Mobile Information Service and Its Architectural Design for Rural Development

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Abstract – Implementing successful rural computing applications requires tending to various significant challenges. Late advances in mobile phone computing capabilities make this gadget a possible contender to address the customer equipment requirements. Long battery life, wireless connectivity, strong state memory, low cost and quick utility all improve it suited to rustic conditions than a PC. In any case, current mobile software stages are not as fitting. Electronic mobile applications are difficult to utilize, don't exploit the mobile phone's media capabilities and require an online association. Custom mobile applications are hard to create and convey. To address these impediments we exhibit CAM - another system for creating and sending mobile computing applications in the country creating world. CAM applications are gotten to by catching standardized identifications utilizing the mobile phone camera, or entering numeric strings with the keypad. Supporting negligible route, guide linkage to paper hones and disconnected multi-media communication, CAM is interestingly adjusted to provincial gadget, client and framework requirements. To show the broadness of the system, we list various CAM-based applications that we have actualized or are arranging. These incorporate preparing miniaturized scale back advances, encouraging provincial supply chains, recording grassroots development and getting to electronic medical histories.

Keywords: Mobile Computing, Mobile Phones, Paper User Interface, Rural Development, ICT, Client-Server Distributed Systems.

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INTRODUCTION

Providing timely and productive information services in rural areas of the developing world is a troublesome errand. Current data practices are overwhelmingly paper and memory based. This forces extreme restrictions on the collection and spread of data. In any case, because of natural and client limitations, the acquaintance of registering with robotize this procedure is similarly challenging. Most rural villages in the developing world don't have the economy or foundation required to bolster a PC. Hence, rural people must go to bigger towns or urban communities to get to advanced assets, either in an open place or through a middle person. Given the state of rural roads, and the irregularity of open transportation, this requires critical time and motivation. (Belotti *et. al.,* 2008). Otherwise they should sit tight for somebody to acquire assets to them a medium that they can get to. In either case, the idleness is high and the access is limited.

The newest mobile handsets developed by a few producers give an open application advancement stage and noteworthy computing capabilities (Brewer *et. al.,* 2009. Lam and Baudisch, 2010. McCune *et. al.,* 2005. Parikh, 2009). Given the ubiquity of these gadgets with creating world populaces, and the quick utility of voice correspondences, these "cell phones" are a chance to bootstrap processing in the creating scene. They are little, handheld PCs with a few imperatives and extra components. A few of these (battery operation, strong state memory, wireless connectivity, reasonable cost) could improve them a suited gadget for provincial creating world conditions than an ordinary PC.

In earlier work, we presented the thought of processing paper documents with a camera-prepared mobile phone (Parikh *et. al.,* 2009. Pentland *et. al.,* 2010. Rohs, 2005), and formally assessed the ease of use of a prototype system with rural users (Rutherford, 2009). Here we broaden this work in a few particular ways. We give a point by point depiction of the CAM framework engineering, including another numeric route interface and offbeat networking approach. We talk about the particular qualities of the rural developing world environment that have driven the outline decisions we have made. We layout the benefits of our framework contrasted with different stages for rural computing. To outline the broadness of the system, we list various CAM-based applications that we have actualized or are thinking about. We trust this depiction will be valuable for other researchers developing rural computing frameworks, or are occupied with utilizing CAM for their own applications.

LIMITATIONS OF CURRENT MOBILE APPLICATION PLATFORMS:

Mobile phones appear like an astounding approach to acquaint information technology with the rural developing world. Their ease, long battery life and prompt utility specifically address a few of these challenges. Besides, on the grounds that they are convenient, they can be conveyed forward and backward amongst associated and disengaged areas, shipping information forward and backward (Toye *et. al.,* 2010). While as yet requiring travel, now one gadget and one individual can play out this undertaking in the interest of a villager region. Field operators conveying cell phones can offer an assortment of administrations to rural residents. Wireless infrastructure exists in practically every nation, making this approach sufficiently adaptable to send anyplace. Be that as it may, while mobile phone hardware is appropriate to rural conditions, the same can't be said in regards to programming. Mobile web interfaces are famously difficult to utilize, notwithstanding for developed world users. Typing URLs with a numeric keypad is moderate and excruciating. In this manner, clients must depend on an entry or set of bookmarks to get to sites. Most site pages are intended for bigger screens, making route inside a page additionally hazardous. Connection depends on an obliged interpretation of the WIMP representation that is unbalanced, best case scenario. Mobile phones additionally don't give any approach to work with web content without a dynamic association. Also, most online applications don't exploit the inherent elements of mobile phones, similar to a mouthpiece, speakers or even a camera.

Developing custom applications for mobile phones is turning out to be more normal. Be that as it may, this requires information of new APIs (some of which require costly authorizing). Dispersing applications is unwieldy. Either suppliers must push substance to clients, or clients must explore to sites and download thesoftware. Because of the trouble of utilizing mobile web browsers the most effortless way is frequently to utilize a PC to download the installer and afterward exchange it to the telephone using Bluetooth or USB.

CHALLENGES:

Rural areas in the developing world represent a number of challenges for sending computing technologies. In this segment we talk about some of these challenges. While the vast majority of these perceptions were drawn from the creator's encounters in rural India, they are characteristic of comparative conditions existing in other creating areas around the globe. Energy about these challenges is critical to planning reasonable system architecture.

➢ **User Challenges:**

1. **Limited Education:** The low quality of schools in rural areas, and the demands of agricultural work, often forces children to abandon schooling at an early age. Those that do succeed in attaining a high school or college education seek employment in the city, where salaries are considerably higher. Less educated people have difficulty with abstraction and symbolic manipulation. Many rural people, especially those in older generations, may be illiterate. If they are literate, it is almost definitely in the vernacular.

However, predicting that computing technologies will directly be used by illiterate or semi-literate people is sometimes a naive assumption. Many villages have an educated, literate member that they rely on for performing tasks be-yond their individual capacity. At the same time, it is important that the illiterate person understand the process, so that they can safeguard their personal interests (for example, when performing financial transactions).

2. **Limited Disposable Income:** Almost all of poor people’s income goes towards their livelihood and social requirements (Wang *et. a.,* 2004). Very little money is left for leisure or exploratory purchases. Given the dramatic difference in income and expenditure levels between cities and villages, electronic devices must be shared to even be within reach for most rural populations. A new system or technology must fulfill an immediately perceived need to be relevant in this context.

➢ **Environmental Challenges:**

1. **Intermittent Power:** The power grid in the developing world is notoriously unpredictable. Both spikes and outages are common. There is load-shedding in both cities and rural areas (scheduled power outages to conserve energy). While the authors have often enjoyed power outages as an opportunity for a restful nap or a stroll along a

village road, the repercussions are not always so pleasant. A trail of fried laptop batteries and hard disks attests to this fact. A battery-powered uninterruptible power supply (UPS) is a necessity for any PC in the developing world. This creates an additional expense that consumers are reluctant to bear. Even for laptops and mobile phones, a surge protector helps to maintain the life of the battery and AC power supply.

2. **Long Travel Times:** The quality of roads is generally poor in rural areas, increasing driving times considerably. Public transportation, while ubiquitous in many countries, is also delay-prone. Several transfers may be required to travel from one place to another. Travel is incredibly time-consuming, often taking an order of magnitude more time than in the developed world.

3. **Intermittent Connectivity:** As opposed to the temporally intermittent nature of power, connectivity is spatially intermittent. Landlines are prohibitively expensive to extend to villages with a limited revenue base. Even if a village is connected, it is probably only with low-quality copper wire. The local phone exchanges may use outdated equipment that hinders digital communications. Internet connections established over these links are slow and frequently disconnected. Cellular penetration is growing, but thus far wireless towers are concentrated near cities, large towns and major roads. It is possible that novel wireless technologies will eventually make connectivity more accessible, but differing topographies and population densities means that some percentage of the world's population will never be within arm's reach of a connected device.

4. **Variable Population Density:** One factor that varies greatly from country to country and continent to continent is population density. To note two extremes, in Bangladesh the density is over 1000 people per square kilometer, while in some parts of Central and Indian it is less than 10. This greatly impacts the economics of providing information access - in countries with less density the same physical infrastructure will serve fewer people, and have a correspondingly smaller revenue base. Infrastructure technologies must be cheap and flexible enough to serve all possible conditions, or different solutions will be required for different areas.

CAM ARCHITECTURE:

In this section we present CAM, a mobile phone application platform that addresses these software limitations. By supporting minimal, paper-based navigation, a simple scripted programming model and off-line multi-media interaction, CAM provides a platform uniquely adapted to rural computing requirements.

SYSTEM OVERVIEW:

The driving element of the CAM design is a mobile phone application called the CAM Browser. CAM Browser has been executed for a few Nokia phone models in view of the Series 60 stage (Yin and Zhai, 2009). (We expect to port this application to different mobile platforms in the future.) Users explore inside and between CAM applications by catching scanner tags utilizing the mobile phone's inherent camera, or by entering numeric strings. These scanner tags and numbers can be printed specifically on paper forms for prepared get to (see Figure 1). Frames based information section is to a great degree basic in the developing world. CAM Form analogs of existing paper structures fill in as effective disconnected customers for CAM applications. Data is initially entered on paper, from where it is interpreted, handled and transferred utilizing the CAM Browser. Information exchange can happen either quickly or later when the phone has an association. The CAM Browser downloads and executes applications written in Simkin, a XML-based scripting dialect including support for capacity calls, control stream, number-crunching and fundamental datatypes [10]. CAM gives an API to getting to the mobile phone's UI, systems administration and interactive media info and yield capacities. Applications are downloaded on request from an online source, either by means of the web or a multimedia message (MMS). The XML is stored locally on the phone along with its related parallel information, in an index structure composed by the server and application ID. In the accompanying segments we depict the subtle elements of the CAM design, including its route, content improvement and networking features, and talk about how each of these locations the rural developing scene's computing requirements.

NAVIGATION:

In an earlier design test, we watched the route challenges experienced by semi-proficient rural users when utilizing a conventional PC interface. These problems can be exacerbated by the restricted show and information capacities of a mobile phone. Regardless of the possibility that clients are educated, customary menu-based route is confused, particularly on a mobile phone, requiring noteworthy time to comprehend and pass on. Additionally, in a menu-based framework, just a set number of choices can be gotten to at one time. Other researchers have noticed the trouble of hierarchical navigation for rural users [3]. Entering a URL in English utilizing a numeric keypad is totally implausible for these clients. To dodge the impediments of standard route strategies, we have adopted an alternate strategy. Applications and application capacities are listed utilizing numeric strings, encoded either as standardized identifications to be caught through the mobile phone camera, or as numbers to be entered by means of the keypad. Both scanner tags and numbers can be imprinted on paper frames. Along these lines route is specifically attached to a paper representation of the undertaking. The paper frame additionally fills in as a neighborhood record of the activity if a printer is not available.

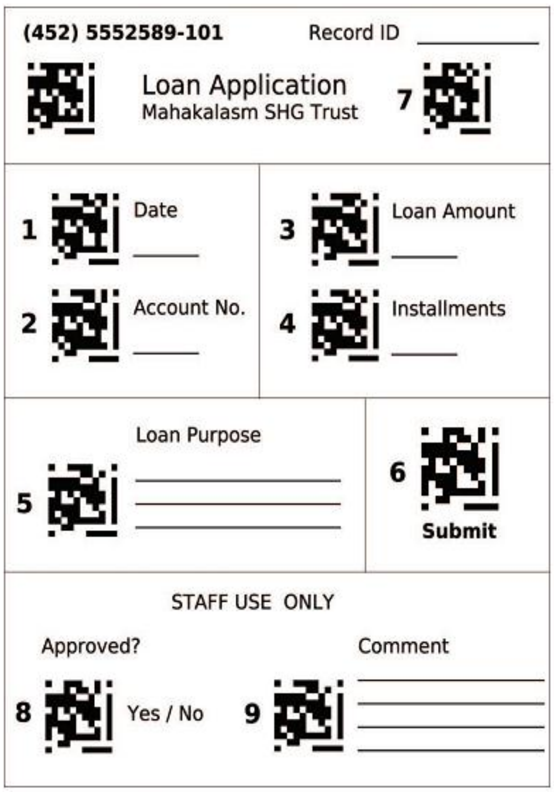

Figure 1: An example CAM Form, for submitting a microfinance loan application.

For barcode acknowledgment and era, we are utilizing the open source toolkit developed. This incorporates a 2D barcode recognition library for Nokia Series 60 phones. A client can catch a scanner tag by taking a photo of it utilizing the mobile phone camera. Each standardized tag contains 83 bits of information, 7 of which are being utilized for blunder adjustment (leaving 76 bits of powerful information conveying limit). A few scanner tags can be recognized from a solitary camera image. To explore to a new application, the client catches a standardized tag in the upper left corner of a CAM Form (see Figure 1). This scanner tag has its initial two bits set to 0. The following two bits speak to the convention to be utilized for downloading the code and information (at present either HTTP or SMS), and the following 48 bits encode the address (either an IP address or a SMS phone number). The last 24 bits specify a server-particular application list. Application code and information is asked for from the server and stored locally on the phone for disconnected get to (this will be talked about in the networking section). A similar application can be gotten to by entering a numeric string utilizing the phone keypad. This is helpful for mobile phones without a camera, or for applications that don't have a related paper representation. The numeric string can be organized like a phone number, giving a natural representation to rural users. An application is "dialed" by first entering a subjective length phone number (or 12-digitIPaddress) for the server, a "*" delimiter (two for an IP address), and after that a server-particular application ID. On the off chance that the address or phone number is excluded, it is dealt with like a local application (the likeness getting to neighborhood have in a web browser).

Content: Users navigate inside an application in a comparative way. The capacities traded by each application are indicated as components in a XML document, written in the Simk in scripting dialect. Scanner tags with the initial two bits set to 1 allude to application functions. The following 8 bits specify an application particular capacity ID (each application can send out up to 256 unique functions). Whatever is left of the bits in the scanner tag is sent to the capacity as a static parameter. Utilizing the keypad, capacities are gotten to by entering only the numeric function ID. Parameters can be indicated utilizing a discretionary "#" delimiter. This string can be linked toward the finish of the application string depicted in the past segment, isolated by another "#" delimiter. This makes a one of a kind numeric URL that can be utilized to recollect and share references to subjective application functions. Table 1 details the standardized tag and numeric keypad inputs used to get to different CAM applications and functions. If an application is connected to a structures based process, the scanner tags and IDs for capacities can likewise be imprinted on structures for relevant get to. These Cam Forms are outlined utilizing standard word processing software. Scanner tags are produced utilizing a PHP script, and glued into the structures physically. We are as of now planning an IDE that will bolster coordinated creating of CAM structures and applications. Figure 1 demonstrates a CAM-empowered advance application intended for a microfinance establishment. The standardized tag in the upper right, when clicked, initiates a capacity that shows a succession of prompts for the client to enter each of the qualities from the frame. An area of the code for this capacity is demonstrated as follows. Input date, conf note, record sound and put are all CAM API capacities. A full rundown of API capacities is given in Table 2.

```
<function name="7_click" params="param1">
if (!input_date(date, "dprompt.wav", "dprompt.bmp"))
    return false;
...
if (!conf_note("purpprompt.wav", "purpprompt.bmp"))
    return false;
recordaudio("data\".recordid."\purp.wav");
if (!conf_note("cprompt.wav", "cprompt.bmp"))
    return false;
put("mms","+12065551695","data\".recordid."\");
</function>
```

The prompts are shown in grouping as opposed to lie out spatially (like in an electronic entry form). This is more qualified to the small screen of the mobile device, on which it is hard to show or enter a few snippets of data at one time. We call this "wizard" connection, as it looks like the undertaking wizards utilized for introducing or arranging software applications. Clients are guided stride savvy through the process, lessening route necessities. This strategy dodges "choice focuses", where the client needs to psychologically stop after each activity to choose what to do next, and how to do it. This respite can make superfluous disarray for learner clients. Rather, in our system, clients simply pick an abnormal state undertaking and then follow the prompts.

Figure 2: On the left, reviewing an entered value by focusing on a barcode. On the right, clicking brings up a prompt for editing the value. An audio prompt is also played.

Figure 2 shows a CAM prompt in the provincial Tamil dialect. Be that as it may, the mobile phone working framework does not bolster Tamil data entry or show. The content is shown as a bitmapped picture, joined by a voice cut demonstrating the name of the field. Each CAM prompt can be related with arbitrary audio and graphics. This builds the adaptability of the framework, particularly to deal with unsupported dialects or uneducated clients. Regardless of the possibility that another person is playing out the errand, an ignorant client can tune in and hear the prompts as information is being entered. The sound input adds to the wizard allegory, making the connection continue like a discussion between the client and the gadget. The gadget poses a question, and the client answers. When we tried a CAM application in rural India, a few clients didn't take a gander at the screen provoke before entering esteem. To address the problem of nearby dialect printed input, we adopted an alternate strategy. The vast majority of the qualities to be entered from the frame in Figure 1 are numeric values. Rather than requesting the advance candidate's name or login, we depend on a numeric account number. The credit intention is caught by recording a sound clasp. We could have additionally provoked the client to catch an image of the whole shape, or a particular passage field. In the event that required, voice and image data can be translated later at the bank office, where a PC is accessible, to be performed by staff prepared in nearby dialect keyboard input. We can allude back to these translated records utilizing a numeric identifier, as we did with the account number.

Table 1: Barcode and numeric inputs for accessing CAM applications and functions

Application	
Barcode	00-Protocol(3 bits)-Addr(38)-AppID(24)
Numeric	[Addr-*]-AppID-[FuncID[#Param]]
Function	
Barcode	11-FuncID(8 bits)-Param(66)
Numeric	FuncID[#Param]

Table 2: Functions provided by the CAM API. All prompts and messages can be accompanied by arbitrary audio and/or images.

input_int, input_date, input_password, input_pin, input_phone_number, input_time, input_number, input_text	Prompts asking the user to enter different kinds of values
record_audio, take_picture	Ask the user to record an audio clip, or take a picture of a form or other object
message_note, conf_note	Send a message to the user, or display a confirmation dialog
get, put	Retrieve or submit application data to the server using using http, sms or mms
encrypt, decrypt	Encrypt or decrypt application data with a specified key
sms, mms, email	Send arbitrary messages
phonecall, browser	Make a phone call or launch a web browser
log	Write a string to the application log

After data has been entered, the client can audit the entered values before submitting them to the server. By centering the mobile phone camera on a standardized tag related with a shape field, the present esteem is shown on the screen, alongside the esteem entered on paper (see Figure 2). By concentrating on the advance reason field, the recorded sound clasp is played. In the event that any of the qualities is off base, the client can catch an image of that standardized tag, showing an insight to alter the esteem. The execution is the same as that for different capacities. Each scanner tag is connected to separate output and snap callback capacities. Whenever checked, the esteem returned by the sweep callback is shown. This is the estimation of the field. Whenever clicked, a provoke is shown to alter the esteem. Case outputs and snap callback functions are shown below.

```
<function name="1_scan">
return date;
</function>

<function name="1_click">
input_date(date, "dprompt.wav", "dprompt.bmp");
</function>
```

Networking: The first time CAM Browser experiences an application, it endeavors to download the code and data from the predefined server. The scanner tag or numeric string indicates the protocol to present the demand. At present, the alternatives are sending a HTTP asks for to a web server, or a SMS to a phone number. In the principal case, the reaction is gotten instantly as XML over HTTP. In the second case, the application code and data is sent by the server as a MMS message with a SIS connection. A SIS document is a self-extricating installer for the Series60platform.

Figure 3: An example set of steps in accessing and using a CAM application. Except for steps 4-5, there can be arbitrary time and distance between each step, supporting an offline, asynchronous interaction model appropriate for rural areas.

The SMS-based method supports offline use. The first run through a detached telephone tries to get to an application, it won't not be accessible. When the browser sees the shape, it makes a SMS ask for, which is stored in the phone's active message queue. The message will consequently be sent when the phone enters an associated region. After the SMS is gotten by the server, it sends back the suitable SIS document to the sender as a message attachment. The phone will consequently download the message on the off chance that it is associated. At the point when the client opens the message, they will be guided to introduce the application in the best possible area. The entire code for the application is then stored on the telephone for offline use. Whenever the phone returns to the village, the application can be utilized. Inevitably a few applications may must be flushed from the store to prepare for others. By executing a savvy reserving plan, we can guarantee that the most much of the time utilized applications are held. This has not been a necessity up to this point due to the small number of CAM applications that have been developed. All of these effectively fit inside the accessible blaze memory of the phone (32 MB, expandable to 1 GB). The client can likewise physically ask for a flush of the neighborhood store, or constrain a server revive of a particular application. The CAM API bolsters sending a revive demand to the server automatically. Application data is additionally reserved locally. Caught information qualities are put away as XML, while recorded sound and images are put away as twofold documents. This information is put away in a particular index for each application. Multiple records can be honed by further sub-separating this registry utilizing a special numeric ID for each record case. This record ID can be imprinted on a shape (either as a numeric string or standardized identification), or naturally created and showed when first sparing the data. The client can duplicate the produced ID back to the frame for future reference (for instance, in the upper right of Figure 1). Afterward, the client can audit or alter already entered records by entering the correct ID or standardized identification. The phone's memory fills in as a nearby reserve of the information put away on the server. The application can automatically duplicate the data for any registry from the phone to the server, and the other way around. This is expert utilizing the get and put capacities. For a put, the application sends information either as a HTTP POST ask for, or as a connection to a MMS message. At the end of the day, the MMS message is stored in the active line until an association is accessible. The application is in charge of picking the correct convention in view of its prerequisites, the setup of the server and the available connections.

ADVANTAGES OF CAMAPPLICATIONS:

In this section we outline some of the advantages of the CAM platform for developing rural computing applications.

- **Easy to Use -** CAM interaction is based on simple primitives that do not require knowledge of extended metaphors. Learning to use an application is as easy as taking pictures of barcodes, or entering numeric strings, and then following the prompts. The limitations of the smaller display and a numeric keypad dovetail nicely with this approach. During usability testing of a CAM application with microfinance field agents, we found that all users were able to use the system effectively with a few minutes practice.

- **Easy to Document -** This understanding is easily conveyed from person to person, without training or user manuals. In our testing, users explained the system to each other without any intervention. Being able to convey knowledge of how to use the system by word of mouth will allow CAM applications to scale virally and increase their impact correspondingly.

- **Easy to Bootstrap -** Due to the demand for voice communications, a mobile phone is much easier to introduce to rural areas than a more expensive and less immediately useful PC. Service providers can generate an initial revenue stream by offering calling services (Rutherford, 2009). Later, other applications can be bootstrapped as demand increases and network effects set in.

- **Can be used Offline -** CAM applications can be used without an active Internet connection. While this increases the latency of information exchange, it is still much better than having to make a trip to the city for each task individually. Users can also perform preliminary data entry on paper forms without having access to any technology, providing another level of offline access. This improves the efficiency and accessibility of the system, given the high person / device ratio,

- **Easy To Distribute -** Because most people will not have their own dedicated device, distributing electronic references to applications and data to individuals is not feasible. By referring to applications and data using paper forms and numeric strings, they can be distributed via both person-to-person and paper-based channels. These can be exchanged without any access to a device.

- **Localized without OS support -** Using audio and graphical input and output, a paper-based UI and a numeric index to applications and data, CAM applications can be localized even without OS-level support for the target language. Given the tremendous variety of languages and scripts in the developing world, and the difficulty of developing applications for languages not supported by the OS, this removes a tremendous practical obstacle to application development.

- **Tied to Paper Forms -** By linking CAM interaction to forms, the process becomes more familiar to users accustomed to paper-based tasks. Preliminary data entry can be done completely offline, without access to a phone. Query results can be sent as printed, possibly interactive reports. Given that one phone is probably being used for many tasks in many villages, this maximizes the efficient use of available time and resources. When the phone is available, data entry and review is done in the direct context of the paper form, reducing errors and increasing the trust of village users.

METHODOLOGY:

Mobile phones were circulated to the rural communities in Indian rural area. Deliberate activity research and process documentation were utilized as a part of this review to screen the utilization of various information and communication technologies. The methodologies encouraged correspondence and data stream between farmer institutions at different levels, (farmer groups, Indian rural area and district levels), amongst farmer institutions and the telecentres and between data sources and the telecentres or data centers. Data needs evaluation convention was utilized to distinguish farmers ‘information needs and tried with farmer groups in India. The convention was then used to gather data needs on agro-endeavor, agriculture NRM and markets.

RESULT & DISCUSSION:

Using telephones the limit of rural communities to get to ICTS in the review region was constructed. The use of mobile phone was found to benefit farmers in various regions. Most obvious zones are profitability, market access, characteristic asset administration and knowledgebase.

Gender factor on use of Indian level (VICE) mobile phones: The following activity empowered to discover who has been utilizing the phones and for what reason in the Indian rural area. The outcomes are exhibited in Figures 4. The general sex examination of telephone use demonstrated that more male farmers (59.3%) made utilization of the telephone than female agriculturists (40.7%) (Figure 4). Comparative discoveries were accounted for in India that ladies had 36% less ICT-related open doors and benefits than men.

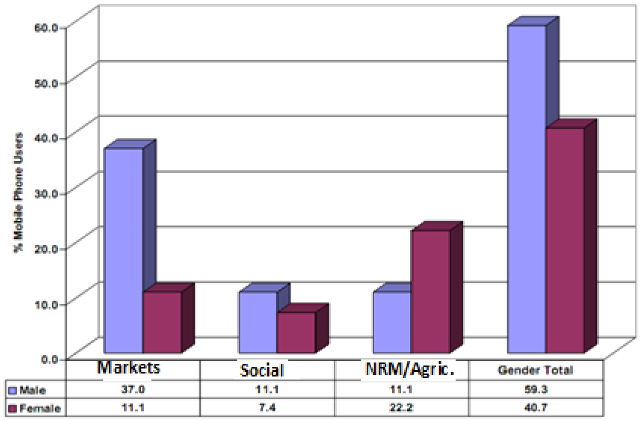

Figure 4: General Use of the Mobile Phone across the Indian rural area

The analysis of gender in the usage of phones across the India indicate that more male farmers made use of the phones in two India (Markets – 76.9% and Rural area - 60.0%) while more female farmers (66.7%) made use of the telephone in Indian rural area (Figure 5).

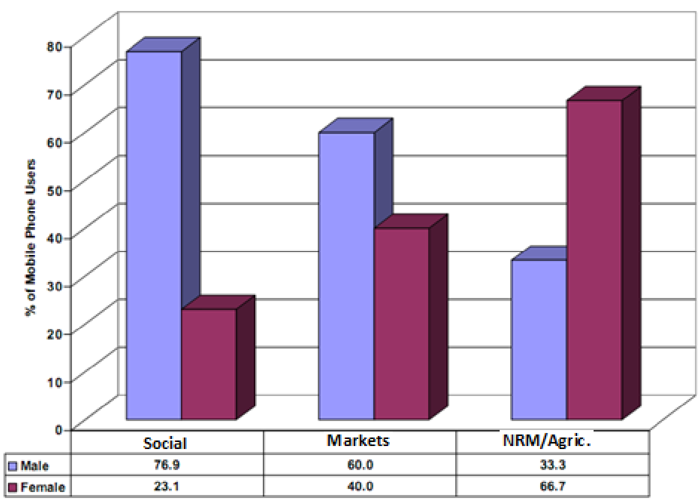

Figure 5: Mobile Phone Usage by Indian rural area

CONCLUSION:

In this paper we have introduced CAM: mobile information benefit design for the rural developing world. Not being obliged by an introduced application base or previous suspicions about the conveyance of electronic administrations, we have begun from first standards to develop an architecture that is exceptionally suited to rural device, client and framework limitations. We are right now outlining, developing and conveying a number of applications utilizing CAM. CAM has been driven from the earliest starting point by the requests of real applications, and we expect the advancement of the framework to occur by similar means. For that and different reasons we plan to discharge the CAM Browser application under an open source permit, so that the framework can benefit from the commitments of different scientists and developers around the Indian rural area.

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