queues at booking counters or logging to The internet with good speed. M-Government services can help in bringing transparency in the system (Napoleon and Bhuiyan, 2014). Use of cloud computing technology can lower the cost of operation as it works on the notion of pay-as-you-go. Cloud computing serves an opportunity to offer complex, on-demand services. It works on the concepts of Infrastructure-as-a-Service (IaaS), Software-as-a-Service (SaaS) and Platform-as-a-Service (PaaS) (Bhadani and Chaudhary, 2010; Goncalves and Ballon, 2011; Pallis, 2010). Some of the examples include controlling remote server, data storage, data processing (Bhadani and Chaudhary, 2010). Designing relevant services using Cloud-based solution can help in increasing the usage of mobile for different purposes. These services can generate additional revenue to beat the competition and control falling ARPU (Ahmed, 2011). To understand what customer will adopt is one of the most challenging tasks and can be predicted with lesser accuracy. However, Mobile service development is a gray area and needs a considerate amount of research. R&D is the only feasible way to innovate new services with USSD, SMS or simple interface design for a better penetration of VAS among least privileged group (Medhi et al., 2011).

2.11 VAS Prioritization over Voice

The Indian market is overcrowded by a number of TSPs, where more than ten service providers work simultaneously in a particular circle. Consumers have multiple choices while considering a new connection or changing the service provider. They select TSPs based on several factors such as call charges, service experience, customer support, coverage, and customer support (Varma and Sharma, 2011). To break the price-driven competition, MSPs need to understand their customers better and offer them services that are most likely to subscribe. It can help in increasing usage and reduce churn (Allee and Taug, 2006; Ray and Ray, 2010). Innovative ways, like tracking how much time a consumer remains active on the official portals after signing in, which areas of the page are being surfed more, which links are being clicked, how they behave socially, are they influencers, and activity in social media can be utilized to design different services and packs (Friedrich et al., 2009). They need to analyze customers' data from various sources so as to predict their needs with a greater accuracy. To remain competitive and innovative, TSPs should consider buying best applications from the developers by paying them a greater share to encourage innovation.

2.12 Sales of Devices

A vast growth is being observed in the sales of smartphones and tablets all over the world. It has crossed 900 million units, which accounted for 54% of all cellphone sales in 2013 (Evans, 2013; Investor's Business, 2014). In 2013, the sales of smartphones in India showed a growth of 62.9% in the electronics industry, which accounts for around 10% of total mobile phones in the country (IRL, 2013). However, the main area of growth in Indian mobile market was seen in sales of tablets showing a growth of up to 424% reaching 1.90 mn units in total market share (BMI, 2014). It allows users to install applications just like any other computer program and provides features that computers used to perform few years ago (Verkasalo et al., 2010).

2.13 Telecom Data Analytics

With the advancement in database storage technology, algorithms and computing power, it becomes important for the TSPs to utilize available technologies and mine useful information. It can help in understanding their customers better through community identification, identifying influencers, virtual city/town, population density, and many more hidden patterns. These findings can help to target customers by offering relevant services to these segmented users. Data mining and Machine Learning algorithms like clustering, segmentation, and rule mining can prove to be useful in identifying needs and preferences. It can help in predicting roaming patterns, churn prediction and many interesting facts that are not possible with conventional computing (Friedrich et al., 2009; Magedanz and Simes, 2009). It becomes important to customize the services or products to cater the diversified needs of people, based on languages, place of residence, the infrastructure of the region, electricity, and demography. Personalization and target marketing can provide MSPs an edge over their competitors and can penetrate the untapped market in semi-urban and rural areas.

2.14 Upgraded Telecom Infrastructure

Telecom Infrastructure has been considered as an independent infrastructure sector, just like any other infrastructures such as rail and roads. To make efficient usage of the spectrum, the government has imposed service obligations for promoting uniform growth and development of telecom services and broadband services in the country (NTP, 2012). With the launch of 3G and upcoming 4G/LTE, it has become possible to develop applications that entail high data bandwidth on the fly. Several applications can be integrated that require support for rich and streaming content over a mobile device in near real-time. Mobile devices, robust telecom infrastructure and service providers can play an important role in delivering other services apart from voice over the mobile phone platform to generate revenue from additional sources.

3 Methodology

In this study a two-stage methodology is adopted. First, questionnaire-based survey and t-test are used for factor validation and Second, Interpretive Structural Modeling (ISM) and MICMAC have been used to achieve the research objectives. These methodologies and the respective results are discussed below.

3.1 Questionnaire survey and Factor Validation

The questionnaire was developed on the basis of literature review and pilot survey was conducted. The questionnaire was mailed to people ranging from senior manager to top-level managers of all telecom companies operating in India. In addition, to that, we also approached policy makers, academicians and mobile application developers to get a holistic view of the factors influencing investment in mobile services R&D. The questionnaire was circulated to 82 people; however, only 27 responses were obtained. During the pilot phase, we asked the respondents to rate the identified factors on a five-point Likert scale (1 - Least Important, 5 - Extremely Important). The data obtained from the survey were analyzed by single sample t-test. Results of this analysis are provided in Table 1. All the factors are significant at $p < 0.01$.

Table 1: Critical Factors for Mobile Service Investment Decision in India

S.No.	Factors	Mean	SD	t-value
F1	Conducive Policy	3.852	0.948	21.094
F2	Context-awareness	3.482	0.753	24.026
F3	Convergent Services	3.593	0.748	24.981
F4	Global MVAS Leader	3.592	0.797	23.420
F5	Community Identification	3.630	0.742	25.44
F6	Quality of Service	3.778	0.800	24.52
F7	Indian Language Support	4.038	0.854	24.56
F8	Information Security Concerns	3.037	0.587	26.878
F9	Low VAS Usage	3.037	0.758	20.802
F10	R&D in M-Services	3.0	0.734	21.24
F11	VAS Prioritization over Voice	3.296	1.013	14.82
F12	Sales of Devices	3.296	0.541	31.69
F13	Telecom Data Analytics	2.888	0.577	26.0
F14	Upgraded Telecom Infrastructure	4.18	0.8337	26.083

Significant at $p < 0.01$

3.2 ISM methodology

Multiple entities or factors constitute a system and these entities interact with each other directly or indirectly. Interpretive Structural Modelling (ISM) is useful in analyzing the order and direction on the complex relationship among the entities. The basic idea is to use experts practical exposure and experience to construct a multi-level structural model. The method is interpretive as the model can be represented using digraph (Sage, 1977; Warfield, 1974). ISM has two components: a) building the hierarchical relationship, and b) analysis using MICMAC. The application of ISM typically forces managers to reassess perceived priorities and improve their understanding of the linkages among key concerns.

3.2.1 Building the hierarchical relationship

ISM handles the complex relationships among the entities elegantly and forms a hierarchical structural arrangement. The direct and indirect relationships among the entities explain the systems appropriately than the isolated entities. Using the simple notions of graph theory, the relationships among the entities become more comprehensible. The relationships are determined based on experts' advice about how different entities are interrelated, hence ISM works on the principle of group decision making. It proves to be very useful in determining the level and order based on the basic principles of set theory i.e., reachability, transitivity, antecedents, and intersection.

3.2.2 Analysis using MICMAC

MICMAC is an abbreviation of *"Matrice dImpacts croises-multiplication applique a classment"*, which means cross-impact matrix multiplication applied to classification. It is based on the principle of multiplication properties of the matrices (Saxena et al., 2006; Sharma et al., 1995). It is used to analyze the driving power and dependence power of the entities under consideration. This is carried out to find the key entities that are driving the whole process. MICMAC provides valuable insights about the relative importance and interdependencies of the entities. The entities or factors are normally classified in four clusters namely: Autonomous, Linkage, Dependent, and Independent. Hereafter, the terms entities and factors are used interchangeably.
ISM has been used in various disciplines like logistics and supply chain management, manufacturing (Ramesh et al., 2010; Singh et al., 2007), flexible manufacturing (Raj et al., 2008), technology transfer (Kumar et al., 2009), M-Banking (Ketkar et al., 2012), and information security management (Chander et al., 2013).

3.3 ISM Steps

Step 1: Identifying the Factors

The survey, expert advice or group decision-making process is used to identify the factors influencing the system under analysis. The factors can be an individuals, actions, and outcomes. The factors are identified with the help of literature review and is validated with the experts view. The enumerated list of factors discussed in Section 2 are presented in Table 1 for further reference throughout the text.

Step 2: Establishing the contextual relationship between the factors

A contextual relationship of 'reaches to' type is used among the factors identified in Step 1 with the help of experts presented in Table 2.

The following four symbols have been used to denote the direction of the relationship between two factors (i and j):

Table 2: Expert's Profile

Profile of the Expert	Type of Organization	Years of Experience
Senior Manager	Private Telecom Operator in India	23 Years
Vice President Global Human Resources - Operations & Services	Private Telecom Non-Indian Multi-National Company	17 Years
Retired Officer (Associate Director General)	Public Telecom Governing Body in India	36 Years
Senior GM Sales, Marketing & Business Policy	Public Telecom company operating in India	20 Years
Senior Researcher	Government Academic Institute	16 Years
Senior Mobile Application Designer	Private Software Company	11 Years

- V is used for the relation from factor i to factor j (i.e. if factor i influences or reaches to factor j).
- A is used for the relation from factor j to factor i (i.e. if factor j reaches to factor i).
- X is used for both direction relations (i.e. if factors i and j reach to each other).
- O is used for no relation between two factors (i.e. if factors i and j are unrelated).

Step 3: Development of structural self-interaction matrix (SSIM)

The following would explain the use of the symbols V, A, X and O in SSIM:

- Factor F1 affects factor F14. 'Conducive policy' leads to 'Upgraded Telecom Infrastructure'. Thus, the relationship between factors F1 and F14 is denoted by V in the SSIM (Table 3).
- Factor F13 affects factor F2. 'Telecom Data Analytics' affects 'Context-awareness'. Thus, the relationship between factors F2 and F13 is denoted by A in the SSIM (Table 3).
- Factors F3 and F14 affect each other. The factor F3, 'Convergent Services' and factor F14, 'Upgraded Telecom Infrastructure' affect each other. Thus, the relationship between factors F3 and F14 is denoted by X in the SSIM (Table 3).
- No relationship exists between factors F1 (Conducive Policy) and F13 (Telecom Data Analytics) and hence the relationship between these factors is denoted by O in the SSIM (Table 3).

Based on similar contextual relationships, the SSIM is developed for all fourteen factors leading to influencing the mobile service investment decision as a viable solution to control falling ARPU is presented in Table 3.

Step 4: Development of the reachability matrix

The next step is to develop the reachability matrix from SSIM. This is obtained in two sub-steps. In the first sub-step, the SSIM is converted into the initial reachability matrix by transforming the information of each cell of SSIM into binary digits (i.e. 0 or 1), which is checked for transitivity. Transitivity states that if an element α is related to β and β is related to γ, then α is necessarily related to γ. In the second sub-step, final reachability matrix is obtained

Table 3: SSIM

Factors	F14	F13	F12	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2
F1	V	O	V	O	O	O	O	V	V	O	V	V	O
F2	A	A	A	X	V	A	A	X	A	A	V	A	
F3	X	V	V	V	V	O	V	O	X	O	O		
F4	O	A	O	A	X	O	O	O	O	A			
F5	O	A	O	V	V	O	O	V	O				
F6	X	O	V	V	O	O	V	O					
F7	O	A	O	X	O	O	O						
F8	A	O	O	O	O	V							
F9	O	V	O	O	V								
F10	O	A	A	A									
F11	A	A	A										
F12	A	O											
F13	O												

(Table 5). For this purpose, the concept of transitivity is used so that some of the cells of the initial reachability matrix are filled by inference, such that no information is missed out during the development of SSIM. This transformation has been carried out as per the following rules:

- If the cell (i, j) is assigned with symbol V in the SSIM, then, this cell (i, j) entry becomes 1 and the cell (j, i) entry becomes 0 in the initial reachability matrix.
- If the cell (i, j) is assigned with symbol A in the SSIM, then, this cell (i, j) entry becomes 0 and the cell (j, i) entry becomes 1 in the initial reachability matrix.
- If the cell (i, j) is assigned with symbol X in the SSIM, then, this cell (i, j) entry becomes 1 and the cell (j, i) entry also becomes 1 in the initial reachability matrix.
- If the cell (i, j) is assigned with symbol O in the SSIM, then, this cell (i, j) entry becomes 0 and the cell (j, i) entry also becomes 0 in the initial reachability matrix.

Following the above rules, the initial reachability matrix for the system under study is presented in Table 4. After incorporating the transitivity rules, the final matrix is obtained (Table 5).

Step 5: Partitioning the reachability matrix

A digraph is obtained from the final reachability matrix. Based on the suggestions of Warfield (1974), the reachability set and antecedent set for each factor are found from the final reachability matrix. After finding the reachability set and antecedent set, the intersection for these sets are derived for all the factors. The top level factors are those factors which do not reach the other factor above their own level in the hierarchy. As a result, the intersection of the reachability set and the antecedent set will be the same as the reachability set (Farris and Sage, 1975). Once the top level factor is identified, it is not considered for further iteration other top level factors from the remaining subgraph are calculated. This procedure continues till all elements get exhausted and levels of the structure are identified.

Table 4: Initial Reachability Matrix

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14
F1	1	0	1	1	0	1	1	0	0	0	0	1	0	1
F2	0	1	0	1	0	0	1	0	0	1	1	0	0	0
F3	0	1	1	0	0	1	0	1	0	1	1	1	1	1
F4	0	0	0	1	0	0	0	0	0	1	0	0	0	0
F5	0	1	0	1	1	0	1	0	0	1	1	0	0	0
F6	0	1	1	0	0	1	0	1	0	0	1	1	0	1
F7	0	1	0	0	0	0	1	0	0	0	1	0	0	0
F8	0	1	0	0	0	0	0	1	1	0	0	0	0	0
F9	0	1	0	0	0	0	0	0	1	1	0	0	1	0
F10	0	0	0	1	0	0	0	0	0	1	0	0	0	0
F11	0	1	0	1	0	0	1	0	0	1	1	0	0	0
F12	0	1	0	0	0	0	0	0	0	1	1	1	0	0
F13	0	1	0	1	1	0	1	0	0	1	1	0	1	0
F14	0	1	1	0	0	1	0	1	0	0	1	1	0	1

Step 6: Development of conical matrix

Further, a narrowed matrix is developed by clubbing factors in the same level, across rows and columns of the final reachability matrix, presented in Table 5. The driving power (DR) of a factor is derived by summing up the number of ones in the rows and its dependence power (DP) by summing up the number of ones in the columns. Next, driving power and dependence power ranks are calculated by giving highest ranks to the factors that have the maximum number of ones in the rows and columns respectively.

Table 5: Final Reachability Matrix

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	DRIVING (DR)
F1	1	1*	1	1	1*	1	1	1*	1*	1*	1*	1	1*	1	14
F2	0	1	0	1	0	0	1	0	0	1	1	0	0	0	5
F3	0	1	1	1*	1*	1	1*	1	1*	1	1	1	1	1	13
F4	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2
F5	0	1	0	1	1	0	1	0	0	1	1	0	0	0	6
F6	0	1	1	1*	1*	1	1*	1	1*	1*	1	1	1*	1	13
F7	0	1	0	1*	0	0	1	0	0	1*	1	0	0	0	5
F8	0	1	0	1*	1*	0	1*	1	1	1*	1*	0	1*	0	9
F9	0	1	0	1*	1*	0	1*	0	1	1	1*	0	1	0	8
F10	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2
F11	0	1	0	1	0	0	1	0	0	1	1	0	0	0	5
F12	0	1	0	1*	0	0	1*	0	0	1	1	1	0	0	6
F13	0	1	0	1	1	0	1	0	0	1	1	0	1	0	7
F14	0	1	1	1*	1*	1	1*	1	1*	1*	1	1	1*	1	13
DEPENDENCE(DP)	1	12	4	14	8	4	12	5	6	14	12	5	7	4	

In this work, level identification gets completed in eight iterations. Based on iterations, each obtained level has been presented in Tables 6. Top level factors are positioned at the top of a digraph and so on.

Step 7: Conceptual inconsistency check and Development of digraph

Based on the conical matrix, an initial digraph including transitivity links is obtained. After removing the indirect links, a final digraph is developed. In this development, the top level factor is positioned at the top of the digraph

Table 6: Final iteration results and level partitioning

Iteration	Elements	Levels
1	F4, F10	I
2	F2, F7, F11	II
3	F5, F12	III
4	F13	IV
5	F9	V
6	F8	VI
7	F3, F6, F14	VII
8	F1	VIII

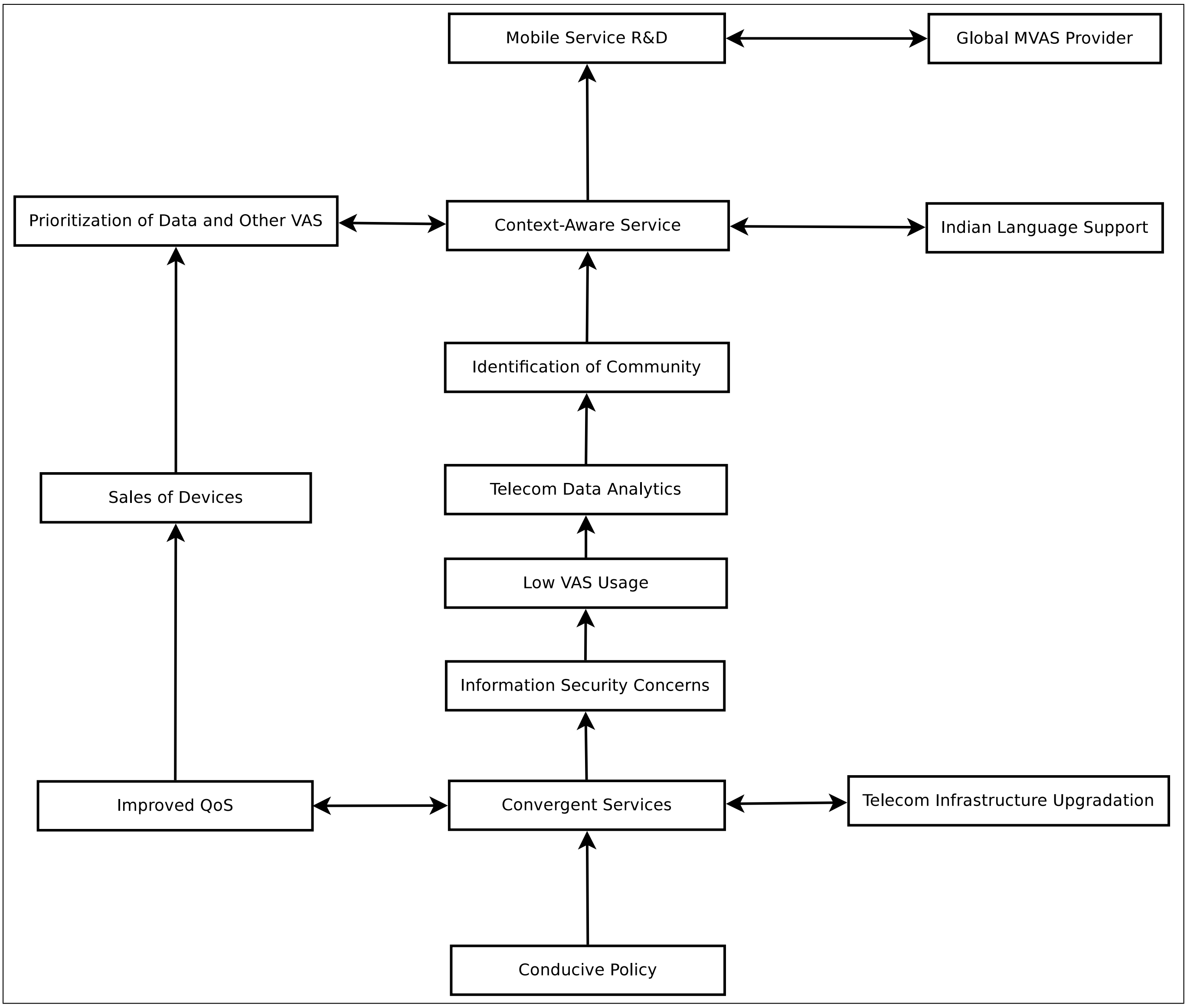

Figure 1: ISM Model for factors affecting Mobile-based services investment

and second level factor is placed at the second position and so on, until the bottom level is placed at the lowest position in the digraph. The resultant digraph is developed into an ISM (Figure 1), by replacing the element nodes with statements.

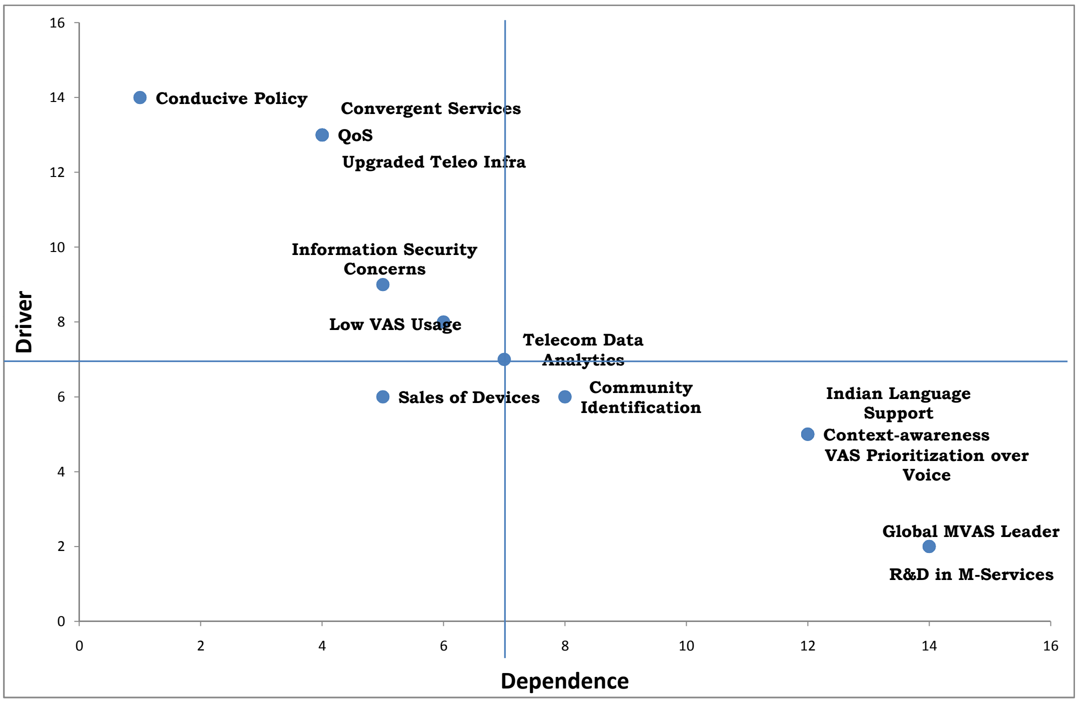

Figure 2: Driving Power - Dependence Power graph

Step 8: Analysis using MICMAC

MICMAC is based on the principle of multiplication properties of the matrices (Duperrin and Godet, 1973). It is an extension of the driver-dependence power obtained based on the indirect reachability matrix of the ISM model (Figure 2). It can be explained based on the transitive property of the sets. If a variable i directly influence variable k, and if variable k directly influences variable j, then any change on i will have a repercussion effect on j through the transitive relationships. Numerous indirect relationships of ij type that exist in the ISM model cannot be taken into account in a direct relationship approach. When the direct matrix (Table 7) is multiplied, second order relationships are revealed. Similarly, if the power is raised, again and again, the hidden paths can be found.

This helps in forming a new hierarchy each time till it stops changing further, which stabilizes the matrix and further iteration is stopped (Refer Table 8, 9). This hierarchy is termed as MICMAC classification (Figure 3).

Table 7: Direct Reachability Matrix (**M**)

Factors	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**	**F11**	**F12**	**F13**	**F14**	**DR**	**DR-RANK**
F1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3
F2	0	0	0	0	0	0	1	0	0	1	1	0	0	0	3	1
F3	0	0	0	0	0	1	0	1	0	0	0	0	0	1	3	1
F4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3
F5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
F6	0	0	1	0	0	0	0	0	0	0	0	1	0	0	2	2
F7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
F8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	3
F9	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3
F10	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	3
F11	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
F12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3
F13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3
F14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3
DP	0	3	3	1	1	1	1	1	1	2	2	1	1	1	-	-
DP-RANK	4	1	1	3	3	3	3	3	3	2	2	3	3	3	-	-

Table 8: Matrix Stabilization using MICMAC

FACTORS	M^2		M^4		M^6		M^8		M^{10}		M^{12}		M^{14}		M^{16}		M^{18}		M^{20}	
	DP	DR	DP	DR	DP	DR	DP	DR	DP	DR	DP	DR	DP	DR	DP	DR	DP	DR	DP	DR
F1	5	2	10	3	11	3	10	3	11	3	11	3	11	3	11	3	11	3	11	3
F2	1	2	3	4	3	4	2	4	2	4	2	4	2	4	2	4	2	4	2	4
F3	3	1	6	2	7	2	6	1	7	1	7	1	7	1	7	1	7	1	7	1
F4	3	3	5	6	5	7	4	7	5	7	5	7	5	7	4	7	4	7	4	7
F5	4	2	9	4	10	4	9	4	10	4	10	4	10	4	10	4	10	4	10	4
F6	2	1	5	1	6	1	5	2	6	2	6	2	6	2	6	2	6	2	6	2
F7	2	2	4	4	4	4	3	4	4	4	4	4	4	4	5	4	5	4	5	4
F8	2	3	5	6	6	6	5	6	6	6	6	6	6	6	6	6	6	6	6	6
F9	4	3	8	5	9	5	8	5	9	5	9	5	9	5	9	5	9	5	9	5
F10	1	3	1	6	1	7	1	7	1	7	1	7	1	7	1	7	1	7	1	7
F11	1	2	2	4	2	4	2	4	3	4	3	4	3	4	3	4	3	4	3	4
F12	4	3	8	5	9	5	8	5	9	5	9	5	9	5	9	5	9	5	9	5
F13	4	3	7	5	8	5	7	5	8	5	8	5	8	5	8	5	8	5	8	5
F14	2	2	5	3	6	3	5	3	6	3	6	3	6	3	6	3	6	3	6	3

Table 9: Indirect Reachability Matrix (M^{20})

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	DR	DR-RANK
F1	0	1024	0	769	0	512	1024	512	0	1793	1280	0	256	512	7682	3
F2	0	1024	0	1023	0	0	0	0	0	0	0	0	0	0	2047	4
F3	0	2304	1024	1793	256	0	1024	0	512	1793	1024	512	0	0	10242	1
F4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	7
F5	0	0	0	0	0	0	512	0	0	1023	512	0	0	0	2047	4
F6	0	1024	0	769	0	512	1280	512	0	2304	1536	0	256	512	8705	2
F7	0	0	0	0	0	0	512	0	0	1023	512	0	0	0	2047	4
F8	0	256	0	255	0	0	0	0	0	0	0	0	0	0	511	6
F9	0	0	0	0	0	0	256	0	0	511	256	0	0	0	1023	5
F10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	7
F11	0	0	0	0	0	0	512	0	0	1023	512	0	0	0	2047	4
F12	0	512	0	511	0	0	0	0	0	0	0	0	0	0	1023	5
F13	0	512	0	511	0	0	0	0	0	0	0	0	0	0	1023	5
F14	0	1024	0	769	0	512	1024	512	0	1793	1280	0	256	512	7682	3
DP	0	7680	1024	6401	256	1536	6144	1536	512	11264	6912	512	768	1536		
DP-RANK	11	2	7	4	10	6	5	6	9	1	3	9	8	6		

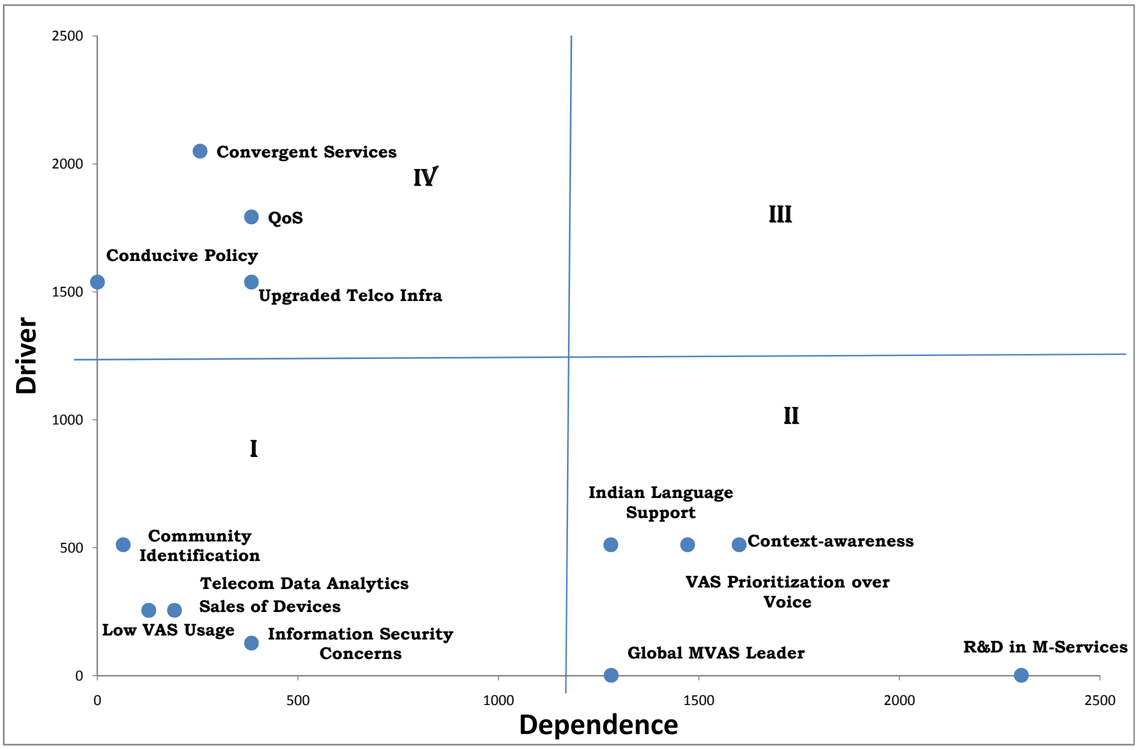

Figure 3: Driver and Dependence obtained after MICMAC

4 Results, Discussion and Managerial Implication

4.1 Results and Discussion

The objective of developing ISM model in this research is to develop a hierarchical relationship among the factors leading to focus on investment decisions for exploring mobile services as an additional source of revenue. Analyzing these factors is important because it would help TSPs on decisions related to exploring research and collaboration with other parties (i.e., Mobile Apps developers, content providers, and content aggregator) so as to remain competitive and recover the huge investment required for building next generation network. It is generally perceived that mobile services are the next big thing in telecom space which can fuel the growth in this sector with the convergence of services.

Various factors leading to the encouragement of the usage and growth of mobile services are classified with the help of driving power–dependence power diagram (Refer Figure 2). However, MICMAC analysis helps in identifying the indirect relationships by raising the power of the direct relationship matrix (M) (See Table 7) till a stable rank is obtained based on the driving power and dependence power of the matrix. In this case, we reach a stable rank at M^{16} for the factors under study. So we stop the iteration after confirming at M^{20}. The final driving-dependence diagram based on MICMAC analysis is presented in Table 9 and is shown in Figure 3. It helps to determine the key variables using both direct and indirect relationships among the variables. The direct relationship (Table 7) is obtained by examining the direct relations between the digraph, ignoring transitivity and making diagonal entries as 0. The driver power of the variables is derived by summing the number by of interactions in the rows and dependence are obtained by column sum. Ranks are then obtained based on the driving and dependence power.

Region I (shown in Figure 3) is classified based on weak driver and weak dependence values derived from stabilized matrix (M^{20} in this case). This is also referred as autonomous variables. These variables are relatively disconnected from the system. It is also notable that it has only a few links though these links could be very strong. Sales of devices, VAS usage, concerns of the users related to information security, community identification, and Telecom data analytics fall under this category. The increase in sales of Smartphones and Tablets has widened the scope for offering mobile services and applications. At the same time, expectations from mobile services have fueled the growth in sales of tablets and smartphones. Interestingly, though the interest in mobile services and expectations from mobile phones have risen, but the usage is low. People have started expecting dedicated services, which can be made possible through personalization. It can be achieved by identifying the needs and patterns of users so that services can be designed as per their requirements. To remain competitive, it essentially becomes important to understand the customers' community and their paying capacity for a particular service. Identifying the community or group can help in designing relevant services that might be of interests to a group or community. If they are willing to pay a premium charge, services can be customized as per their requirement.

Region II is classified based on weak driver and strong dependence values and is also referred as dependent variables. Indian language support, context-awareness, becoming VAS leader, investment on research and development on mobile services, and prioritization of VAS over basic services fall under this category. To cater rural and semi-urban population, mobile services should be made available in Indian languages. This would lessen the apprehension among the people who are not comfortable in The English language. Though India being the largest exporter of IT services and mobile apps to the entire world, Indian mobile service sector has been highly underestimated and overlooked. Developing services would enable TSPs to cater large Indian market. With the convergence of services and advent of cloud-based services, using a mobile phone for high-end operations has become a dream come true. With dedicated R&D centers related to developing mobile services, India can become a global MVAS provider. Mobile service market has not been channelized as there are no policies that encourage the participation from other channel partners i.e., content providers, aggregators, and app developers.

Region III is classified based on strong driver and strong dependence values. It is referred as linkage variables. Factors under this category are unstable in nature. Any action on these will have an impact on others and a feedback effect on themselves would amplify or support the initial pulse. In our case, no variables are unstable and completely represents the stable system.

Region IV referred as independent variables are classified based on strong driving power and weak dependence power. QoS, convergent services, conducive policy and telecom infrastructures fall under this category. Policies like financial incentives from the government can fuel development of services that can be used as a tool for empowering common man. Similarly, regulations pertaining to fulfilling service obligations for obtaining spectrum would push as well as encourage provisioning of services thus making efficient utilization of 3G or 4G spectrum within stipulated time-period. Promoting and offering services through a mobile phone can act as a socio-economic empowerment tool, leading to increasing in the adoption of different utility-based services. The factor at the top of hierarchy represents the result of actions of remaining factors. Hence, it can be observed that remaining factors affect the investment decision on R&D in mobile service and leading to becoming a global VAS provider.

4.2 Managerial Implications

From our research, it is evident that TSPs need to invest in research and development of m-services to remain competitive and to become an MVAS leader. There are many compelling factors such as a large number of subscribers and availability of high bandwidth spectrum for commercial use such as 3G, 4G, and LTE services. Since voice services and other basic services have already been commoditized, TSPs have to understand the customers' need in a better way and push approach is not going to work anymore. India being a vast country with diversified culture and language, it becomes evident to make services available for every customer irrespective of his/her social stature. This is only possible if the services are available in their language, interactive and easy to use. Since most of the devices by default come in English language, it is important for TSPs to closely work with the companies that offer trans-language solutions to support the Indian languages.

Personalization and target marketing can be achieved by processing and analyzing structured or unstructured information collected from different sources like social media, call detail record, time spent online through mobile, apps being used or downloaded, in-degree calls, out-degree calls, and roaming pattern using advanced data analysis techniques like Data Mining, Machine Learning and Big Data analytics to gain competitive advantage. These advanced techniques would provide useful insights to understand the customers' behavior and preferences.

Today, the customers are forced to remember multiple service numbers or access codes (USSD codes) for activating or deactivating a particular service. It becomes even challenging when the customers change their service provider, they have to learn a new set of codes and access numbers. These create angst among the users, ultimately leading them to either give up or find an alternate solution, thus losing a potential customer. It is important to make all mobile services available at a single point-of-sale platform so that customers can easily subscribe to the service of their choice with ease. Policies related to uniform access codes or USSD need to be addressed for better service accessibility. To promote adoption of services among low digitally skilled users, the focus should be on the innovation of the interface design by understanding their needs. Design should be simple to navigate and use. Support of services in local dialect can act as a catalyst in positioning mobile as a socio-economic empowerment instrument and can promote adoption of multiple services in remote locations.

5 Conclusions, Limitations and Future Work

This paper suggests a framework that can aid decision makers and policy makers in telecommunication sector by identifying various factors that force telecom companies to invest in mobile services by improving R&D to cater the local needs of the Indian market. Mobile services adoption is considered as a viable solution for controlling the downfall of ARPU in the telecom sector. Group decision-making technique, ISM has been used to determine the complex hierarchical structural relationships among factors influencing the mobile service investment decision. Modeling these forces in a hierarchical manner, gives a basic understanding of the cause and effect of the independent and linkage factors. Further, analysis using MICMAC was carried out to understand the driving and dependency power of each enabling factor on the overall system. Based on driving and dependence power, four clusters were identified namely autonomous, linkage, independent and dependent factors. This model helps policy makers and managers to strategically plan on investment in mobile services and integrating several isolated services such that it can be overcome in the due course of time and gain a competitive advantage over others and become a global VAS leader. Finally, it can be concluded that there is a dire need to focus on the design of innovative services, supporting Indian languages, developing personalization tools and investing in mobile service R&D to remain competitive by effectively using telecom data analytics.

ISM helps in establishing a hierarchical structure systematically, however, it has some limitations as well. It is observed that the finalization of the structural model becomes difficult especially in cases where feedback and too many loops are present in the model. Though this problem has been tackled substantially by the level partitioning of the matrix, the determination of the ranks of sub-elements from the traditional ISM model, in the case where sub-elements have the same level is difficult. Another noteworthy limitation of this approach lies in the process of hierarchy generation is subject to the process of power i.e., it ends up representing the views of the most powerful person. The methodology of concern has no way of dealing with this difficulty. This model can further be enhanced using ANP/AHP approaches to find the ranks of the factors. It would yield in identifying the most important factors and least important factors that are an important source to identify and prioritize the investment decisions of the mobile companies.

References

Ahmed, S. (2011). Cloud computing for policy makers - The potential for economic impact. *Information Technology in Developing Countries*, 21(1):Article No. 3.

Allee, V. and Taug, J. (2006). Collaboration, innovation, and value creation in a global telecom. *The Learning Organization*, 13(6):569–578.

Bhadani, A. and Chaudhary, S. (2010). Performance evaluation of web servers using central load balancing policy over virtual machines on cloud. In *Proceedings of the Third Annual ACM Bangalore Conference*, COMPUTE '10, pages 16:1–16:4, New York, NY, USA. ACM.

Bhadani, A., Shankar, R., and Vijay Rao, D. (2013). A computational intelligence based approach to telecom customer classification for value added services. In Bansal, J. C., Singh, P. K., Deep, K., Pant, M., and Nagar, A. K., editors, *Proceedings of Seventh International Conference on Bio-Inspired Computing: Theories and Applications (BIC-TA 2012)*, volume 201 of *Advances in Intelligent Systems and Computing*, pages 181–192. Springer India.

BMI (2014). India consumer electronics report. *India Consumer Electronics Report*, 6(1):1 – 69.

Bouwman, H., Bejar, A., and Nikou, S. (2012). Mobile services put in context: A Q-sort analysis. *Telematics and Informatics*, 29(1):66–81.

Bucicovschi, O., Douglass, R. W., Meyer, D. A., Ram, M., Rideout, D., and Song, D. (2013). Analyzing social divisions using cell phone data. In *Mobile Phone Data for Development (D4D) Challenge: Social and Economic Development*, volume Article No. 3, pages 41–54.

Caceres, N., Wideberg, J. P., and Benitez, F. G. (2007). Deriving origin destination data from a mobile phone network. *Intelligent Transport Systems, IET*, 1(1):15–26.

Carlsson, C., Hyvonen, K., Repo, P., and Walden, P. (2005). Asynchronous adoption patterns of mobile services. In *38th Annual Hawaii International Conference on System Sciences*, Hawaii. Accessed on 15 August, 2013.

Chander, M., Jain, S. K., and Shankar, R. (2013). Modeling of information security management parameters in Indian organizations using ISM and MICMAC approach. *Journal of Modelling in Management*, 8(2):171–189.

Constantiou, I. D. (2009). Consumer behaviour in the mobile telecommunications' market: The individuals' adoption decision of innovative services. *Telematics and Informatics*, 26(3):270 – 281.

de Leon, M. and Adhikari, A. (2010). A user centric always best connected service business model for MVNOs. In *Intelligence in Next Generation Networks (ICIN), 2010 14th International Conference on*, pages 1 –8.

de Reuver, M. and Haaker, T. (2009). Designing viable business models for context-aware mobile services. *Telematics and Informatics*, 26(3):240 – 248.

Djamal-Eddine, M., Tinku, R., and Yvon, G. (2011). On the role of infrastructure sharing for mobile network operators in emerging markets. *Computer Networks*, 55(7):1576 – 1591.

Duperrin, J. and Godet, M. (1973). Methode de hierarhisation des elements d'un systeme. *Rapport Economique du CEA*, R:45–51.

Evans, B. (2013). Smartphones: High prices, huge market. *Technology Review*, 116(3):72 – 73.

Farris, D. and Sage, A. (1975). On the use of Interpretive Structural Modelling for worth assessment. *Computers & Electrical Engineering*, 2:149–174.

Ferguson, R. and Brohaugh, B. (2008). Telecom's search for the ultimate customer loyalty platform. *Journal of Consumer Marketing*, 25(5):314 –318.

Friedrich, R., Grone, F., Holbling, K., and Peterson, M. (2009). The march of mobile marketing: New chances for consumer companies, new opportunities for mobile operators. *Journal of Advertising Research*, 49(1):54–61.

Gayomali, C. (2012). The text message turns 20: A brief history of SMS. The Week. Accessed on 22 December, 2013.

Ge, Y., Meng, R., Cao, Z., Qiu, X., and Huang, K. (2014). Virtual city: An individual-based digital environment for human mobility and interactive behavior. *SIMULATION Transactions of The Society for Modeling and Simulation International*.

Goncalves, V. and Ballon, P. (2011). Adding value to the network: Mobile operators experiments with Software-as-a-Service and Platform-as-a-Service models. *Telematics and Informatics*, 28(1):12 – 21.

Iden, J. and Methlie, L. B. (2010). Penetration of services on future networks: Exploring market players' opinions. *Journal of Telecommunications Management*, 3(3):238–255.

Iden, J. and Methlie, L. B. (2012). The drivers of services on next-generation networks. *Telematics and Informatics*, 29(2):137 – 155.

Investor's Business, D. (2014). Smartphones saturate market. *Investors Business Daily*, page A02.

IRL (2013). Mobile value added services market in India 2014-2018. Technical report, Infiniti Research Limited. http://www.researchandmarkets.com/research/6vmcf8/mobile_value Accessed on 14 January 2014.

Ivanek, F. (2008). Convergence and competition on the way toward 4G [from the editor's desk]. *Microwave Magazine, IEEE*, 9(4):6 –14.

Jain, D. and Banwet, D. (2013). Modelling critical elements of selection for strategic alliance partner for network managed services using Interpretive Structural Modelling (ISM). *Journal of Modelling in Management*, 8(3):290 – 304.

Jiang, Y. and Gille, L. (2006). Three-dimensional layered approach for analyzing value chain re-organization cross ICT industries for converged mobile multimedia services. In *Proceedings of the 2006 IEEE Asia-Pacific Conference on Services Computing*, pages 58–63, Washington, DC, USA. IEEE Computer Society.

Kailasam, R. (2014). m-Governance Leveraging Mobile Technology to extend the reach of e-Governance. In *m-GovWorld*. Accessed on 19 June 2014.

Kamthania, D. (2014). A big need for indic-language solutions. *CSI Communications*, 37(12):7–8.

Ketkar, S. P., Shankar, R., and Banwet, D. K. (2012). Structural modeling and mapping of M-Banking influencers in India. *Journal of Electronic Commerce Research*, 13(1):70–87.

Kumar, N., Prasad, R., Shankar, R., and Iyer, K. (2009). Technology transfer for rural housing: An Interpretive Structural Modeling approach. *Journal of Advances in Management Research*, 6(2):188–205.

Magedanz, T. and Simes, J. (2009). What happens when you mix social networks, contexts and mobile advertising in the same glass? *International Journal of Mobile Marketing*, 4(2):52–60.

Medhi, I., Patnaik, S., Brunskill, E., Gautama, S. N., Thies, W., and Toyama, K. (2011). Designing mobile interfaces for novice and low-literacy users. *ACM Transactions on Computer Human Interaction*, 18(1):2:1–2:28.

Mistry, P. (2007). Digital user interface for inputting indic scripts. US Patent App. 11/437,463.

Napoleon, A. E. and Bhuiyan, M. S. H. (2014). Contemporary research on mobile government. In *mGovWorld*. Accessed on 19 June 2014.

Nikou, S. and Bouwman, H. (2013). Ubiquitous use of mobile social network services. *Telematics and Informatics*, 31(3):422 – 433.

Nikou, S. and Mezei, J. (2013). Evaluation of mobile services and substantial adoption factors with Analytic Hierarchy Process (AHP) . *Telecommunications Policy*, 37(10):915 – 929.

NTP (2012). National Telecom Policy. Technical report, Telecom Regulatory Authority of India.

Pallis, G. (2010). Cloud computing: The new frontier of internet computing. *Internet Computing, IEEE*, 14(5):70 –73.

Pruthi, P., Dutta, A., Amogh, N., and Kalle, R. K. (2013). Convergence through next generation cloud and service oriented networks in the indian scenario. *Journal of ICT Standardization*, 1:187–204.

Raj, T., Shankar, R., and Suhaib, M. (2008). An ISM approach for modelling the enablers of flexible manufacturing system: The case for India. *International Journal of Production Research*, 46(24):6883–6912.

Ramesh, A., Banwet, D. K., and Shankar, R. (2010). Modeling the barriers of supply chain. *Journal of Modelling in Management*, 5(2):176–193.

Ratti, C., Pulselli, R. M., Williams, S., and Frenchman, D. (2006). Mobile landscapes: using location data from cell phones for urban analysis. *Environment and Planning B: Planning and Design*, 33(5):727 748.

Ray, P. and Ray, S. (2010). Resource-constrained innovation for emerging economies: The case of the Indian telecommunications industry. *IEEE Transactions on Engineering Management*, 57(1):144 –156.

Sage, A. (1977). *Interpretive Structural Modeling: Methodology for Large-scale Systems*. McGraw-Hill, New York.

Saxena, J. P., Sushil, and Vrat, P. (2006). *Policy and Strategy formulation-An Application of Flexible Systems Methodology*. GIFT Publishing, Delhi.

Sharma, S., Terence, A. S., and Shin, J. (1995). Consumer ethnocentrism: A test of antecedents and moderators. *Journal of the Academy of Marketing Science*, 23(1):26–37.

Singh, R. K., Garg, S. K., Deshmukh, S., and Kumar, M. (2007). Modelling of critical success factors for implementation of AMTs. *Journal of Modelling in Management*, 2(3):232 – 250.

Spohrer, J., Maglio, P., Bailey, J., and Gruhl, D. (2007). Steps toward a science of service systems. *Computer*, 40(1):71–77.

Telecom-Snapshot (2013). Mediatek based 4G smartphones to launch in India starting 2014; company partners with domestic smartphone makers. *Telecom Snapshot*, page 7.

TRAI (2014). Telecom subscription data [press release no. 09/2014]. Technical report, Telecom Regulatory Authority of India. Accessed on March 1, 2014.

Varma, N. and Sharma, S. (2011). Game analysis of price competition among telecommunications operators in India. *Journal of Telecommunications Management*, 3(4):352 – 359.

Verkasalo, H., Lòpez-Nicolàs, C., Molina-Castillo, F. J., and Bouwman, H. (2010). Analysis of users and non-users of smartphone applications. *Telematics and Informatics*, 27:242–255.

Warfield, J. (1974). Developing interconnection matrices in structural modeling. *IEEE Transactions on Systems, Man and Cybernetics*, 4:81–87.

Yang, K. and Laura, J. (2006). Value-added mobile data services: The antecedent effects of consumer value on using mobile data services. *International Journal of Mobile Marketing*, 1(2):11–17.

Yelmo, J., del Alamo, J., Trapero, R., Falcarm, P., Yi, J., Cairo, B., and Baladron', C. (2008). A user-centric service creation approach for next generation networks. In *First ITU-T Kaleidoscope Academic Conference on Innovations in NGN: Future Network and Services (K-INGN)*, pages 211–218.

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