

TECHNICAL CHALLENGES WITH ADOPTION OF IOT IN IMPLEMENTATION OF SMART CITIES IN NEPAL

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Abstract

The Internet of Things (IoT) is one of the most used components that are used for the development of infrastructures of big cities today. The IoT has helped many cities to improve the quality of life of the people living in those cities with the smart facilities like smart health, smart parking and smart transportation etc. The IoT and its use has not been limited to making cities smart, rather IoT has been part of many households recently. We can see innovative smart houses with automated water pulling pump, heating system, lights and other components that are operated by sensors. Smart cities ideas have flourished for long time and has been a pivotal component in defining the complexity of services in many cities around the world. Smart cities include automates service delivery with help of Artificial Intelligence (AI), Internet of Things (IoT), and Big Data Analytics. Government is realizing the importance of developing smart cities. Nepal Government has designed a framework that will be used as a base in digitization of government service delivery.

The concept is new and the technologies used for the implementation are latest state-of-the-art technologies that are not easily available in the low-income generating countries like Nepal. The challenges that were discussed during the research included the reluctant population when it comes to using smart devices and services. Nepal still lacks enough technological infrastructures that are required for proper implementation of smart city model. Uninterrupted electricity and high-speed internet connection are must for operating the services of smart city. In Nepal, we still face unscheduled power cuts and interruption in the internet service.

All the cities that are planning to implement smart cities can start their transformation with the basics like e-literacy for all the citizens of the city. There is possibility of extending the 5G service for high-speed internet service. People must be made aware about the available e-services from the government offices. Apart from the technological barrier, the local bodies can work on improving the service delivery with Big Data Analytics. The data collected from the IoT devices can be analyzed to better understand the situation and used for improving the service delivery. The smart city implementation can be smooth only when the discussed barriers are addressed properly and in time.

Keywords: IoT, Smart Cites, Big Data Analytics, Internet, Connectivity

1 INTRODUCTION

Smart city can be defined as a concept that transforms the urban areas keeping in consideration the environment sustainability and provide quality life and possibility for economic growth for its citizens (Toli & Murtagh, 2020). We can find several definitions of smart cities which are diverse and the diversity ranges from the required elements to resources to be deployed to make any city smart. The term smart city is being used increasingly in recent years but with diverse scope in the definition of smart cities can create confusion among the policymakers, and related stakeholders. This is why it is important to have well defined framework for the transition to smart cities. The transition is deemed important by the policymakers and has been reflected as a part of 11th UN Sustainable Development Goal (SDG) with an aim to establish smart cities that are inclusive, resilient, safe and sustainable (UN, 2018).

Internet of Things (IoT) is a new shift in the paradigm which has drastically changed the way of living from traditional approach to state-of-the-art style. The components like smart home appliances, smart parking, smart waste management, energy saving devices have helped the transformation of

the cities and the citizens. The achievement from the IoT in recent years have been able to draw attention from numerous researchers and has been hot topic for discussion. The researchers and developers have worked together in expanding the available technologies for the benefit of the people and making their life easy (Sachin, et al., 2019).

In context of Nepal, the IoT devices and their connectivity might come ahead as a major challenge. We have very interruptive electricity supply, mostly during the winter which is another major challenge in terms of using IoT devices. Policy makers must think about such issues while making the framework for smart cities and Digital Nepal. The positive step has been initiated by Nepal Government by releasing the Digital Nepal Framework 2019. This can be the blueprint for the digital Nepal movement and all the local bodies who are eager to transform into smart cities can utilize this framework.

1.1 Internet of Things (IoT), its history and evolution

The term Internet of Things was first used back in the year 1999 by Kevin Ashton. Although the concept was coined back in 1970's with some other names like pervasive computing or embedded internet the history of IoT is not so old (Lueth, 2014). The term has been in use excessively in recent years with the increased number of smart city transformation. The technology gives us the sense of being smart and helps us make our life easy and accessible. There are several advantages of using the IoT devices in our daily life (Talari, et al., 2017). The reason for increasing use of IoT devices are the features that have enabled us to live our life with ease. In the beginning the IoT concept was more focused on the embedded system where several devices were combined together to make a system that can process faster. The concept began popular during the summer of 2010. This was when the Chinese Government declared to make IoT a part of its strategic priority and include it in their Five-Year Plan.

1.2 Ethical issues, challenges

There were ethical issues that needs to considered as the research conducted had sample and subject matter that might require written consent before being part of research. Some of the respondents were from government offices, who were provided with the written consent and a briefing letter. The letter had the significance of the research being conducted. The option of withdrawal from the survey was provided to the sample and a debriefing letter was handed over. The letter stated that the participation was voluntary and they had chance to withdraw from the survey at any time they wished. The participants were made aware about the confidentiality and the objective of the research was explained to them. They were assured that their responses will be used for the academic purpose only and this research specifically. No physical or psychological harm was done to the participants. All the appropriate manners were followed during the online survey, research and interview.

1.3 Research Questions

The questions included in the research study which are to be answered by the local government, relevant stakeholders, vendors and citizens are as follow:

- RQ1. What are the technological challenges in using IoT devices for implementing smart cities in Nepal?
- RQ2. What is the current state of technological infrastructure, IoT Devices, Internet services in major cities of Nepal?
- RQ3. How can the captured data is being analyzed and how relevant can the big data analytics be in providing feasible solution for the citizens of the city?

1.4 Objectives

The specific objectives of this study for answering the research questions are listed below:

- To investigate the challenges that are existent in the implementation of smart city development.
- To determine the present state of technological infrastructure in Nepal that includes the state of IoT devices and the internet service quality.

- To figure out the importance of big data analytics in context of Nepal and how can smart cities benefit from the use of big data.

1.5 Scope and significance of research

The research is focused on discovering any technical issues that implementing bodies might face in transforming their city into smart city. The research is particularly keen in finding the technical issues associated with the use of Internet of Things (IoT) and what precautions other cities implementing similar projects need to take in future. The researcher aims at covering the 13 smart cities proposed by the Nepal Government and in particular the 4 smart cities in Kathmandu Valley (Arjun & Sudhamshu, 2019). The municipalities and Metropolitan cities around Kathmandu that have implemented the smart city projects or are currently implementing will be part of the research. The scope of this research will be limited to finding the technical challenges along with the opportunities that come along while implementing the smart city concept. The big data analytics and its use for the better service delivery will be discussed briefly by the paper.

The study done for the research is specific to context of Nepal and can be referenced for other similar developing economy as well. This study can be used by the stake holders involved in the implementation of the Digital Nepal Framework which is considered to be the backbone of the digitization in Nepal. Other areas that can benefit from the research can be:

- Any researcher who has keen interest in IoT implementation in building smart cities can benefit from the paper.
- The stake holders in the local bodies of Nepal like the member of ward committee, vendors dealing with technology, and other concerned people can use this paper to understand the potential challenge they might face while implementing the smart city initiative in their city.
- The government bodies can use the paper to understand the role of Big Data in providing better service delivery and improving their services.

1.6 Limitations of the study

The dissertation does have certain limitations like any other research:

- The sample size is small due to the pandemic situation the number of interviewers were limited.
- Although the research aims to study the overall situation of Nepal, not all the stake holders could be involved in the survey
- People might have been missed out in the sampling as some of them remain out of focus although they have huge contribution
- Government employee may not provide all the details
- Very little research papers are available that have studied the research subject in Nepal's perspective.

2 LITERATURE REVIEW

The term Internet of Things was first used back in the year 1999 by Kevin Ashton. Although the concept was coined back in 1970's with some other names like pervasive computing or embedded internet the history of IoT is not so old (Lueth, 2014). The term has been in use excessively in recent years with the increased number of smart city transformation. The technology gives us the sense of being smart and helps us make our life easy and accessible. There are several advantages of using the IoT devices in our daily life (Talari, et al., 2017). The reason for increasing use of IoT devices are the features that have enabled us to live our life with ease. In the beginning the IoT concept was more focused on the embedded system where several devices were combined together to make a system that can process faster. The concept began popular during the summer of 2010. This was when the Chinese Government declared to make IoT a part of its strategic priority and include it in their Five-Year Plan.

We can see that the IoT started to gain the notice of the researchers after 2010, each year there has been some global events that were IoT focused. The concept was still a proposal during its early stage when even Google would return the search for IoT as "a proposed development". The

proposed development is now real and its happening. The credit of this development can be given to number of researchers who have been working rigorously for betterment of people's life. During the expansion of IoT, there are another contradicting concept that came in the horizon as well. (Mobo, 2018) in his article discuss on how the human life has become gadget centric and explains the way our day gets started with gazing into our mobile phones and ending our day still scrolling the screen of phone, tablets etc.

The impact of gadgets and IoT devices is huge in today's life. It is in our hand to use them in right way or make our life miserable with complete dependency on them. There are always two sides of the coin. The way IoT has emerged and become one of the leaders in IT industry, we can say that it is vital part of human life already. We can use it in the proper manner to make our life easy, there are several examples of IoT devices helping us. We can close the water pump with one click in our smart phone when we get the alert from home that our water tank is full. We can even monitor our house and its surrounding when out of the town in our devices. These are some positive impact IoT has made in our life since its evolution (Hammi, et al., 2017).

There was a prediction made based on several industry report that assumed more than 70 billion devices to be connected by 2020 (Ray, et al., 2016). Looking at the past when it all started in 2010, no one would have imagined IoT to leapfrog in the industry so quick. This is the impact it has made in our daily life that within a decade of its invention we cannot imagine our day-to-day life without IoT and its devices. The paper further elaborates on the evolution of IoT and how it has affected every aspects of our life including our personal activities to our business and health. (Ray, et al., 2016) have analyzed on how the IoT have evolved to present condition and the paradigm shift in the field of technology has been achieved. The paper however misses on what are the negative impact that has happened due to the over dependence in IoT and its associated devices. There are critical aspects associated with over use of technology and this has not been addressed whatsoever. The paper looks at the challenges that IoT have to face during its expansion and discuss on the tradeoffs that are involved in the establishment of IoT regime.

3 RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This is not a research that is completely new but it can be said that the subject being researched is still new and requires comprehensive study in Nepal's context. We can find a number of research papers and journals covering the topic. The papers have concentrated mostly on the role of IoT in transforming any city into smart cities along with Big Data usage for better service delivery. The papers look for the technical challenges in adoption of IoT while building smart cities but for other cities and countries. The proposed research is somehow new for the country specific perspective but the research subject did exist already.

3.2 Research Strategy

The method used for this particular research is mixed method. This is the research methodology that uses the components from both qualitative and quantitative methodologies. The advantage of using the mixed method is it allows a complete data synergy compared to qualitative and quantitative separately. This method actually oriented in the social sciences but has expanded into other field of researches as well. There has been series of refinement to this approach in the past few years to make it best fit in the research of all domain (Wisdom & Creswel, 2013). The features of this method have been further explained by the paper as it utilizes data collection in both qualitative and quantitative method. This method of mixing both data have evolved after 1980 and have gained rapid popularity among researchers.

3.3 Research Method

In order to achieve the objective of the study, this research needs to be conducted with the help of mixed approach combining qualitative and quantitative research methodology. The study that comprises small sample size can best utilize the characteristics of qualitative research. The reason for this is the difficulty in measuring and quantifying the outcomes of the study. In qualitative

research the researcher can enjoy the freedom of describing the research subject and perform restriction free analysis of the subject. The research is not limited for use of qualitative research methodology only and it needs to consider the response from the participants of the survey along with the variety of response coming from the participants. The differences between qualitative and quantitative research methodology have been tabulated in the table below.

There are school of thoughts who critically evaluate the qualitative research methodology and believe the effectiveness of the research is completely dependent on the researcher's skillset. The judgement delivered by the researcher becomes the outcome of the research. The outcome is based on the interpretation made by the researcher based on his perception. The research methodology is deemed useful for sample size that are small and there are opinions that say the sentiment of the whole population may not be represented by this sample.

3.4 Research Approach

The method used for this particular research is mixed method. This is the research methodology that uses the components from both qualitative and quantitative methodologies. The advantage of using the mixed method is it allows a complete data synergy compared to qualitative and quantitative separately. This method actually oriented in the social sciences but has expanded into other field of researches as well. There has been series of refinement to this approach in the past few years to make it best fit in the research of all domain (Wisdom & Creswel, 2013). The features of this method have been further explained by the paper as it utilizes data collection in both qualitative and quantitative method. This method of mixing both data have evolved after 1980 and have gained rapid popularity among researchers.

3.5 Data collection method and tools for data collection

Mixed approach was used by the researcher to conduct the research. It was done by reviewing the papers from previous research and case studies from different cities were researched. Similarly, a number of municipality employees were interviewed and online survey was conducted. The aim of this study was to identify the gap and technical challenges associated with the use of IoT in smart city implementation. The benefit of having personal interview is the elimination of non-response problem and direct communication between researcher and interviewee. The unstructured interview gives an opportunity for both interviewer and interviewee the freedom to express without binding themselves in the limited domain. The risk with such interview is that the interview itself may get deviated from the research subject. This is where the researcher was aware about the situation and this was made sure that interview is conducted within subject domain.

Online survey form was used as the tool for the data collection of the research. The pandemic situation in Nepal still limits the movement of the people and there are restrictions imposed. The situation forced the researcher to use the MS Forms and design the structured questionnaire for data collection. The survey form was distributed among the related stake holders of local bodies including the IT department employees. The data analysis was conducted with statistical tool from IBM SPSS 64-bit edition Statistics Subscription.

3.6 Sample Selection

The research being conducted to figure out the technological challenges in smart cities adoption, required stakeholders from the local bodies to be part of the survey. Non-probability sampling technique was used a basis for selecting the sample and the sample were selected based on the knowledge they possessed and the expertise they had in the subject being researched. The sample population selected for the research did had connection with the IoT, smart cities and Big Data. These people are part of local government that is working in the transformation of the city into smart city. The implementation is under way somewhere and some are planning to initiate the movement. The sample population is somehow aware about the terminology like IoT, smart cities, Big data, connectivity, 5G etc.

The participants of this survey were selected from the authorities, bodies in and around Kathmandu valley where smart city was about to be implemented. Some of the key municipalities in Kathmandu Valley:

- Kathmandu Metropolitan
- Lalitpur Metropolitan
- Bhaktapur Municipality
- Budhanilkantha Municipality
- Kageshwori Manohara Municipality
- Tokha Municipality

Apart from the municipalities inside Kathmandu, some key municipalities outside Kathmandu will be selected for the online survey. Waling Municipality in Syangja District from Gandaki Province is considered to be the first smart municipality of Nepal. Nepal Government has planned to build 13 smart cities in the country, the researcher will be looking into these places as well. The survey questions were distributing online with the MS Forms link and offline in printed forms. A total of 400 questionnaire were distributed online and offline and a total of 213 response received.

3.7 Reliability and Validity

Online survey forms were used as the tool for data collection for this study. The questionnaire was distributed to the employees, stakeholders, vendors and other related people working in the transformation of the cities. Similarly, some offline interviews were conducted to figure out the exact information regarding the situation of IoT and smart cities implementation in Nepal. The researcher aimed at finding the status of technological infrastructures in the country and analyzing if these are enough for achieving the smart city transformation. The study was conducted using the reliable source for data collection and data validation has been carried out by the researcher.

The email addresses for the municipalities and other government offices were taken from reliable government websites. The interviewee was selected from the IT department of the municipality who could provide insights into the technological infrastructure of the local bodies. The academic papers used for the review were chosen from 2015 or later.

4 DATA ANALYSIS AND FINDINGS OF RESEARCH

4.1 Reliability test analysis (Cronbach’s Alpha Reliability Test)

Reliability Testing is done to see the reliability of the questions asked in the survey and determine if all the relevant questions are measuring the same variables. In this survey we are trying to determine the possibility of establishing smart city with the use of IoT devices. The survey also is looking for the better service delivery with big data analytics. So, the questions asked in the survey must be able to measure the variables like Smart city, IoT, Internet, Bid Data etc. The output given by the reliability testing determines the quality of the questions asked in survey. There is rule set by George and Mallery which states (Bhatnagar, et al., 2014): >.9 is excellent, >.8 is good, >.7 is acceptable, >.6 is questionable, >.5 is poor and <.5 is unacceptable.

In SPSS, this is called as Cronbach’s alpha reliability test and the value ranges between 0 to 1. We can say that the coefficient value if closer to 1, the internal consistency of the variables is greater. Below is the output of the Cronbach’s alpha test for the questions used in the survey.

Case Processing Summary

| | | N | % |
|-------|-----------------------|-----|-------|
| Cases | Valid | 210 | 98.6 |
| | Excluded ^a | 3 | 1.4 |
| | Total | 213 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

Figure 1 Case Processing Summary for Variable

Reliability Statistics

| Cronbach's Alpha | N of Items |
|------------------|------------|
| .712 | 26 |

Figure 2 Cronbach's Alpha Test Value

The output in the first figure (Figure 3) is the summary of the case processing while the second figure (Figure 4) is the reliability statistics. We can see that our coefficient value is .712 which as per the George and Malley rule means acceptable.

4.2 Concept of Smart City, IoT and Big Data

The summary table 4 illustrates the mean and standard deviation on the concepts of the variables being studied. The output from the above analysis shows that there are a greater number of smart device users (Mean 1.95). People choices are in sync with Urban Development when asked about focus for the city authorities with mean value close to 2 (Mean 1.88). People are aware about sharing their health condition to smart application (Mean 1.86).

Table 1 Summary of evaluations of concept

| Yes/No Questions for variables | Mean | Std. Deviation |
|---|------|----------------|
| Do you know about smart city? | 1.78 | 0.412 |
| Do you know about Internet of Things (IoT)? | 1.70 | 0.457 |
| Do you use smart devices, sensors, and other IoT devices in your day-to-day work? | 1.95 | 0.725 |
| Do you know about Big Data? | 1.66 | 0.770 |
| Are you aware about the devices that can collect data using sensors and other technologies around us? | 1.69 | 0.777 |
| Are you willing to let your personal data to be used for service enhancement by local bodies? | 1.79 | 0.838 |
| Does your smart device asks for your personal information? | 1.72 | 0.855 |
| Have you ever used smart health services? | 1.53 | 0.704 |
| Do you wish to share your health condition to any application? | 1.86 | 0.863 |
| What should be the focus of the city authorities? | 1.88 | 0.838 |

4.3 Analysis of the concepts

The table below (Table 5) is the summary of the responses people gave on the concepts like smart city, IoT, Big Data and their relation. The table summarizes the responses with Positive for Yes, Negative for No and Neutral for Not Sure. The responses with Yes indicates that the people are aware about the variable being discussed, No means people are not aware about the variable being discussed and Neutral means they are not sure if they know or don't know the concept.

Table 2 Smart City/IoT/Big Data Concept and responses associated to them

| Yes/No Questions for variables | Positive | | Negative | | Neutral | |
|---|----------|------|----------|------|----------|------|
| | Yes | % | No | % | Not Sure | % |
| Do you know about smart city? | 104 | 48.8 | 91 | 42.7 | 18 | 8.5 |
| Do you know about Internet of Things (IoT)? | 85 | 39.9 | 106 | 49.8 | 22 | 10.3 |
| Do you know about Big Data? | 63 | 30 | 111 | 52 | 39 | 18 |
| Are you aware about the devices that can collect data using sensors and other technologies around us? | 64 | 30 | 108 | 51 | 41 | 19 |

| | | | | | | |
|---|----|----|-----|----|----|----|
| Are you willing to let your personal data to be used for service enhancement by local bodies? | 55 | 26 | 101 | 47 | 57 | 27 |
| Does your smart device asks for your personal information? | 41 | 19 | 116 | 55 | 56 | 26 |
| Have you ever used smart health services? | 60 | 28 | 127 | 60 | 26 | 12 |
| Do you wish to share your health condition to any application? | 50 | 24 | 98 | 46 | 65 | 30 |

5 Discussion

5.1 Interpretation of findings

While the political situation of Nepal is considered favorable for the development in Nepal along with the belief from the public that Nepal can focus on Smart city despite other developmental needs, technical challenges were considered as primary reason for smart city not being implemented by the respondents. These challenges including the lack of proper internet connection, slow internet speed, interrupted electricity supply, lack of technologies which are directly responsible for difficulties in smart city implementation.

5.2 Concept of Smart City, IoT and Big Data

Based on data analysis, we can see that still half of the respondents don't know about Smart city. The output shows that people are still unaware about the Smart City concept and this can be taken from the fact that Urban Development is still considered as benchmark of development in lower income country like Nepal. The analysis based on Figure 12 illustrates the current scenario where only population slightly more than one-third are aware about IoT and IoT related devices. This result can be associated with the facts that people love smart phones but still lack idea on operating smart devices.

There are several reasons why general public are not aware about Big Data and its impact on smart city implementation and better service delivery. The most obvious reason being the technicality associated with the concept. It is obvious that not everyone will be fascinated with the ICT and its products. Based on the Figure 21, the above statement can be further validated as this survey shows only a quarter of population understands Big Data. One such example of people lacking concept of smart city has been discussed by (Arjun & Sudhamshu, 2019) where they highlighted unmanaged waste management system in Kathmandu Metropolitan.

5.3 Research questions and findings of the survey

Based on the results obtained from the survey the research questions and their related answers or findings are discussed below in brief.

RQ1. What are the technological challenges in using IoT devices for implementing smart cities in Nepal?

Findings: The statistical analysis of the answered received in the survey showed some of the technical challenges that can affect the smart city implementation using IoT are:

- Internet connectivity
- Internet speed
- IoT devices and their operation
- Complexity in using IoT device
- Unwillingness to change lifestyle

RQ2. What is the current state of technological infrastructure, IoT Devices, Internet services in major cities of Nepal?

Findings: The survey output showed that Nepal is still lagging behind in terms of technological infrastructure and related services. The internet speed in many cases cannot handle the operation of IoT devices. The mobile network in Nepal is still operating 2G and 3G internet in most of the cities. Only selected cities of Nepal have 4G internet which is expensive.

RQ3. How can the captured data is being analyzed and how relevant can the big data analytics be in providing feasible solution for the citizens of the city?

Findings: Big Data seemed to be relevantly new term for the respondents and very few believed big data analytics can be beneficial for the city authorities for better service delivery. This was expected as Nepal still lags behind in terms of technology.

5.4 Conceptual Model for Smart City Implementation

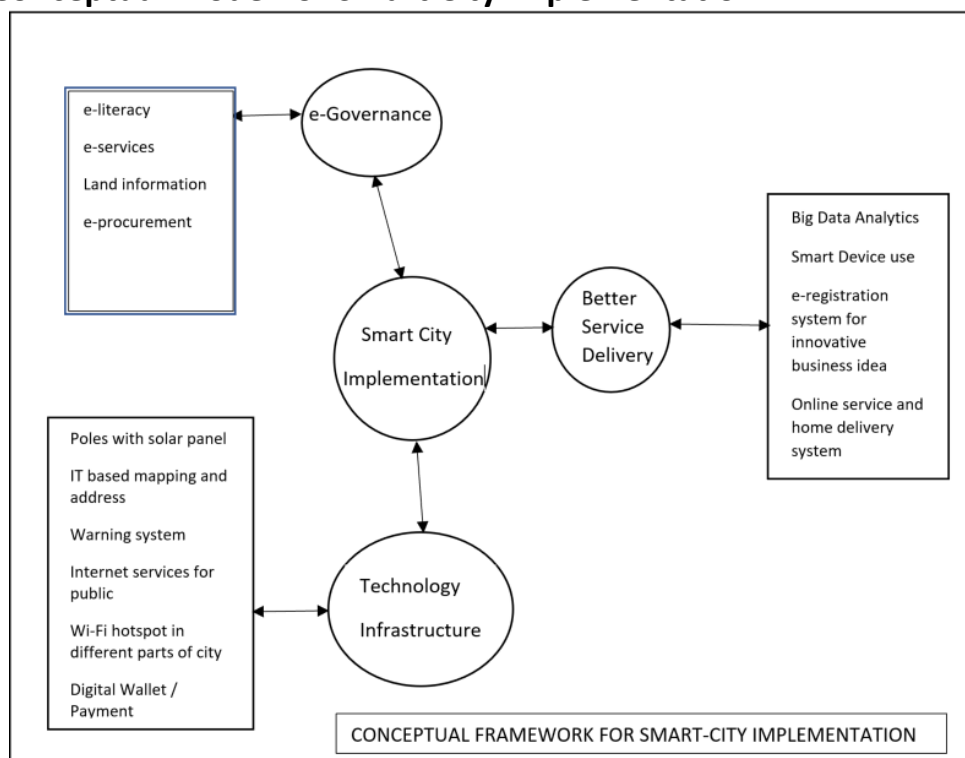


Figure 3 Conceptual framework for Smart-city implementation

The number of researches done and journal published for smart city implementation around the world showed that the concept is achievable with strong desire from the policy makers. Smart city can be implemented only when Government itself takes the initiative and includes ICT as one of its strategy in development. In Nepal, Digital Nepal Framework has been taken as a base document / strategy for digitization of services provided by Government. In recent time there has been launch of an app called Nagarik whose English translation will be Citizens. This app aims at storing all the relevant data electronically for the registered users. This is something that be pivotal in future while implementing paperless governance (Kautish et al, 2020, 2021)

The model being described here will be influential and cities can implement their plan based on the proposed model. The important thing to keep in mind is that not all cities in the country can be smart city at an instance. This should be a gradual process and based on availability of resources the cities must be prioritized for this. A model with the listed components and their associated indicators can be used as suggested by (Arjun & Sudhamshu, 2019) for Lalitpur Metropolitan.

The model proposes three different components of a smart city as listed in Figure 25 above. The first component is E- Governance where several services provided by government or local body are proposed to be made electronic. This way the service becomes faster and easily accessible. It will avoid people standing in long queue to pay for tax or some other fees. A small yet well managed Data Center can help the city maintain all the records electronically and make them accessible using cloud-based services.

The survey has clearly indicated that the city must be prepared with the technological infrastructure for transforming itself into smart city. Some of the basic indicators of technology infrastructure are listed below. The list goes on increasing as the listed indicators are achieved.

The last component proposed by this conceptual model is the improvement of service delivery to the citizen of the city. This can be achieved with proper analysis of the data collected from several smart devices and services in the city. The city can also reward the innovative business ideas by making online registration for such business. The city authorities can provide online services and make home delivery available if necessary.

Although the figure is just an outline of how a smart city be built, this can be taken as a base to start improving the services available in the city. A smart city must have smart citizens and this way the implementation will be successful. This is why the conceptual model has focused on e-literacy in the very beginning. A city where the people cannot access available smart services can never succeed as a smart city.

5.5 Validation of the proposed framework

The proposed framework for IoT implementation in Smart Cities has been validated by two participants from IT department of IOM (International Organization for Migration). The feedback received by the framework was exciting as both of the participants believed this could work as a base / guide for any city who are intending to implement smart city concept. The validation questions and the feedback from the participants are kept as appendices. The validation was carried out in the English language as this is the mode of communication for International students. Both participants have suggested few changes / updates with minor improvements. Please refer to appendices for detailed question answer and feedback.

6 Conclusion and Recommendation

6.1 Conclusion

The challenges that any smart city might face while implementing the concept can include technical, economic, political, social and others. However, the important fact that we need to keep in mind is that smart cities are technology based. It requires a city to be technically prepared for smart city concept to be implemented and successful. The analysis of the survey data obtained that 50% of the respondents are not even aware of the concept. The large section of population is still hesitant in using smart devices in their day-to-day life. This will make it difficult for the city authorities to deliver the output. The citizens must be aware of any smart services that are available in the city. This is why, the researcher has proposed for e-literacy as a variable that needs to be implemented by city. As long as people are technically aware of what is happening the concept can be implemented successfully.

The present technological infrastructure as shown by the survey is still not sufficient for the smart city implementation. This has been supported by the fact that people who participated in the survey do not seem to agree that these infrastructures will be enough to build a smart city. Several definitions presented by different researchers regarding smart city clearly mention that smart city will be a jungle of inter-connected devices. this will require a high-speed internet with no interruption in the services. All these components in present context are not available in Nepal and hence such things must be prioritized by the government while doing the procurement of the devices.

Big Data is one of the newest concepts in ICT and this is still very new to many people in Nepal. The fact has been clearly proven by the statistics showing three-fourth of the respondents do not know what is Big Data. Hence big data is somehow a new terminology for Nepal and it has to be researched more for better output. Big data analytics must be done in order to improve the services provided by the city authority. People in the survey did agreed that big data can be pivotal in success of the city transmitting into smart city. But the output cannot have significant in the output of the research as the concept is yet to be tested in Nepal. The researcher firmly believes that Big Data Analytics can be a topic to research and dig more to see how Nepal can benefit from this.

6.2 Recommendation

There has been a trend mostly in South East Asian countries to build smart city and provide smart services to the people. The countries are mostly developed and have good internet access. Nepal has recently entered the market of ICT and still has lot to improve. One good initiation taken by the government of Nepal is to design the Digital Framework of Nepal. This has a lot of potential and can be beneficial for ICT development and digitization of Nepal. However, when we talk about smart city and IoT for smart cities, there are plenty of rooms for improvement.

- Developing a curriculum where students from lower level can understand the technological terms like Smart City, Internet of Things (IoT), Big Data etc. General public should also be informed about such terms and their meaning.
- Gradually transform the manual services to e-services for the people of the city. This will help in smooth transition and can be economically feasible.
- Built the infrastructure in phases. This will help the people understand the services gradually and adapt to them accordingly.
- Make people aware technologically. It is important to convince people that technology are here to help us live our life easily.
- Implement smart services in different parts of the city. This can include smart parking, smart bus services, smart pollution control etc. This way people are slowly attracted to use them.
- Prepare man power that are technically sound and proficient. This will help in big data analytics and figure out where the services can be improved and made better.
- Make the services from the city easily accessible. People will only use services that can be accessed easily and has good UI.
- Developing a good internet connectivity and uninterrupted power supply is a must for successful smart city implementation.
- A smart city needs to have 5G internet connection with strong network that can be helpful in accessing any web services. Nepal still relies heavily on 2G / 3G services.

This research is a small study considering the population and cities in Nepal. However, the researcher firmly believes that the output of this research or study can be vital for the municipalities that are planning to implement smart city. Nepal Government itself has planned to establish 13 smart cities. The digital Nepal framework can work as backbone for this but understanding the ground reality is equally important. The researcher is hopeful that the outcome of the study can somehow benefit fellow researchers, government, government officials and local body representative to implement smart city successfully.

6.3 Future work

It is obvious that any research cannot give everything that we are looking for. The research has limitations and the limitations has been discussed in above section. This part of the chapter is used for the possible discussion on what work can be done in future in similar niche. The research was focused on the technical challenges that any city in Nepal might face while implementing Smart cities using IoT and we concluded with the number of technical shortcomings that are existent in Nepal. The fellow researchers can look on specific technical issues like internet availability for smart city adoption or the IoT awareness among local people for successful implementation of smart cities. This way the research becomes limited to one or two areas and the survey can be expanded accordingly. The future researcher can also expand the number of participants to make it more inclusive and collect more data for better data analysis.

In order to support the government initiative on Digital Nepal Framework, smart city is going to play a vital role. There will be more research opportunities in the field of smart cities, IoT and Big data. The future research can also focus on data analytics and use of Big Data to make services easily accessible. The outcome of this research clearly show there is need of more technology along with technological man power. Hence, another topic for research can be to see the preparedness in terms of technological infrastructure.

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