
# UNIVERSITY OF DHAKA

## DBA Dissertation

# STRATEGIC ICT MANAGEMENT IN BANGLADESH'S TRANSITION TO E-GOVERNANCE: FRAMING OUT A REALISTIC SUSTAINABLE APPROACH

**Researcher**

**A.K.M. GOLAM BAHARUL**

## Doctorate of Business Administration
## in
## Management Information Systems

**Department of Management Information Systems**
**Faculty of Business Studies**
**University of Dhaka, Bangladesh**

**UNIVERSITY OF DHAKA**

# Strategic ICT Management in Bangladesh's Transition to E-Governance: Framing out a Realistic Sustainable Approach

[A Dissertation Submitted to the Department of Management Information Systems, Faculty of Business Studies, University of Dhaka, in partial fulfillment of the requirement for the degree of Doctorate of Business Administration]

**Researcher**

**A.K.M. GOLAM BAHARUL**

Reg. No.: 16/2014-15 and Re-Reg. No.: 19/2021-22

**Supervisor:**

## Professor Mohammad Moqbul Hossain Bhuiyan

Department of Management Information Systems
Faculty of Business Studies
University of Dhaka, Bangladesh

**June 18, 2023**

# Research Declaration

I agree that, should the University wish to retain it for reference purposes, a copy of my Research Project may be held by University of Dhaka.

**Confidentiality**

I confirm that this Research Project does not contain information of a commercial or confidential nature or include personal information other than that which would normally be in the public domain unless the relevant permissions have been obtained. In particular any information which is collected through survey from the expert has been anonymized unless permission has been granted for its publication from the person to whom it relates.

**Copyright**

The copyright for this Research Project remains with me.

**Requests for Information**

I agree that this Research Project may be made available as the result of a request for information under the Freedom of Information Act.

**Originality Declaration**

I declare that this Research Project is all my own work and the sources of information and material I have used (including the Internet) have been fully identified and properly acknowledged.

I hereby give permission for my Research Project to be made available to staff and students for reference purposes.

Place: Dhaka (A K. M. Golam Baharul)

Date: June 18, 2023 DBA Researcher

# Certificate of Approval

This is to certify that the dissertation titled "**Strategic ICT Management in Bangladesh's Transition to E-Governance: Framing out a Realistic Sustainable Approach**" is a research work carried out by A.K.M. Golam Baharul, Bangladesh Civil Service Official of BCS (Telecommunication) Cadre of the People's Republic of Bangladesh, a student of Department of Management Information Systems (MIS), Student Reg. No. 16/2014-15 and Re-Reg. No.: 19/2021-22, Faculty of Business Studies (FBS) of the University of Dhaka, under my supervision. This research work has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Doctor of Business Administration (DBA). I therefore, recommend it to the Dean of Faculty of Business Studies for further necessary action.

Place: Dhaka, Bangladesh
Date: June 18, 2023

(Signature of Supervisor)

Professor Mohammad Moqbul Hossain Bhuiyan
Department of Management Information Systems
Faculty of Business Studies
University of Dhaka

# Abstract

Applications of Information and Communication Technologies (ICTs) have come out as the most effective tools for quick, easy, hassle-free, convenient, transparent, responsible, accountable, participatory and responsive way of Government service delivery to the citizen all over the world. In the present world, Technology is a vital strategic element specially the ICT, as ICT is the part and parcel of everyday life. Different citizen services are also giving through ICT by the Government and thus transforming the governance to e-Governance in many countries of the world. Bangladesh is also at the take off stage of e-Governance and advancing very first. But a huge percentage of e-governance initiatives and projects failed in developing countries like Bangladesh due to the lack of proper strategic ICT management. This research focuses on insights into the strategic ICT Management for sustainable e-Governance in Bangladesh's transition to e-Governance.

This research work explores the CSFs (Critical Success Factors) and ranking the CFS's according to preference level for strategic ICT management regarding sustainable e-Governance in Bangladesh. Institutional techniques Fuzzy AHP and Delphi are used by the researcher to handle the Multi Criteria Decision Making (MCDM) complex issues for decision making as these techniques have the ability to assess the ambiguity of real complex problems for better planning and decision making. Due to this reason, Fuzzy AHP and Delphi technique were used in this research work as it is MCDM complex issue. The research findings obtained by these two techniques were also validated for getting more reliable and trustful result. Sensitivity test of research findings were conducted to check the stability and robustness of research findings for quality decision making.

The researcher developed questionnaire for Fuzzy AHP and Delphi method to carry out qualitative and quantitative analysis using multi-methods approach for data collection. The series of techniques adopted for this study which are questionnaire responses, brain storming, document analysis, observation and relevant experience. To collect the expert opinion about the CSFs for strategic ICT management in Bangladesh's transition to e-Governance, a "Google Form" was formulated and sent to relevant experts through e-mail with preamble .The research findings suppose that most of the Critical Success Factors : Infrastructure Development and Resource Sharing, Government Policy, Available Skilled

Human Resource, Availability of service, Personal Information Security, Cost of service, Cyber Security, Awareness of Citizen, Technology Transfer by Vendor, Quality of service, Acceptability in socio-Cultural aspects, Legal protection, are similar to those discussed in existing literature, although some may be specific to the Bangladesh context.

The three new specific CSFs are identified/ proposed for strategic ICT management of sustainable e-Governance by the researcher and assessed these accordingly, the proposed new CSFs are: Environmental Hazard, Resource Consumption and Resource Conservation; as environmental issues are very important for any development for the betterment of Earth and human. Two CSFs such as Infrastructure development and Resource Sharing are mentioned separately in different literature review, in this research work, the researcher considered it as one CSF: Infrastructure Development and Resource Sharing to the Bangladesh context and assessed accordingly, as this two CSFs are interdependent for successful operation.

Total 15 CSFs are identified and assessed in this research work. Based on the assessment of CSFs and findings of research, the researcher was able to frame out a new conceptual Triangular model of strategic ICT management for sustainable e-Governance in the perspective of Bangladesh's transition to e-Governance, which was a unique and specific outcome of this research study.

The conceptualized new Triangular model of strategic ICT management should help Decision Makers, Planners, Policy formulators, academicians and researcher to understand the step-by-step guide for strategic ICT Management of sustainable e-Governance in the perspective of Bangladesh's transition to e-Governance.

The researcher therefore has accomplished that this study extends to the knowledge in the aspect of strategic ICT management regarding sustainable e-Governance of Bangladesh. This new conceptualized model enables the development of a holistic plan for strategic ICT Management in implementing sustainable e-Governance throughout the development life cycle of e-Governance in Bangladesh.

# Acknowledgement

I am grateful to the Almighty for the good health and wellbeing that were necessary to complete this dissertation. I do pray to his Greatness to inspire and enable me to continue the work for the benefits of humanity.

This dissertation has been written as a requirement of the partial fulfillment of Doctor of Business Administration (DBA) degree. Many people have helped me during the entire research work. I would like to extend my gratitude, appreciation and regard to them.

First of all, I would like to express my deep and sincere gratitude to my supervisor, Mohammad Moqbul Hossain Bhuiyan, a respectable, responsible and resourceful scholar, professor and research expert of University of Dhaka who has provided me with valuable guidance in every stage of this dissertation. I sincerely appreciate his effort to help me in this research work.

I would like to express my sincere appreciation to Engineer Saiful Islam, an ICT Expert and Bangladesh Civil Service Official. He gave me a lot of valuable suggestions and expert opinion for my dissertation, especially in developing online research survey instrument.

I would like to thank all officials of MIS Department, University of Dhaka who have helped me a lot to complete this research work.

I wish to express my profound gratitude and thanks to my mother and also beloved wife and two kids, for their love, trust, support and encouragements to complete this dissertation work.

Last but not least, I would like to thank all the Expert participants who contributed to my research by giving their expert opinion. Without their participation the completion of this research project was quite impossible.

(A.K.M. Golam Baharul)

# Table of Contents

# List of Figures

# List of Tables

# List of Acronyms

***A***

Acceptability in socio-Cultural aspects: (ASC) · 41
access to information: A2I · 2
Analytic Hierarchy Process: AHP · 52
Analytical Hierarchy process: AHP · 10
Availability of service: (AS) · 41
Human Resource: (HR) · 41

***B***

Bangladesh Bureau of Educational Information and Statistics: BANBEIS · 22
Bangladesh Computer Council: BCC · 23
Bangladesh Data Centre Company Limited: BDCCL · 24
Bangladesh Internet Governance Forum: BIGF · 24
Bangladesh National Digital Architecture: BNDA · 23
Bangladesh Telecommunications Company Limited: BTCL · 21, 145, 155
Birth Registration Information System: BRIS · 27

***C***

Central Procurement Technical Unit: CPTU · 29
Commonwealth Centre for Electronic Governance: CCEG · 2
Cost of service: (CS) · 41
Critical Success Factors: CSFs · 6

***D***

Doctor of Business Administration: DBA · iii
Domestic Network Coordination Committee: DNCC · 24

***E***

Economic Co-operation and Development: OECD · 14
Economic F a c t o r s : EF · 165
e-Government Procurement: e-GP · 29
Electronic Taxpayers Identification Number: e-TIN · 30
Environmental Hazard: (EH) · 41
e-participation index: EPI · 17

***F***

Fuzzy Analytic Hierarchy Process: Fuzzy AHP · 8

## *U*



## *W*

# Chapter 1

# Introduction

## 1.1 Background of the study

The word strategy came from a Greek word “strategos”, that means army guidance from the position of army Commander General. The use of this concept starts to at least 400 years B.C. (Jeżak, 1990). Prussian military general and theoretician Karl von Clausewitz argued that strategy is concerned of creation of the war plan and determination of war campaigns and individual undertakings under their scope (Pszczołowski, 1976). The word “strategy” gains recognition in other fields of human activity, particularly in politics and, noticeably later, in economy and now in technology (Palladan and Adamu, 2018).

There is no single definition of strategic management, which is generally acceptable to all (Markiewicz, 2011). The strategy is a long-term goals and objectives of a company or organization, actions adoption, and necessary resources allocation for the achievement of the objectives and goals (Chandler, 1962).

The model of the objectives, policies, purposes, goals, and plans to achieve them addressed in such a way that they define in which business the company or organization is or will be in future is called strategy (Andrews, 1971).

The strategy is a top management activity, which deals with decisions making, regards to the purpose of the organizational mission, vision, philosophies, objectives, strategies and well-designed policies. It also encompasses the development of long-term plans for efficient management of environmental opportunities and threats to overcome the future challenges for its success (Sababu, 2007).

Selection of the set of activities in which a company or organization stands out to establish a sustainable difference in its position; the differentiation arises of the activities chosen and how they are the carried out, is strategy (Porter, 2008)

Now a day, Technology is also a vital element of strategic management specially the ICT, as ICT is essential in every moment at everywhere in human's everyday life. Different citizen services by the government are also giving through ICT and thus transforming the present governance to a new era called e-Governance.

Information and Communication Technology (ICT) plays a prominent role in everyone's daily life, social life, organization's success both Civil and Military, private and public, infrastructure development of country, economic boost up of country, poverty and corruption eradication of country and above all the e-Governance implementation.

When properly planned and implemented, e-Government may save costs and increase efficiency for citizens, businesses, and the government itself. It can also make it easier to comply with regulations, increase citizen involvement, and build public trust.

In the context of national development agendas, electronic governance (e-Governance) presents a chance for governments to reinvent themselves, improve citizen engagement, and forge closer alliances and partnerships with a variety of communities of interest, practice, expertise, conviction, and interdependence. E-government services include providing services to individuals, businesses, organizations and industries as well as processing documents and facilitating citizens for access to information (A2I).

The goal of e-Government, both as a concept and an emergent practice, is to implement systems and structures for maximizing the potential of information and communication technologies (ICTs) at all levels of government, in the public sector, and elsewhere in order to improve good governance.

The Commonwealth Centre for Electronic Governance (CCEG) has also been established, and its purpose is to advance electronic governance by offering a knowledge base of best practices and guidelines for the adoption of information technology in public-sector organizations. Additionally, CCEG offers expertise and advice to governments all over the world on e-business, e-government, and e-democracy.

E-government systems are a component of the broader public sector digital transformation process. Countries with effective e-government systems are able to lower the administrative and bureaucratic burden on private citizens and businesses while also enhancing the performance, transparency, and accountability of their governments (Agbozo and Asamoah,2019).

There are many stages of e-Government implementation in countries all around the world. Therefore, evaluating a country's e-Government status is useful for developing policies and initiatives that are suitable for that country. Different international organization working on e-Governance has developed some indicators to measure the position of e-Governance position of a country.

The UN Department of Economic and Social Affairs (UNDESA) developed the E-Government Development Index (EGDI), which examines how effectively a country uses ICT to serve its citizens with a diversity of e-Government services. This index assesses a nation's performance based on three sub-indices: Telecommunications Infrastructure Index (TII), Human Capital Index (HCI), and Online Service Index (OSI) . It yields a composite index that is graded on a scale from 0 to 1. The recent report reveals that Bangladesh was ranked 111th out of 193 countries and with a score of 0.5630. From the UNDESA'2022 report it is found that Bangladesh leads with the highest EGDI values among the LDC countries. Bangladesh scored 0.6521 in the Online Service Index (OSI), 0.446 in Telecommunications Infrastructure Index (TII), and 0.59 in Human Capital Index (HCI) (UNDESA e-Gov Survey, 2022).

A crucial element of e-Government is the electronic connectivity between the government and the people. Global Connectivity Index (GCI) 2019, which was published by Chinese technology behemoth Huawei, Bangladesh is rated 73rd. The GCI calculated the rankings of 79 nations by considering factors including ICT investment, ICT maturity, and digital economic performance. Bangladesh received a score of 28 on that a scale while the United States scored 85.

Starters, Adopters, and Frontrunners are the three groups that GCI divided nations into based on performance. Because of the improved user experiences brought forth by more

affordable fixed and mobile Internet, better cyber security, and cloud services, Bangladesh, a pioneer, has experienced a considerable increase in the demand for smart phones and mobile broadband subscriptions over the years. Currently, Bangladesh is seven positions ahead of Pakistan ,76th with a score of 27, and three position bellow of India, 65th with score 34. (Rust and Kannan, 2016).

Bangladesh was listed as one of the Top Movers in the report, along with Ukraine, South Africa, and Algeria., that adopted digital technology the fastest for altering their economy (Huawei Report, 2019).

The growth and advancement of ICT (Information Communications Technology) in every aspect of human existence transforms people to interact with society, as well as the ways that people accomplish their jobs in relation to one another. We can refer to the current era as the "Information & Communications Technology" era as a result of these advances, which transformed human societies into scientific societies and people into consumers of information networks (Telali et al., 2003).

So, to increase the EDGI, GCI rank of Bangladesh, to become the E-Governance leader in Asia and make those changes sustainable, a strategic ICT plan is necessary. For strategic ICT plan of sustainable e-Governance in Bangladesh, it has the utmost necessity to find out the CSFs of strategic ICT plan, ranking the priority of CSFs and finally Framing out a model of strategic ICT management for sustainable e-Governance in Bangladesh as ICT is the backbone of E-Governance services.

Owing to the significance and importance of sustainable e-Governance, the importance of strategic ICT management is emphasized. With the rapid growth of e-government in Bangladesh, it is essential to establish a strategic ICT management plan for long-term success. Many e-Governance initiatives fail in Bangladesh due to the lack of proper ICT management strategy. The purpose of this research project is to identify the critical success factors and ranking them as per level of significance/preference and finally Farming out a new model of strategic ICT management for sustainable e-Governance in the perspective of Bangladesh’s transition to e-Governance.

## 1.2 Statement of the Problem

Technological innovation optimizes corporate processes or the labor of businesses to provide them a competitive advantage. But E-government is not just like a technological innovation, its aims to increase the efficacy, efficiency, and transparency, decrease harassment, corruption of governance and the provision of deliver public services much easily (Manda and Backhouse,2016). Building trust on government and increasing government accountability to its citizens, are the goals of innovation in the public sector, which includes electronic government or e-government. The goals of e-Governance also include quality public service delivery, a reduction in stress and bureaucracy associated with accessing public services, and the creation of trust in government (Borzdy, 2009). E-governance is not only improving the citizens' access to public services, but it is also a transformative tool and being a transformative tool for the society (Medvedeva and Davletbaev, 2016). E-government also enables the promotion of business to business (B2B) networking, serving as a bridge between organizations and facilitating the exchange of resources and effective communication (Telali and Farandez, 2003). ICT is a strategic element for e-Governance as well as to promote public services, because ICT is the driver of e-Governance.

Bangladesh is also going forward very fast to the new horizon of e-Governance. But Many Challenges and hurdles involved in managing and keeping this advancement in e-Governance. Many e-Governance initiatives are being taken by different projects in public and private sector, but in many cases these initiatives did not be so successful due to the lack of strategic ICT management. After finishing the project, the foreign Vendor organization goes away and the projects which are taking for enhancing the e-Governance also became inactive or failed and thus do not sustain due to lack of proper strategic ICT Management.

Only 15% of the 40 e-Government projects studied in underdeveloped nations actually achieved their primary objectives. Regarding e-Governance-related projects in emerging and post-transitional nations, 50% of e-governance projects are "partial failures" and 35%

are "complete failures" (Heeks, 2003). It is revealed that high cost e-governance projects failed highly, that failed projects includes not only tangible costs but also the intangible costs like citizen trust (Heek,2003).

Bangladesh is now at the transitional stage of e-Governance and it is very fast growing. But extensive research work on strategic ICT Management for sustainable e-governance is not done sufficiently in Bangladesh perspective. The critical success factor for strategic ICT management regarding sustainable e-Governance in Bangladesh is not identified in recent research work. This research project has been taken for extensive research work to identify the CSFs, assess those CSFs and framing out new model of strategic ICT Management for Bangladesh's sustainable e-governance which time is demanding for the country as well as society.

With the help of this research, it is possible to pinpoint the tasks and initiatives required for future strategic ICT planning in order to fully capitalize on the benefits of e-Government for the advancement of Bangladesh.

In this research project two strong widely used powerful research tools have been used to find out and ranking the Critical Success Factors (CSFs) for framing out a strategic ICT management model regarding sustainable e-Governance of Bangladesh: One is Fuzzy AHP Method and another is Delphi Method.

The fuzzy analytic hierarchy process (Fuzzy AHP) is frequently used to address decision-making complex issues involving the evaluation of many criteria/factors. It has the advantage of being able to handle qualitative criteria and produce findings that can be trusted (Ayag and Ozdemir, 2006).

The basis for the Delphi Method is the idea that organized groups of people make decisions that are more accurate than unstructured ones (Rowe and Wright, 2001). Delphi method is used for decision making of different complex issues by the researcher.

So, by using this strong research tools, framing out a new strategic ICT model for sustainable e-Governance of Bangladesh's transition to e-Governance is very much rationale.

## 1.3 Basic Research Question

To achieve the objectives of research, identification of the key Critical Success factors (CSFs) and their level of significance/preference or rank of CSFs for strategic ICT management for sustainable e-Governance in Bangladesh's perspective are crucial. Because identification and ranking of CSFs for strategic ICT management is a Multi Criteria Decision Making Problem (Catrinu, 20060). It is also necessary to explore Expert opinion of different discipline as this is a multi-discipline issue. To this context, the researcher has set out the questions as:

1. What are the necessary CSFs for strategic ICT management regarding sustainable e-Governance in Bangladesh?

2. What is the level of significance/preference or rank of each identified CSFs, necessary for strategic ICT management?

To get the answer of research questions, the researcher has developed two questionnaires, one for Delphi technique and another for Fuzzy AHP method. The full questionnaire which was developed by researcher is given in **Appendix B** of Fuzzy AHP and full questionnaire of Delphi Method is given in **Appendix A.**

## 1.4 Research Objectives

The following research objectives: Broad objectives and Specific objectives were set out to address the research questions:

The following broad objectives were developed to address and asses the research questions:

1. To identify the Critical Success Factors (CSFs) for strategic ICT Management of sustainable e-Governance in Bangladesh's perspective.

2. Assess the identified CSFs and ranking those CSFs by using Fuzzy Analytic Hierarchy Process (Fuzzy AHP) method which is a strong research tool used for Multi Criteria Decision Making (MCDM) problems.

3. Assess the identified CSFs and ranking those CSFs by using Delphi method which is a popular research tool used for structured group of individuals which gives more accurate result than those from unstructured groups.

4. Compare the obtained result of Fuzzy AHP method and Delphi method for validating the research findings.

5. Sensitivity analysis of Research findings for testing the robustness and stability of research findings for quality decision making.

**Specific Objective:** Framing out a new strategic ICT Management model for sustainable e-Governance in the perspective of Bangladesh's transition to e-Governance.

## 1.5 Research Design

The theoretical and applied studies in this dissertation are combined together. The crucial success factors (CSFs) identified by literature review, piloting, brain storming and relevant experience are evaluated using primary information gathered from expert's opinion. The research design consists of following stages, as illustrated in **Figure 1.**

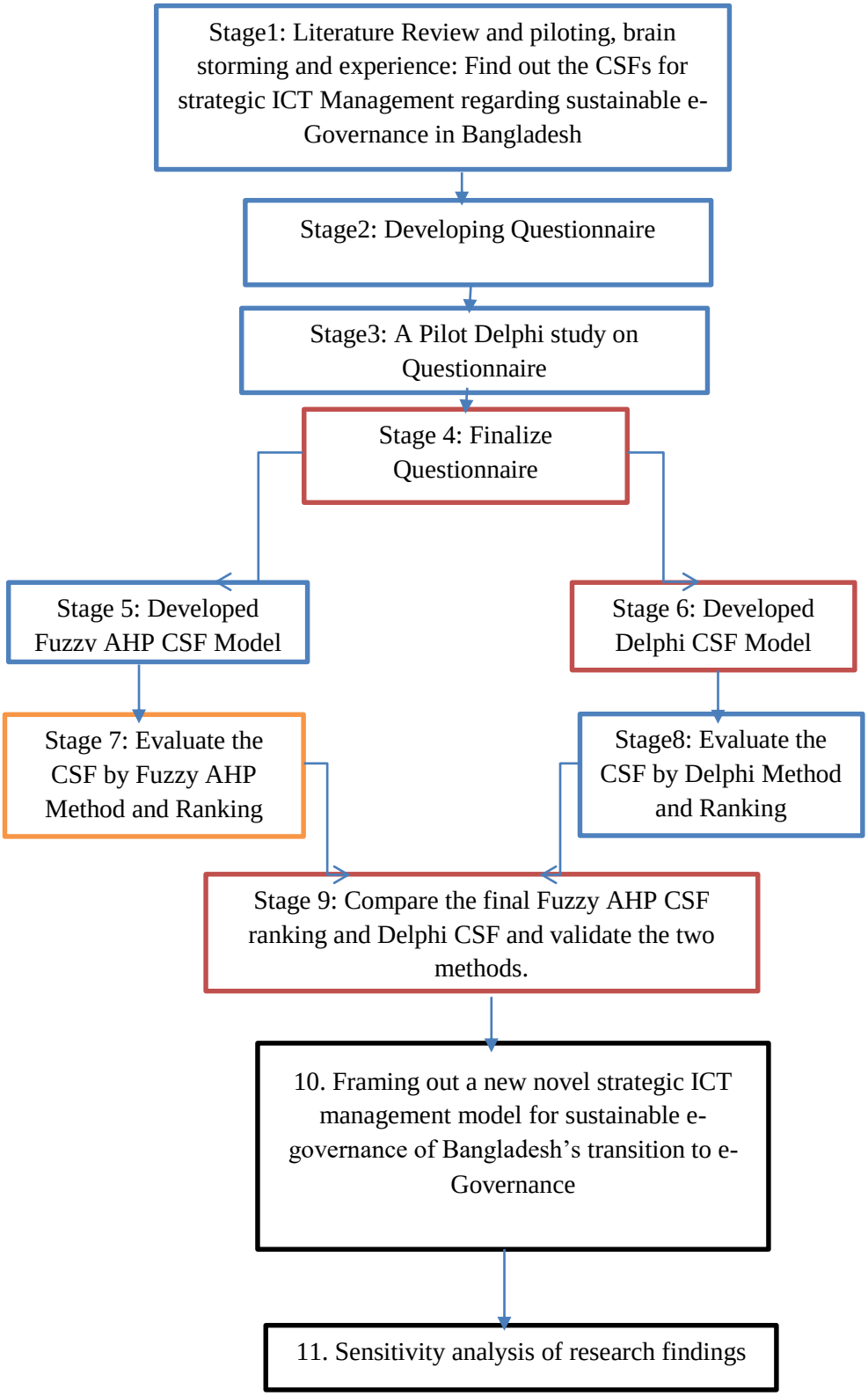



**Figure 1.1: Research Design Presentation (Source: The Author)**

## 1.6 Validation of Methodology

When making a decision that require evaluating variety of criteria/factors, then the fuzzy analytic hierarchy process (Fuzzy AHP) is widely used. It benefits from being able to handle non-quantifiable criteria/factors and generate results that are generally quite reliable (Baharul, Golam., 2016).

The foundation of the Delphi Method is the idea that decisions made by a structured group of people are more reliable than decisions made by unstructured group. This technique is frequently employed for reaching decisions of many complex issues.

The Fuzzy AHP are widely used for extensive research in various field where unquantifiable criteria to get quite reliable result for decision making like Social science, natural science, business, engineering. Many researcher used this technique, amongst them: A research on " A Fuzzy AHP Approach for Selection of Measuring Instrument for Engineering College Selection" (Mahendran, Moorthy and Saravanan,2014), "Evaluation of success factors in e-commerce by Fuzzy AHP" (Kong and Liu, 2005) (Kong and Liu, 2005), "Using fuzzy Analytical Hierarchy process (AHP) to evaluate web development platform" (Sarfaraz, Mukerjee, and Jenab, 2012), "Using fuzzy multi criteria decision making approach for ranking the web browsers" (Meysam, Mahsa, and Sajad, 2012) , "Evaluating IT/IS investments: A fuzzy multi-criteria decision model approach" (Yuan Chou, Seng-cho, Chou, Tzeng 2006) , "The assessment of water management plans Fuzzy AHP" (Sredjevic and Medeiros, 2008); "Critical decisions in new product development Fuzzy AHP" (Büyüközkam and Feyziog lu, 2004); "Flexible manufacturing systems Fuzzy AHP" (Chutima and Suwanfuji 1998), "Safety management in production by Fuzzy AHP" (Dağ˘deviren and Yüksel, 2008); "Selection of enterprise resource planning systems Fuzzy AHP" (Cebeci, 2009); "Implementation of a SWOT-AHP methodology for strategic development of a district heating plant in fuzzy environment"( Veličkovska, 2022); "Policymakers' perspective about e-Government success using AHP approach: Policy implications towards entrenching Good Governance in Pakistan" (Hassan and Lee, 2019) ; "What Should We Do for E-government in Nepal and How? An AHP Approach" ( Basyal and Seo, 2016) ; A research study on "Analytic Hierarchy Process for the Success of e-Government" (Sultan and Khalid, 2012 ).

The Delphi is being used for the long period of time for decision making and forecasting research of complex issues. Many researcher used this tools for research of complex cases, such as: “The Critical Success Factors for Effective ICT Governance in Malaysian Public Sector: A Delphi Study”, (Rosida, Zakaria) ; “Identifying Critical Success Factors for knowledge management implementation in higher education institutions: a study of the use of the Delphi method at King Fahd Security College (KFSC) in Saudi Arabia” (Shaharani, 2016) ; “Analyzing the Interaction of Barriers in E-Governance Implementation for Effective Service Quality: Interpretive Structural Modeling Approach” (Gupta, Suri et al, 2019).

Therefore, it can be said that Fuzzy AHP method and Delphi method are largely used by the researcher and very useful for identifying and ranking the critical success factors for strategic ICT management regarding sustainable e-Governance in Bangladesh. And this is the main reason why these two tools have been incorporated in this study.

## 1.7 Validation of Data

The information gathered from the appropriate experts has been cross-checked and approved. It was done by checking the consistency of each matrix which were found from the expert opinion by pair-wise comparison in case of Fuzzy AHP and by Coefficient of convergence in case of Delphi method. If the collected data of someone was found inconsistent or non-convergent, the feedback has been given to the expert to rechecked the opinion until consistent and convergent data ensured.

For validation of data, in case of Fuzzy AHP method, the Consistency Ratio (CR) of matrices was used. In case of Fuzzy AHP method, if $CR \geq 0.1$ was found then the matrix is considered as inconsistent and sent for revised to the expert. And in case of Delphi method, Kendall’s Coefficient of convergence (W) was used. If $W \leq 0.7$ was found, then the data was not accepted and sent for revised to the experts.

## 1.8 Contribution of the Research

From practitioners' point of view, the findings of this study, the Critical Success Factors and frame of a new strategic ICT management Model developed by this research would be a good guideline for the policy planners, decision Makers (DMs), policy implementer and the different ICT management authorities, especially for the Government authority for the strategic ICT management regarding sustainable e-Governance in Bangladesh's transition to e-Governance. The most significant CSFs (top ranking CSF) of strategic ICT management Model can leads to the planners, Decision Makers to frame out a realistic plan for strategic ICT management regarding sustainable e-Governance of Bangladesh. The findings of this research may contribute remarkably to academics who are interested in working with strategic ICT management and sustainable e-Governance. Especially the CSFs, their ranking, developed new strategic ICT management model may be a milestone for the researchers to study the strategic ICT management for sustainable e-Governance in more details.

## 1.9 Research Outline

**Chapter two** provides an insight of previous studies related to e-Governance, CSFs for e-Governance, present stage of e-Governance and different e-Governance service in Bangladesh. Then, the theoretical framework of Fuzzy AHP method and Delphi method have been discussed. Finally, a conceptual framework for Fuzzy AHP and Delphi method were developed.

**Chapter three** presents the details of the research methodology. The researcher tried to provide a clear picture of the research philosophy, research approach, research strategy, research technique, expert selection, data collection process, research instrument, piloting process, and validity and reliability of the primary data.

**Chapter four** deals with data analysis, data presentation and discussion to address the research questions and related research objectives. A summary of expert's opinion of the respondents were presented here. The measure of significance/preference level of CSFs,

ranking of CSFs have been presented here. Finally, the findings of this research were discussed in this chapter. Finally farming out a new strategic ICT management model, which is depicted in this chapter. Sensitivity test of result findings also discussed here.

Finally, **Chapter five** deals with the theoretical, policy planners and managerial implications of this study. The recommendations based on the research's findings have been laid out in this chapter. The primary limitations of this study were also covered in this chapter, along with suggestions for future research direction.

# Chapter 2

## Literature Review

### 2.1 E-Governance

The term e-Governance is very familiar and trendy to everyone, but difficult to define uniquely. There are many definitions of e-Governance.

As (Joia,2006) gives the definition as, “E-government is still in its infancy as a subject of study, making precise definitions challenging”. World Bank (2009), defines the e-Governance as “e-Government is the use of information technologies by government organizations that can change how they interact with individuals, businesses, and other branches of the government. These technologies include wide area networks, the internet, and mobile computing”.

Organization for Economic Co-operation and Development (OECD, 2003) gave its opinion to define e-Government as “The use of ICTs, and particularly the Internet, as a tool to achieve better government “As per European Commission (2016), the definition of e-Governance is as “E-government is the process of utilizing information and communication technology in public administration. Demand-side elements of e-government include interactions between people or businesses and public agencies via ICT”.

Researcher (Chen et al., 2006), gave a big detailed definition of e-Governance as "a low-cost tool of improving communication between the government and its citizens by allowing online access to data and services. It also symbolizes the government's long-term commitment to improving ties between the public and private sectors through more effective, efficient, and affordable service, knowledge, and information delivery”.

E-Government has four dimensions in relation to the primary duties and pursuits of governments: Electronic delivery of government information is known as "e-Service," and other terms for it include "e-Management," "e-Democracy," and "e-Commerce." " The

terms e-Service means the electronically delivery the government information that is "e-Management" by using ICT which improve management and communication both inside and outside of government structures and also e-democracy which increases citizen participation in democratic activities (Cook et al., 2002)".

Citizens, businesses of private sector, government personnel, government agencies, and other governments are the main stakeholders of e-Government service recipients. There are primarily four forms of e-government: 1) Direct services provided by the government to citizens (G2C) 2), G2B refers to the exchange of services between the public and private sectors businesses. Communication between the government and its employees is known as "Government to Employee (G2E)" 4) Information is exchanged from one government agency to another at the local, national, and worldwide levels through government to government (G2G).

The advantages of enhancing e-Governance are: Improved efficiency of government service, Reduce TVC (Time, Visit and Cost) of service recipients, Better communication facilitation between governments with businesses and citizens, Online access of services, Transparency and less bureaucracy, increase e-participation, Reduce bribe, harassment and corruption, High speed communication.

In spite of the several advantages gathered from successful e-government implementation, there is also an infinite of disadvantages (Ndou, 2004). Among them some are: Lack of equality in public access to the internet and thus creates digital divide, Lack of trust, Increase cyber-crime, Hyper- surveillance by the Authority, False sense of transparency and accountability, Costly Infrastructure, Lack of confidentiality, Frequent Technical Failure.

Human capital, online service and infrastructure are the main three components for e-Gov. The graph about three index and e-Gov index has been given in **Figure 2.1** from 2003 to 2018.

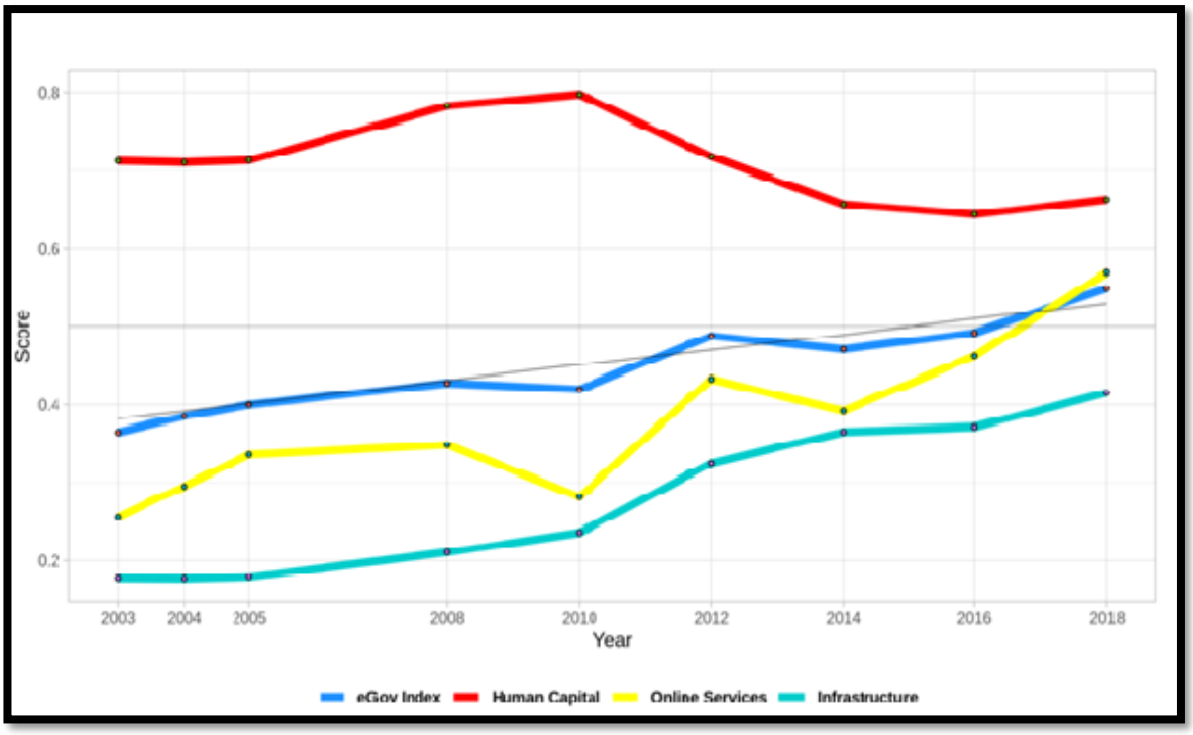



**Figure 2.1 : E-Government Index and Component ( Source: UNDESA e-Gov Survey,2018)**

The human capital decline started in 2010 and thus cannot be explained by the 2014 estimation changes. In any event, it is the only component that has experienced such a fate, decreasing 17% since 2010, albeit recovering a bit (about 3%) in the last report. The other two sub-indices have rapidly increased, particularly since that same year. Here, online services take top honors as it has risen by over 100% in that period. And for the first time in 2018, its average score beats that of EGDI. Comparatively, the latter has grown 30% in the last eight years. On the other hand, infrastructure has proven to be the most stable of all pillars, steadily increasing from the very start and reporting a 73% gain since 2010. Correlation wise, human capital does not manage to cross the 0.50 coefficient barrier when associated with both online services and infrastructure.

We thus have a situation where the steady growth in EGDI has been accompanied by a relatively significant decline in human capital indicators across the board. In the end, gains in EGDI have relied on the growth of both online services and telecom infrastructure with the former being the prime mover in the last four years. A simple regression analysis of the EGDI and its components indicates that online services account for 37% of the changes in EDGI. On the other hand, the e-participation index growth beats online

services as the former has risen almost 200% since 2010 but does not directly factor into EGDI calculations. The reason for such rapid growth is not apparent, however.

For the successful and sustainable e-Governance, e-participation is must. Since its inception, the e-participation index (EPI) has been a staple of the UNDESA e-Government survey. The organization is well aware of the complexities of measuring the use of ICT to foster stakeholder engagement. In this light, the concept is limited to the supply side of the equation and thus only looks at what governments are doing to promote citizen engagement, mostly via the qualitative analysis of national government websites. The survey distinguished three core e-participation features such as 1. Information sharing; 2. Consultation; and 3. Decision-making, which together are used to build the final EPI score. **Figure 2.2** shows the EPI by country income levels, ranked by EGDI.

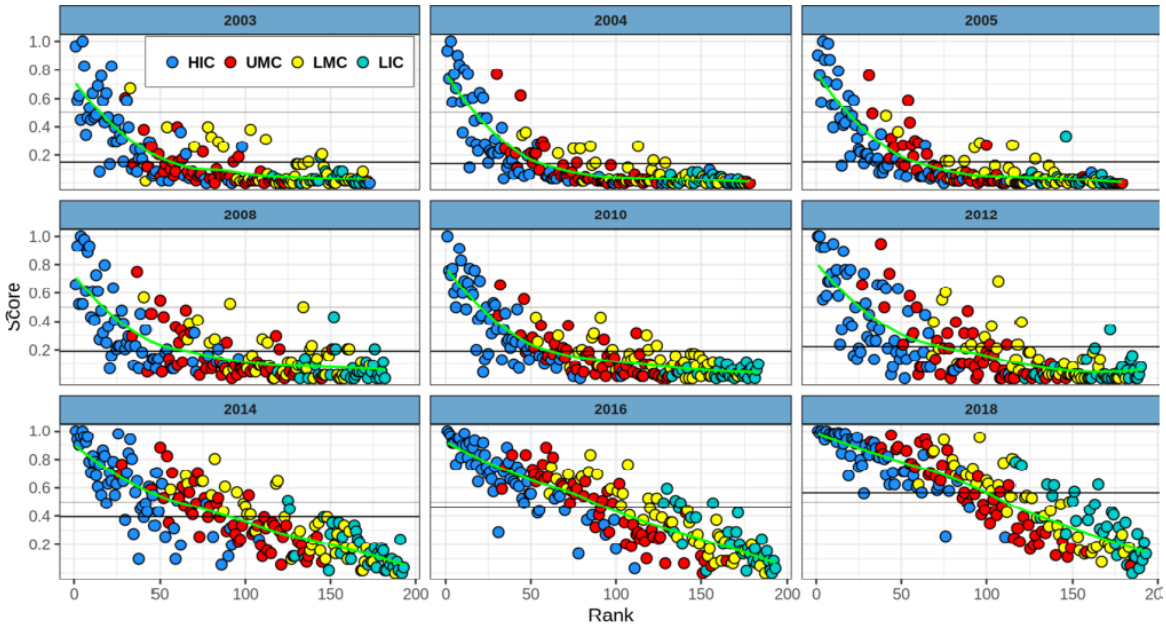



**Figure 2.2: E-Participation by Country Income level (Source: UNDESA e-Gov Survey,2018)**

## 2.2 E-Government Ranking of Bangladesh

There are many stages of e-Government implementation in countries all around the world. Therefore, evaluating a country's e-Government status is useful for developing policies and initiatives that are suitable for that country. A nation's standing in e-Governance and

e-Government can be determined using several indices and indicators developed by internationally renowned organizations.

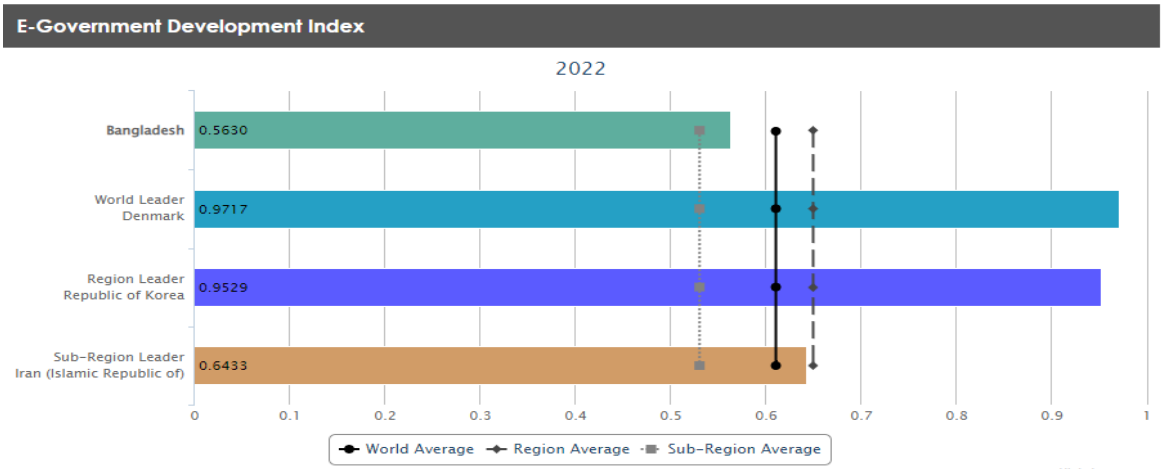
The UN Department of Economic and Social Affairs (UNDESA) developed the E-Government Development Index (EGDI), which examines how effectively a country uses ICT to serve its citizens with a diversity of e-Government services. This index assesses a nation's performance based on three sub-indices: Telecommunications Infrastructure Index (TII), Human Capital Index (HCI), and Online Service Index (OSI) . It yields a composite index that is graded on a scale from 0 to 1. The recent report reveals that Bangladesh was ranked 111th out of 193 countries and with a score of 0.5630. From the UNDESA'2022 report it is found that Bangladesh leads with the highest EGDI values among the LDC countries. Bangladesh scored 0.6521 in the Online Service Index (OSI), 0.446 in Telecommunications Infrastructure Index (TII), and 0.59 in Human Capital Index (HCI) (UNDESA e-Gov Survey, 2022) shown in **Figure 2.3** and **Figure 2.4.**

A crucial element of e-Government is the electronic connectivity between the government and the people. Global Connectivity Index (GCI) 2019, which was published by Chinese technology behemoth Huawei, Bangladesh is rated 73rd. The GCI calculated the rankings of 79 nations by considering factors including ICT investment, ICT maturity, and digital economic performance. Bangladesh received a score of 28 on that a scale while the United States scored 85.

Starters, Adopters, and Frontrunners are the three groups that GCI divided nations into based on performance. Because of the improved user experiences brought forth by more affordable fixed and mobile Internet, better cyber security, and cloud services, Bangladesh, a pioneer, has experienced a considerable increase in the demand for smart phones and mobile broadband subscriptions over the years. Currently, Bangladesh is seven positions ahead of Pakistan ,76th with a score of 27, and three position bellow of India, 65th with score 34. (Rust and Kannan, 2016).

Bangladesh was listed as one of the Top Movers in the report, along with Ukraine, South Africa, and Algeria., that adopted digital technology the fastest for altering their economy (Huawei Report, 2019).

The growth and advancement of ICT (Information Communications Technology) in every aspect of human existence transforms people to interact with society, as well as the ways that people accomplish their jobs in relation to one another. We can refer to the current era as the "Information & Communications Technology" era as a result of these advances, which transformed human societies into scientific societies and people into consumers of information networks (Telali et al., 2003).




| E-Government Development Index | 2022 | 2020 | 2018 | 2016 | 2014 | 2012 | 2010 | 2008 | 2005 | 2004 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bangladesh (Rank) | 111 | 119 | 115 | 124 | 148 | 150 | 134 | 142 | 162 | 159 | 159 |
| Bangladesh (Value) | 0.56300 | 0.51890 | 0.48620 | 0.37995 | 0.27572 | 0.29913 | 0.30278 | 0.29360 | 0.17618 | 0.17875 | 0.16537 |

**Figure 2.3: E-Government Develop Index (Source: UNDESA e-Gov Survey,2022)**

Bangladesh also increases the rank in E-Participation. As per the report of United Nations Bangladesh's rank in 2022 is 75 which was 95 in 2020, that means advances in -20, shown in **Figure 2.4.**

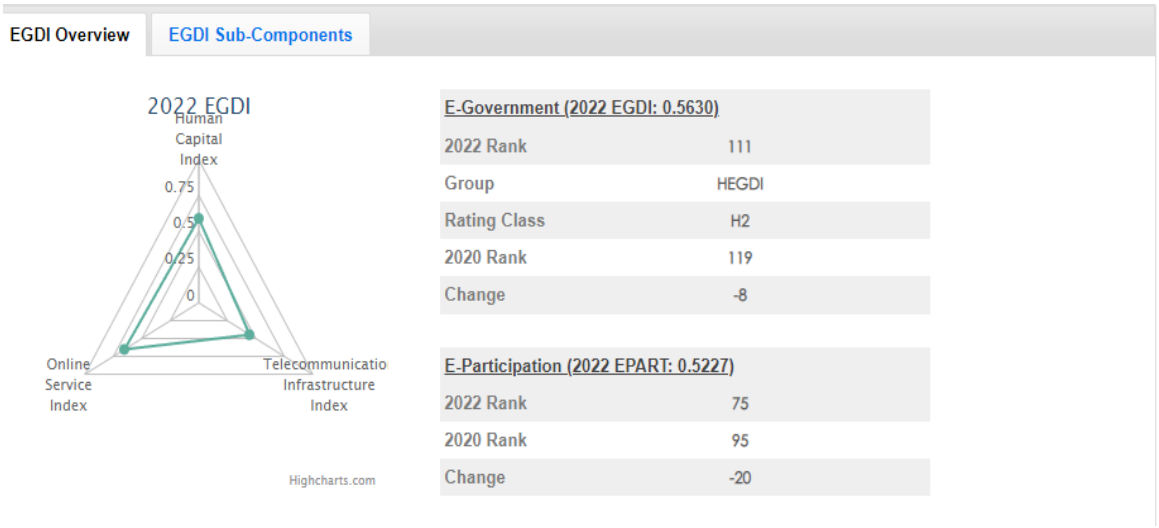



**Figure 2.4 : EGDI and E-Participation Upgradetion of Bangladesh (UNDESA Report , 2022)**

According to a research produced by Huawei, a Chinese tech giant, Bangladesh has maintained its momentum in the ICT sector despite the Covid-19 epidemic based on the development of digital infrastructure and competencies in 79 economies. In compared to previous year, the nation has made advancements in the domains of broadband, the Internet of Things (IoT), and artificial intelligence (AI) (Global Connectivity Index Report, 2020) shown in **Figure 2.5**. In 2020, the country will experience improvements in 4G connection and international internet capacity, as well as more potential in AI and IoT, compared to last year.


**Figure 2.5 : GCI of Bangladesh ( Source: Report of Huawei, 2020)**

This report was published by Huawei based on a total of 40 indicators organized into the categories of supply, demand, experience, and potential. Frontrunners, Adopters, and Starters are the three categories into which the countries are categorized for evaluation. The first group includes Bangladesh, shown in **Figure 2.6**. The 2020 report has shown that Starters have made significant progress in broadband coverage. A digital transformation of sectors will aid nations in raising productivity, accelerating economic recovery, and fostering future competitiveness, claims this 2020 report.

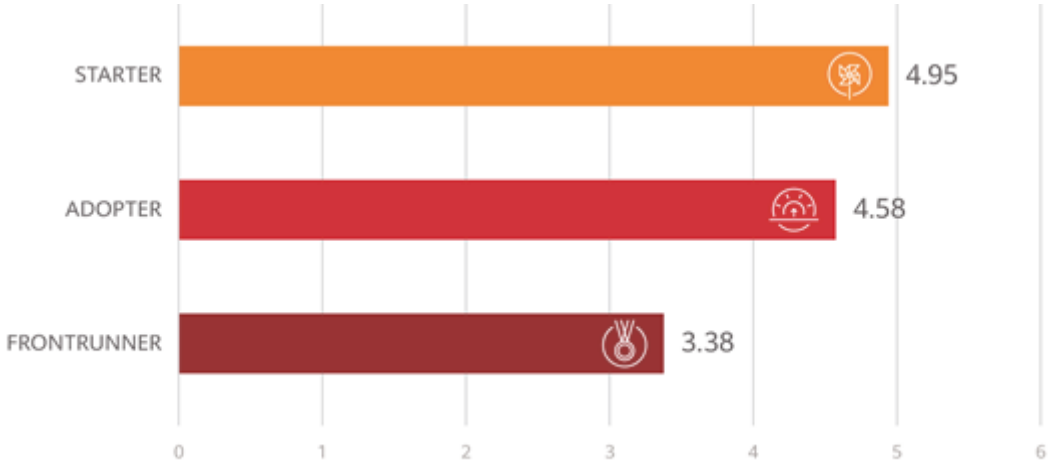



**Figure 2.6: GCI Annual Growth Rate, (Source: Huawei GCI Report, 2020)**

Bangladesh has a strong optical fiber network all over the country up to union level. At present all the Nationwide Telecommunication Transmission Network (NTTN) operators have laid around 1.34 lakh kilometers of fiber optic cables across the country (BTRC's 2019-2020 report). The primary NTTN operators for establishing optical fiber connectivity across the country are Bangladesh Telecommunications Company Limited (BTCL), Power Grid Company of Bangladesh (PGCB), Bangladesh Railways, and Summit Communication Ltd.

One of the top global indices measuring how information and communication technology (ICT) is being used and how it is affecting various economies is the Network Readiness Index (NRI). The NRI Report's most recent edition, which is for 2021, depicts the network-based ready environment for 130 economies depending on how well they execute across four main pillars: technology, people, governance and impact.

Global NRI position of Bangladesh was 95th out of the 130 economies included in the NRI report of 2021 (NRI Report, 2021).

## 2.3 E-Governance Evolution in Bangladesh

Bangladesh is a small country in area is 148,460 square kilometers (57,320 sq. miles) but population is huge about 169 million, most densely populated is the 8th largest in the world. Governance of this huge population in tiny land is always a big problem. E-Governance may be a suitable solution of this governance issue.

The evolution of e-Governance in Bangladesh had three major sequential phases (Siddiquee, 2013), but this is not limited to these three phases. The evolution phases of e-Governance are described below.

**Infrastructure Development Phase**: This phase was started at 1990's and ends at 2005. By automating Bangladesh Railway's ticketing system, the e-service was launched in Bangladesh. The computerization of the Bangladesh Bureau of Educational Information and Statistics ((BANBEIS)) and the Rajshahi City Corporation's e-birth registration project were two other noteworthy initiatives during this time. These initiatives boosted efficiency and automated already-provided services.

A strong ICT Task Force was established in 1997 to support and carry out ICT and e-Government initiatives, while Support to the ICT Task Force (SICT) was established in 2001. Each ministry now has an e-Governance Cell to coordinate e-Government operations. The National Computer Council, which was established in 1983 and later renamed the Bangladesh Computer Council (BCC) in 1990, was tasked for aiding e-Government initiatives. ICT was marked as a thrust sector in Bangladesh in its first ICT policy, which was came into action in 2002.

**E-services Introduction Phase:** It was from 2006 to 2009. Planning inside ministries and government agencies began to gradually replace the top-down approach with a participative one during this phase. The Access to Information (A2i) Program was formed

in 2006 with the main objective of ensuring that every person has easy, affordable, and dependable access to high-quality government services. Through the creation of physical and virtual access points where citizens can quickly, reliably, and affordably access public services, as well as through the support of non-government organizations partnering with governmental organizations. The aim of A2i was to enable citizens to participate in e-Government activities and empower government servants. The government announced its plans for a "Digital Bangladesh" in 2009. The conceptual idea was created for a transparent and functional government that could offer support to the underprivileged citizen and improve Bangladesh's ability to compete in a global market and economy. Government formulated different telecommunication policy, ICT Policy and Telecommunication Act, ICT Acts, passed in 2009 and onwards to boost up the digital Bangladesh initiatives.

**Integration Phase:** it started from 2010 and continues till now. Governments tended to consider e-Government services during this phase as integrated, networked, and transactional rather than as isolated. The integration of government services among agencies and platforms has undergone a number of significant changes. In 2014, a national portal was developed to ease the citizen service. A Digital Service Accelerator has been created to assist ministries for delivering e-Services efficiently. Leveraging ICT for Growth, Employment, and Governance (LICT), a project funded by the World Bank, from 2013 to 2019, which improved the performance of the ICT sector, also assisted the government in providing digital services.

The Bangladesh Computer Council (BCC) developed the e-Government Interoperability Framework (e-GIF) and Bangladesh National Digital Architecture (BNDA). The advantages of BNDA include improved governance that is centered on the needs of the citizen, coordination and communication among government wings, delivering services with less costly, efficiently and smartly, reusing existing infrastructure and services, and establishing standards for ICT goods and services. The national e-service bus is being connected by many departments to their electronic services. The renowned World Summit on Information Society (WSIS) prize was won by BNDA. In order to provide its citizens with better, faster, and more secure digital services, Bangladesh has developed a "Whole of Government" ICT Strategy. As block chain is the most secure technology in the world,

BCC has been developed a block chain platform has to link internet services and systems with the goal of more securely preserving content. This platform's primary function is to detect the usage of false credentials or certificate such as admit cards.

**Quality Implementation Phase:** For e-Governance, Bangladesh has been completed all the necessary phases. Now from 2020 to onwards, it was emphasized to deliver quality service with less cost. Presently many ICT service provider operators or organizations are doing Service Level Agreement (SLA) contract with 99.99% availability of service and these are maintaining the SLA contract. From that it is clear, the service quality of e-Governance has been increased significantly. Bangladesh also has developed a world class tier four data center at Kaliakair, Gazipur and formed a new company named Bangladesh Data Centre Company Limited (BDCCL). Hi-tech parks are also being established in different district of Bangladesh. A high-powered Domestic Network Coordination Committee (DNCC) under Prime Minister Office is also working for fostering the e-Governance services. Bangladesh Internet Governance Forum (BIGF) has also been formed which works in conjunction with the United Nations Internet Governance Forum (UNIGF) for policy making for both public and private sector.

### 2.3.1 ICT Related Policies and Acts

Policies and acts are very important for strategy implementation. Presently the major ICT related policies and acts which are prevailing and regulating the services are as follows:

a. Telecom Policy 1998
b. National ICT Policy 2018
c. ILDTS policy 2010
d. National Broadband Policy 2009
e. Bangladesh Telecommunications Act, 2010
f. Bangladesh Telecommunication Regulation (License) Regulations, 2022

**And the proposed and drafted policies and acts are:**

a. Telecommunication Network Policy, 2023
b. National Broadband Policy 2022
c. Regulation for Digital and Social Media Platform, 2022
d. Quality of Service Regulations, 2022

## 2.4 E-Governance Service in Bangladesh

Similar to other developing nations, the government of Bangladesh is a major provider of public services and information. In Bangladesh prior to 2008, the concept of offering government services digitally did not exist. The government is already capable of offering 70% of services online and aims to provide 100% by 2023. Below are some examples of effective e-Government programs and services in Bangladesh.

**e-Nothi:** To make the dream true, 'Vision-2021' Government of Bangladesh has emphasized on Digital Bangladesh, and so far, has made enormous progress in making more and more services available at the doorsteps of the people with increased digitalization where possible. By this time, the government of the country has applied a large number of projects relating to digital technologies, and a vast number of these are ongoing. As the government remains steadfast in its pursuit of simplifying public services through digitization, simultaneously it is focusing on digitizing government offices across the border and building capacity of civil-servants to become more technology savvy. The 'e-Nothi' system is a result of this intention, launched to make the government administrative activities more efficient and effortless along with the goal of establishing paperless government offices while diminishing the manual system (An Evaluation of 'eNothi' System in Government Office Management, 2019).

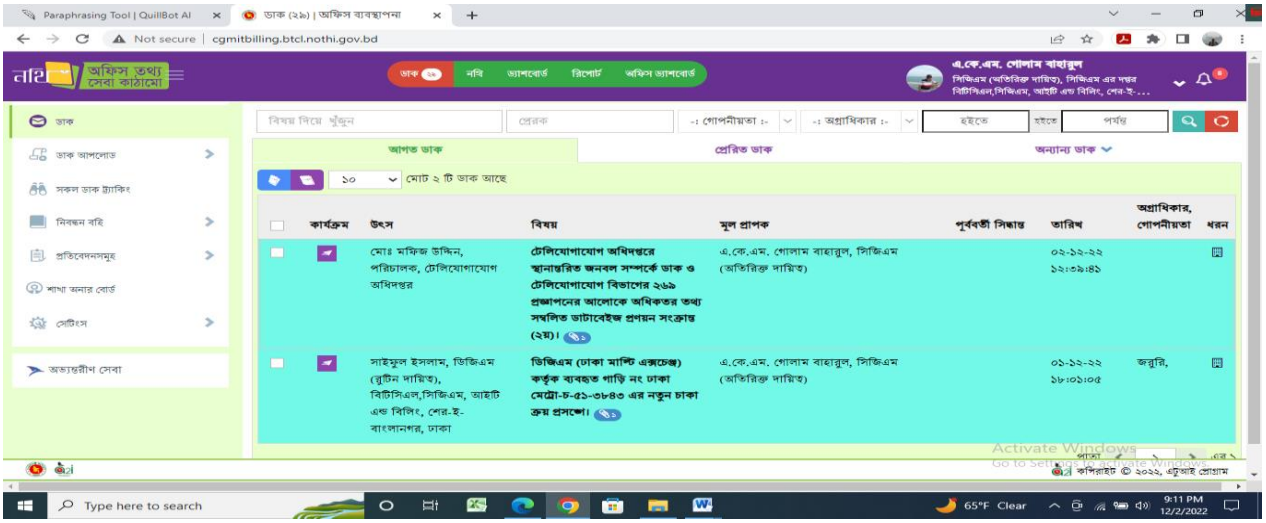



**Figure 2.7: e-Nothi personal Dashboard**

An assessment study was conducted at the end of 2018 on the 'e-Nothi' system. Since launching in 2016, e-nothi system has been working very effectively, and the government officials are becoming habituated with the system. On an average 72% of the total official, activities are performed through 'e-Nothi'. The significant effect has shown in office management which has become more accessible by disposing of the files very quickly. The study also found how the system is creating efficiency in the work process of the civil servants, leading to additional time to focus on citizens' need (An Evaluation of 'eNothi' System in Government Office Management, 2019). **Figure 2.7** shows the personal dashboard of e-nothi.

Among 19,000 government offices, more than five thousand offices are live and using e-Nothi. To date, total users of the system are 69,290. The monitoring authority has provided training among 8, 686 officials to develop the system using capacity and this program is ongoing. The Facebook Group, Mobile application (portable workstation) and hotline number is playing a significant role in smooth and make user-friendly of this system (System in Government Office Management, 2019).

**Web portal of Bangladesh:** The national web portal of any nation serves as a hub for all e-Government initiatives and directs online visitors to relevant connections. In 2014, Bangladesh unveiled its national web portal. This portal provides access to every administrative division in Bangladesh, from the local to the national level. It expanded to

become the largest public portal in the entire world with more than 25,000 webpages. The National Web Portal of Bangladesh has already added two million contents and 700,000 public servant's electronic directory (Tanveer, 2021).

**Forms Portal of Bangladesh:** Maximum Government forms and application are now found in the form portal which was established in 2015 to give individuals access to a single web platform. From this platform citizen could download, fill up, submit the form and application for different government services. This service is a significant step towards e-Government. About now 1,400 forms are now available in this portal (Tanveer, 2021). More online form submission options and downloadable forms are being introduced day by day.

**Trade Portal of Bangladesh:** The first of its type in South Asia, Bangladesh created an online trade portal in 2016 with the goal of providing the business community with a one-stop location for information pertaining to export-import. Basic information about conducting business in Bangladesh, such as an introduction of the Bangladeshi economy, current merchant regulations and procedures, an import and export guide, the steps involved in starting a firm, etc., is now available to anybody from home or abroad (The World Bank, 2016).

**Birth and Death Registration:** In order to plan and provide vital services, the government of Bangladesh introduced the online Birth Registration Information System (BRIS) in 2010. This system allows the government to keep track of every person. There are currently 5029 register offices throughout the nation, including 4571 union councils, 319 municipalities, 15 cantonment boards, 124 zonal offices of 11 city corporations, and 53 registrar offices of Bangladesh missions abroad that together make up a total of 5082 register offices that conduct online birth and death registration (Registrar General Office, 2000), portal is shown in **Figure 2.8**.

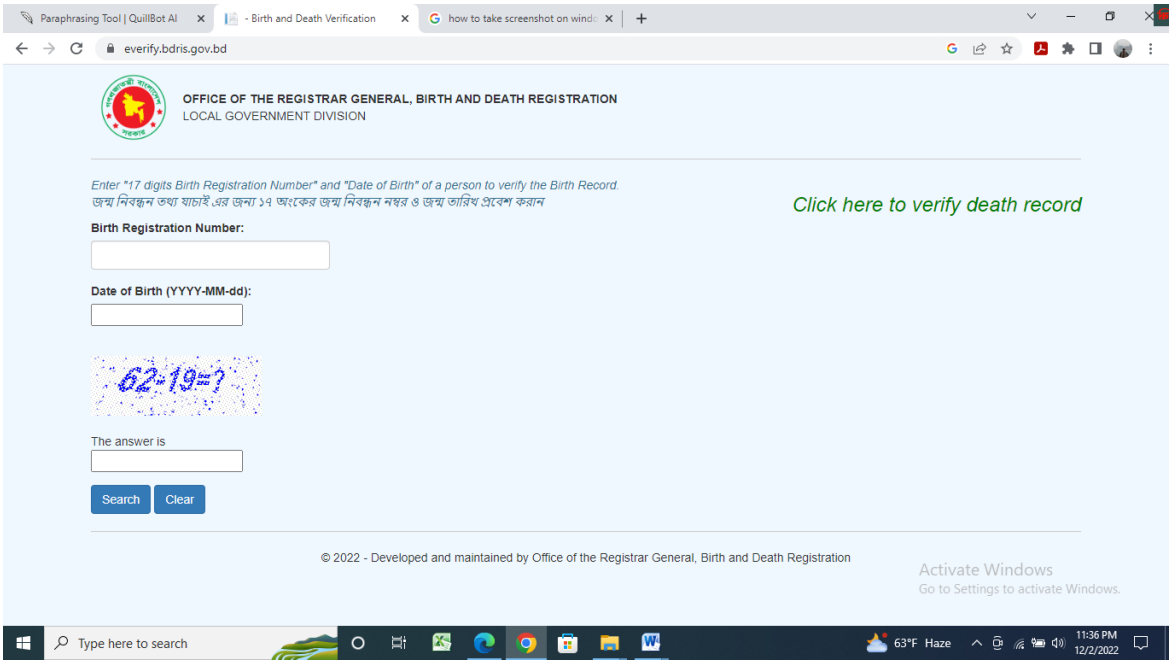



**Figure 2.8: Online Birth and Death certificate verification**

**Online NID Services:** Without going to any office, citizen can correct the name, spelling or any other correction through NID online portal with submission of required documents. Citizen can also apply for new NID through the online NID Portal. The portal is shown in **Figure 2.9.**

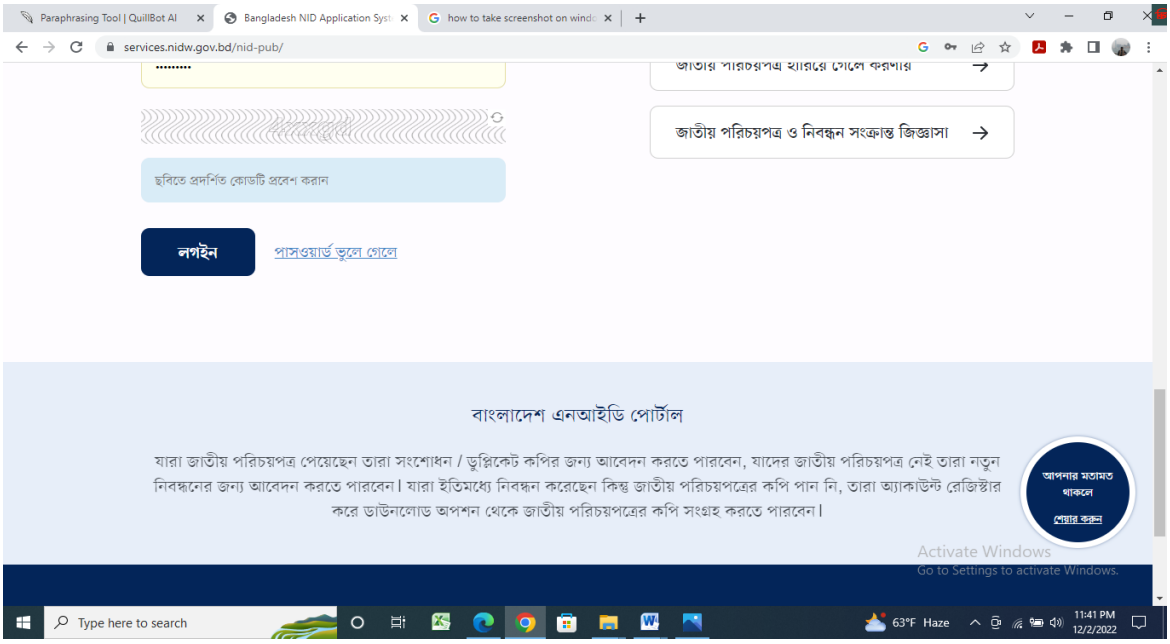



**Figure 2.9: Bangladesh NID portal**

**E-Government Procurement (e-GP) System:** e-Government Procurement system of developing countries can contribute to transparent, efficient and hassle-free procurement in the Developing countries (Haque, Latiful., Hossain, Gahangir., et al,2006). Bangladesh has also taken the initiatives for the public procurement by e-GP (Haque, Latiful., Hossain, Gahangir., et al, 2006). At Present, the Central Procurement Technical Unit (CPTU), IME Division of the Ministry of Planning, develops, owns, and operates the National e-Government Procurement (e-GP) portal for the Government of the People's Republic of Bangladesh. The e-GP system gives public agencies, such as procuring agencies (PAs) and procuring entities, an online platform to conduct procurement activities (PEs). The government established a comprehensive e-GP solution to increase the expertise and transparency in public procurement. E-GP portal is shown in **Figure 2.10.**

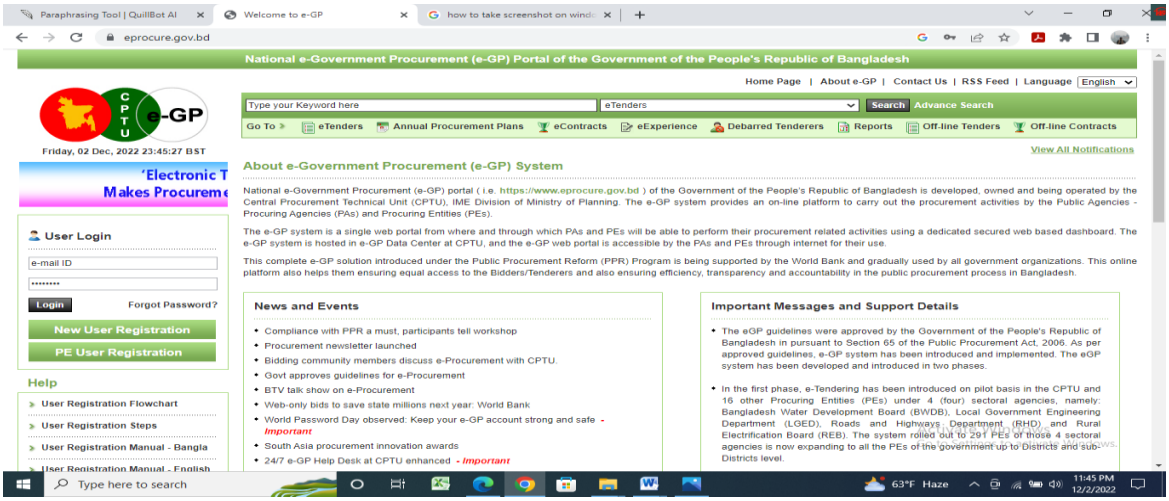



**Figure 2.10: e-GP portal**

**iBAS++ System**: Ibas++ (Integrated Budget and Accounting System) is the government of Bangladesh's integrated financial management information system. It is a centralized, Internet-based, Oracle-based program that performs the creation of budgets, their distribution to field offices, fund releases, re-appropriations, online submission of pay and other bills, payment processing via EFT, cheques and payment orders, accounting of all government receipts and payments, automated bank reconciliation, etc. The system will present a complete view of the government's financial holdings and liabilities at any given time. The iBas system includes four essential features: General Ledger, Accounting, Budgeting, and Budget Execution. Portal is shown in **Figure 2.11.**

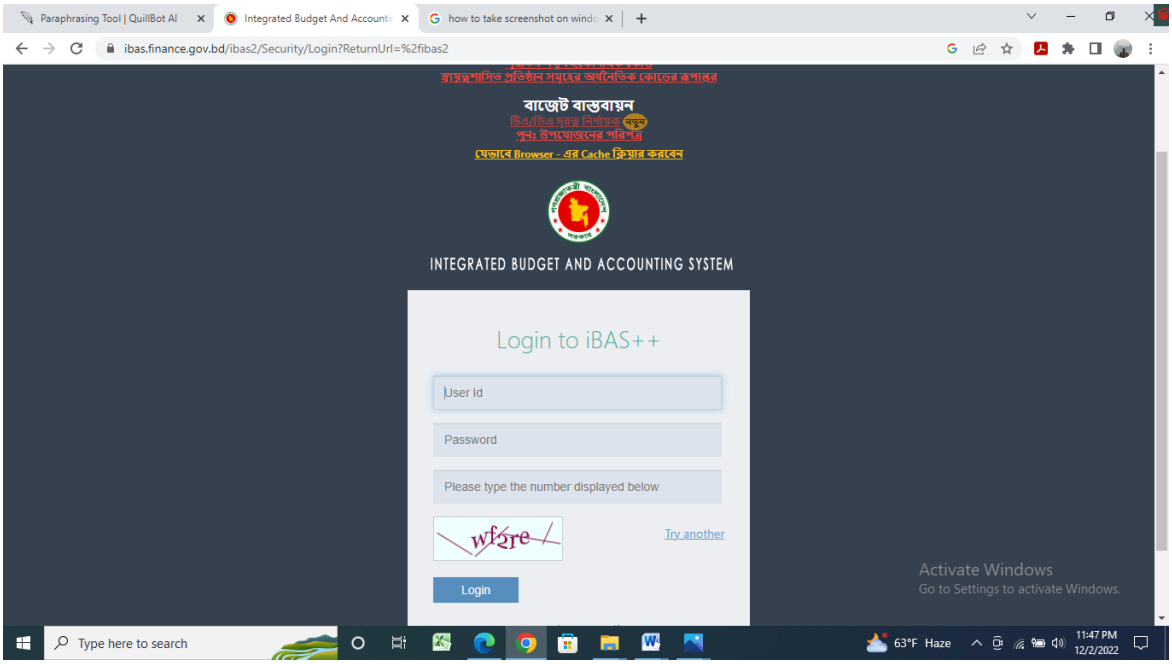



**Figure 2.11: iBas++ portal**

**Access to Information Programme**: In order to expedite the government's aim to turn the nation into a Digital Bangladesh, the UNDP helped launch the a2i program in 2006. The access to information programme (A2i) project under the Prime Minister's Office is the true hub of Bangladesh's e-Government efforts since it makes policy decisions, implements e-Governance initiatives, directs and assigns ministries and agencies specific roles. (A2i, 2020).

**Online Tax System:** In 2013, Bangladesh's e-TIN (Electronic Taxpayers Identification Number) registration process began. By applying through the NBR web portal, anyone can obtain a TIN certificate in less than ten minutes. Potential taxpayers can register, compute their taxes, and then prepare and submit their tax returns if the case is simple.

**E-Porcha**: Bangladesh was using colonial land management practices. Bangladesh is now implementing the e-Porcha, a modern digital land management system. Before introducing e-service, it was difficult to get land document and it was also costly and time consuming. The old system was replaced by E-Porcha, a modern digital system which also introduced an electronic system for receiving papers and digitalized land records. (A2i, 2018).

**Introduction of E-Health:** Health sector of Bangladesh has done huge work through digital connectivity. Citizens can now use telemedicine services in addition to the conventional methods of medical consultation. Virtual private network (VPN) technology connects every government hospital, from the neighborhood level to the specialized national level, and all of them are outfitted with a webcam and a mobile phone. The designated doctors can be contacted by the public for free medical advice, and patients of local hospitals can consult with specialists via video conference. (Hoque et al., 2014).

**E-Passport:** Bangladesh introduced online application for e-Passport service. Citizen do not need to go to passport office physically for application. Only for bio-metric entry applicant has to go to the respective office. Thus, citizen saves their Time, Visit and Cost (TVC). Online portal of e-Passport is shown in **Figure 2.12.**

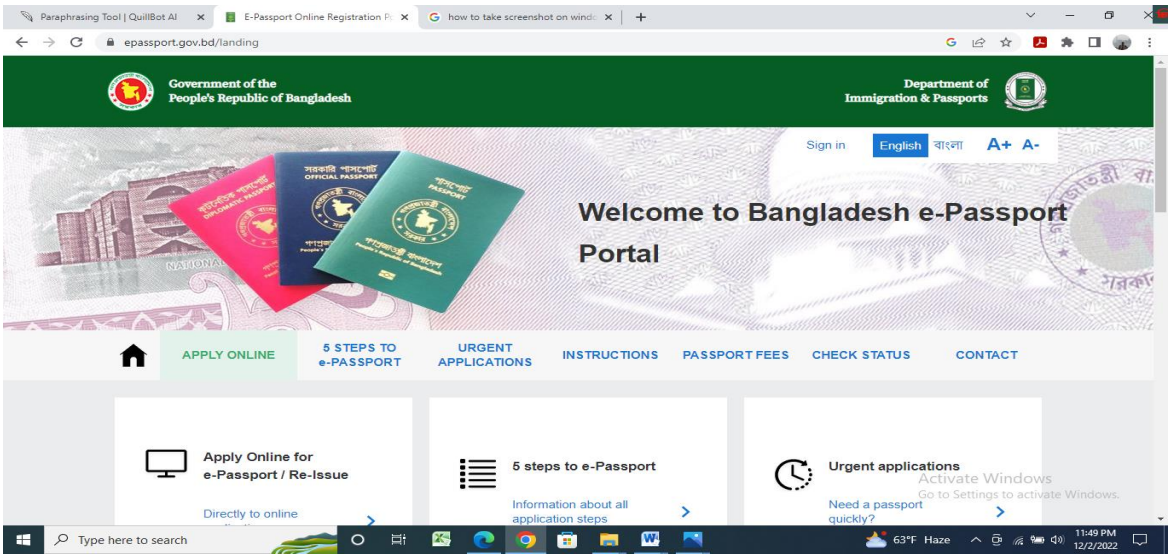



**Figure 2.12: Online E-passport portal**

**Online GD System:** Online GD Application can be made from now on in Bangladesh. The general diary application for all police stations in Bangladesh can be found on the website gd.police.gov.bd. You can apply online from home for a GD for any purpose. The application can be completed easily with the National Identification NID Card information. From now on, the victim will not have to go to the police station physically. It was officially introduced from June21, 2022 shown in **Figure 4.13**. This e-Governance services reduces the citizen's time, visit and cost.


**Figure 2.13: Online GD portal**

**G2P and P2G Payment System**: Government Social Safety Net (SSN) online payment initiatives were debuted in 2018 and are now being paid digitally this safety net payment. Currently, around 140 SSN programs are being managed by 23 Ministries and Divisions all over the country. Both parties, the receiver and the government will save a great deal of time and money when the manual SSN payment system is converted to digital. A initiative named e-Challan and A Challan has been introduced to begin the procedure of transferring a person's money directly to the government treasury and it is now working fine. Along with the traditional method of submission, the following fees can be paid via e-Challan or by online payment: ekpay: passport fee, national ID correction price, fee of clearance certificate from police, VAT, Tax payment and many more (A2i Report, 2020).

**Introduction of UDC**: Union Digital Centers (UDCs), placed at the base of the administrative pyramid, provided a gateway for the general public to e-Services and are widely regarded as a significant initiative in Bangladesh's e-Government. By serving as a single point of contact for information and service delivery, these UDCs decentralized the

provision of public services. One male and one female entrepreneur jointly run these centers as micro-enterprises, which offer services like birth and death registration, exam registration, telemedicine, job applications, passport applications, mobile financial services, citizen certificates, photocopying, photography, computer composition, internet browsing, paying utility and electricity bills, job searches, and land records using present ICT, etc. Already, 76.8 million citizens have received 323 million services through these digital centers (A2i Report, 2018).

**Some Other e-Governance Service:** Bangladesh national Digital Architecture (BNDA), Online Covid-19 vaccine registration, National Information Center (333) and Police (999), Online agricultural advisory service, myGov which integrates 1875 government service in one platform etc. About 52,000 Govt. web site have also been developed for information and government services shown in **Figure 2.14** (A2i Report, 2021).


**Figure 2.14: myGov web portal**

## 2.5 Critical Success Factors

**CSF:** Critical Success Factors (CSF) are particular components or areas of action that a company, team, department or organization must concentrate on and effectively implement in order to achieve its strategic goals. These success elements should be effectively implemented in order to provide a favorable result and add value to the company or organization.

The phrase "critical success factors" refers to a small set of elements that, when combined, will guarantee competitive performance and success for an individual, a group, or an organization. (Alazmi and Zairi, 2003). The produced results of the organization's efforts will be subpar if these aspects are not given due attention (Thierauf, 1982).

The CSFs highlights the important organizational issues, especially those relating to management (Rockart, 1979). Although CSFs don't directly contribute to the strategy's advancement, they do make a substantial contribution to the strategy's development process.

When the CSFs are combined with a complete strategic planning method, they function as elements that are vital to an organization's success. In this research work, from the literature review, we are exploring to find the CSF for strategic ICT management regarding sustainable e-Governance in Bangladesh.

There are different techniques to identify the CSFs, these are:

1. The most common way for creating a list of CSFs is to conduct a literature review. (Nien Tuan, 2020). However, it is advised that researchers take note of the fact that each business or organization or country's CSFs is unique to that particular industry or organization or country (Rockmart, 1979). Therefore, it is dubious to assume that discovering invariant CSFs through literature will apply to all businesses and organizations or country. Actually, it depends on the organization's and the nation's actual situation.

2. In qualitative research, interviews are a frequent method of choice. Additionally, they are employed for CSF identification (Shah and Siddiqui, 2006).
3. There are other approaches used for identifying CSFs as well, such as Analytic Hierarchy Process, AHP (Chua and Kog, 1999)
4. There is another approach for identifying CSFs, such as brain storming and from the relevant experience and important current issues.

### 2.5.1 E-Governance Success Factor

Examining the use of online government services in thirty nations, it was found that the countries with the highest per capita GDP, the best Internet connectivity, the most competitive and open ICT environment, and the most ICT investment are the ones with the highest ICT utilization (Prattipati,2003).

For the successful implementation of e-Governance in India include the lack of understanding among the populace, a lack of content, and concerns about the protection of personal information Mittal and Kaur, 2013)

Researcher Schuppan disputes the idea that there is a Using a "one size fits all" strategy, underdeveloped countries can deploy e-government. He concluded that Sub-Saharan Africa's e-Government initiatives won't be successful after looking at them, by simply importing technology and content from affluent nations because the context in developing countries is different (Schuppan,2009).

By contrasting India, Pakistan, and Bangladesh's government's use of ICT with that of Korea, it was found that the three South Asian neighbors' desire for a true e-government was out of reach due to the high cost of technology, a weak private sector, a lack of infrastructure, and a lack of human resources (Jin-Wan & Hasan,2015).

Insufficient ICT infrastructure, online service index, e-Participation index, a lack of human resources, low levels of trust, telecom infrastructure components, and a lack of

knowledge were found to be some of the major obstacles to achieving e-Government in Bangladesh ( Liton and Habib, 2015).

Successful electronic government (e-government) projects are challenging to implement in many developing nations. Since there is inadequate ICT infrastructure to provide e-government services, a significant portion of these challenges are caused by citizens not using themIn addition to the fact that only a small proportion of people can use such technologies. For successful implementation of e-Governance, there are two major factors, one is electronic readiness and another is trust (Abdelghaffar ,2010).

According to the Unified Theory of Acceptance and Use of Technology (UTAUT), it offers a comprehensive perspective on user acceptance. It is discovered that the usage of ICT is positively impacted by performance and effort expectations, social influence, and facilitating conditions (Gupta and Dasgupta, 2008).

E-Government can help to reduce corruption. Government must give emphasis to improve technological weakness, lack of infrastructure, shortage of human resources, and low budget to successfully adopt e-Government and overcome its challenges (Wan and Hasan,2016).

Lack of strong leadership and political will, political-administrative instability, and reluctance to change inside organizations are some of the major issues related with e-Government (Basyal and Wan, 2016).

The infrastructure in developing nations is insufficient for the successful implementation of e-government initiatives ( Baheer et al., 2020, Hanum et al. 2020, Heeks,2003, Kanaan et al. 2019).

Interoperability in the context of e-government refers to the capacity of separate systems and gadgets to communicate with one another and share resources. (Apleni and Smuts,2020, Sulehat and Taib,2016).

The success of e-government depends heavily on the human resource component. ICT expertise is required to improve the efficient implementation and use of online services after the infrastructure has been set up (Farzianpour et al., 2015).

However, a number of studies have found that the main human factor impeding the implementation of e-government programs is a lack of ICT skills (Aneke, 2019; Khan & Ahmad, 2015; Owusu-Ansah, 2014).

Due of individuals' and government employees' insufficient ICT capabilities, e-governance has failed in underdeveloped nations. Several studies on crucial success elements in the deployment of e-government in developing countries have noted that, in addition to a lack of skills, government employees also lack the knowledge necessary to create, run, and maintain e-government systems (Owusu-Ansah,2014, Aneke, 2019; Khadaroo et al., 2013; Layne & Lee, 2001).

Policy is a deliberate course of action intended to direct choices and achieves wise results (Dias, 2020). One of the elements influencing the implementation of e-government is the problem of necessary policy as well as forms. This is so that various regulations and acts to control electronic activities can be implemented in conjunction with the development and use of e-government systems (Apleni & Smuts, 2020). There isn't a well-defined policy for implementing e-government in developing nations (Islam, 2013).

Clear vision and strategy, top management and government support, ICT infrastructure, and public awareness, education, distinct budget, citizen empowerment are the most important critical success factors (CSF) for an effective implementation of e-Government in Nepal (Bhagat et al., 2021).

Funding, ICT infrastructure, adequate legal and policy development, awareness, top management and government backing, engagement of stakeholders, Training, Civic engagement, communication and change management plan with a clear direction, objectives of government departments are the Critical Success Factors (CSFs) for successful e-Government (Apleni, and Smuts 2020).

The success factors for the implementation of strategic ICT management for e-Governance success identified in the literature are summarized in **Table 2.1.**

**Table 2.1 Identified CSF from Literature Review**

| No. | CSF | Source: Literature Review/Author | Tally |
|---|---|---|---|
| 1 | Lack of People's Knowledge | Mittal & Kaur (2013) | I |
| 2 | Personal Information Security | Mittal & Kaur (2013),Liton & Habib (2015),Hany A. Abdelghaffar (2010) | III |
| 3 | Technology Transfer | Schuppan (2009) | I |
| 4 | Cost of Service | Jin-Wan & Hasan (2015),García, J.R,Theresa A.Pardo, T.A., 2005 | II |
| 5 | Infra-Structure Development and Resource Sharing | Jin-Wan & Hasan (2015),Liton & Habib (2015),Hany A. Abdelghaffar (2010) ,Wan and Hasan (2016) ,Baheer et al., (2020), Hanum et al. (2020), Bhagat, Sharma, and Mishra 2021,Apleni, and Smuts (2020) | IIIIIIII |
| 6 | Skilled Human Resource | Jin-Wan & Hasan (2015), Liton & Habib (2015),Hany A. Abdelghaffar (2010),Wan and Hasan (2016),Farzianpour et al. (2015),Aneke(2019) Khan & Ahmad ( 2015), Aneke (2019) and Khadaroo et al.(2013) | IIIIIII |
| 7 | Content Security | Mittal & Kaur (2013),García, J.R,Theresa A.Pardo, T.A., 2005 | II |
| 8 | Feeble Private Sector | Jin-Wan & Hasan (2015) | I |
| 9 | Online service index | Liton & Habib (2015) | I |
| 10 | e-Participation Index | Liton & Habib (2015) | I |
| 11 | Performance and effort expectancy | Gupta and Dasgupta (2008) | I |
| 12 | Acceptance in Socio-Cultural aspects | Gupta and Dasgupta (2008),Kanaan, A.G, Shahizan, B. H., Shahzad, A., 2016 | II |
| 13 | Facilitating conditions | Gupta and Dasgupta (2008) | I |
| 14 | Technological weakness | Wan and Hasan (2016) | I |
| 15 | Low budget | Wan and Hasan (2016) | I |
| 16 | lack of strong leadership | Basyal and Jin-Wan (2016) | I |
| 17 | Government Policy | Basyal and Jin-Wan (2016),Bhagat, Sharma, and Mishra ( 2021),Apleni, and Smuts (2020),Darmawan Napitupulu, Dana Indra Sensuse,(2014 ) | IIII |
| 18 | Political-administrative instability | Basyal and Jin-Wan (2016),García, J.R,Theresa A.Pardo, T.A., 2005 | II |
| 19 | Awareness of Citizen | Basyal and Jin-Wan (2016),Aneke(2019) Khan & Ahmad ( 2015) ,Bhagat, Sharma, and Mishra (2021),Apleni, and Smuts (2020) , Darmawan Napitupulu, Dana Indra Sensuse,2014 | IIII |
| 20 | Interoperable depicts | Apleni & Smuts (2020); Sulehat & Taib (2016 | II |
| 21 | Resource Sharing | Apleni & Smuts (2020); Sulehat & Taib (2016 | II |

| No | CSF | Source: Literature Review/Author | Tally |
|---|---|---|---|
| 22 | Lack of expertise by government employees | Aneke (2019) and Khadaroo et al.(2013) | I |
| 23 | Training | Bhagat, Sharma, and Mishra ( 2021) | I |
| 24 | Citizen empowerment | Bhagat, Sharma, and Mishra ( 2021) | I |
| 25 | Separate funding | Bhagat, Sharma, and Mishra ( 2021) | I |
| 26 | Funding | Bhagat, Sharma, and Mishra ( 2021) | I |
| 27 | Legal Protection | Apleni, and Smuts (2020) ,García, J.R,Theresa A.Pardo, T.A., 2005 | II |
| 28 | User computer efficacy | Apleni, and Smuts (2020) | I |
| 29 | Stakeholder involvement | Apleni, and Smuts (2020) | I |
| 30 | Clear vision and strategy | Apleni, and Smuts (2020) | I |
| 31 | Training, Government departmental goals | Apleni, and Smuts (2020) | I |
| 32 | Availability of Service | Hakim, M.L., Rahayu,A., Eeng Ahman, Wibowo,L.,A., 2022,Darmawan Napitupulu, Dana Indra Sensuse, 2014 | II |
| 33 | Quality of Service | García, J.R,Theresa A.Pardo, T.A., 2005, Kanaan, A.G, Shahizan, B. H., Shahzad, A., 2016,Abdelsalam, H., Reddick, C.,G., ElKadi, H,2012 | III |
| 34 | Citizen empowerment | Apleni, and Smuts (2020) ,Darmawan Napitupulu, Dana Indra Sensuse,2014 | II |
| 35 | Resource Consumption | Researcher, Brain Storming and Experience as Environmental Issue is very Vital now. | Author |
| 36 | Resource Conservation | Researcher, Brain Storming and Experience as Environmental Issue is very Vital now. | Author |
| 37 | Environmental Hazard | Researcher, Brain Storming and Experience as Environmental Issue is very Vital now. | Author |
| 38 | Political Factor | García, J.R,Theresa A.Pardo, T.A., 2005,Darmawan Napitupulu, Dana Indra Sensuse,2014 | II |
| 39 | Legal Factor | García, J.R,Theresa A.Pardo, T.A., 2005 | I |
| 40 | User perceived Benefit | Abdelsalam, H., Reddick, C.,G., ElKadi, H,2012 | I |

## 2.6 Research Gap

Firstly, there is evidence from the reviewed literature that different researcher mentioned the critical success factors (CSFs) of strategic ICT management regarding successful e-Governance. Literature review shows a recurring set of CSFs that are common across various ICT and e-Governance studies. But it is difficult to find invariant CFSs which are suitable for all country or organization. The CSFs regarding strategic ICT management for sustainable e-Governance varies from country to country or organization to organization. The CSFs for e-Governance success in developed economy is different from less developed or developing country. Hence, it is logical to assume that there are no specific CSFs that are suitable for every country for strategic ICT management regarding

sustainable e-Governance. So, for Bangladesh perspective there is lack of research in identifying the proper CFSs, ranking the CSF, framing out a new model for strategic ICT management and sustainable e-Governance.

Secondly, from the literature review it is observed that ICT infrastructure, Resource Sharing, Available Skilled Human Resource, Government Policy, Cost of service, Cyber Security, Personal Information Security, Technology Transfer by Vendor, Cyber-attack, Legal Protection, Availability of Service, Acceptability in socio-Cultural aspects, Quality of Service and many other factors that are frequently reported by researchers in different name and notation. It is revealed from the literature review that the researcher does not consider the environmental factors for sustainable e-Governance. The author of this research considered the environmental factors such as Environmental Hazard, Resource Consumption and Resource Conservation for strategic ICT management and successful e-Governance. Because considering the present situation of the world the environmental issues are very important for any technology management and sustainability. The author also considers the Infra-structure development, Resource sharing as s single CFS named Infra-structure development and Resource sharing as these two factors are interrelated. This research gap will be fulfilled after completing this research study.

Thirdly, the research about the CSFs and their ranking, framing out a new model for strategic ICT management and sustainable e-Governance in the perspective of Bangladesh is not or rarely performed before.

So, after completing this research study it is expected to fulfill the research gaps in this area and would be able to add knowledge in this area.

## 2.7 Critical Success Factors for Assessment

Three techniques are used to identify the CSFs for this research work, firstly is literature review, secondly using of Delphi pilot study on identified CSFs, and thirdly the brain storming, relevant experience and related situation consideration. Based on these techniques, 5 (Five) Level 1 CSFs in broader aspects and 15 (Fifteen) Level 2 CSFs in specific aspects were identified for this research study. The identified CSFs are shown in **Table 2.2.** The brief description of level 2 fifteen CSFs have been given in **Table 2.3.**

**Table 2.2 Finalized CSFs for this study**

| **Broader Aspects CSFs for this study: Level-1 CSFs** | **Specific CSFs for this Study: Level-2 CSFs** |
|---|---|
| **Technological Factors** | Technology Transfer by Vendor (TFTT) |
| | Infrastructure Development and Resource Sharing (TTID) |
| | Available Skilled Human Resource (TTHR) |
| **Socio-Political Factors** | Government Policy (PFGP) |
| | Awareness of Citizen (PFAC) |
| | Acceptability in socio-Cultural aspects (PFASC) |
| **Economic Factors** | Cost of service (EFCS) |
| | Availability of service (EFAS) |
| | Quality of service (EFQS) |
| **Security Factors** | Cyber Security (SFCS) |
| | Personal Information Security (SFPIS) |
| | Legal protection (SFLP) |
| **Environmental Factors** | Environmental Hazard (ENFEH) |
| | Resource Consumption (ENFRC) |
| | Resource Conservation (ENFRCV) |

**Table 2.3 Brief description of CSFs**

| Name of CSF | Brief description of CSF |
|---|---|
| Technology Transfer by Vendor | Technology transfer, also called transfer of technology (TOT) refers to the process of moving (disseminating) technology from one person or entity to another person or entity. |
| Infrastructure Development and Resource Sharing | ICT Infrastructures are all the information and communications technology infrastructure and systems including software, hardware, firmware, networks, and the company websites that are used in organizations of the country and all the resources installed by the different organizations should be shared in a proper manner for optimal result. |
| Available Skilled Human Resource | The manpower who has attained complete skills and knowledge in ICT is knows as Skilled Human Resource for ICT. |
| Government Policy | A National ICT Policy, Telecommunication policy or other related ICT Policy are policies put into place by governments' and stakeholders' who are committed to the process of bringing digital technology to all individuals and communities so that they can have access to information can get services easily through online. |
| Awareness of Citizen | Awareness is a knowledge that something exists or understanding the situation or subject at the present time based on information or experience. For successful e-Governance citizen of the country must have to be aware about it. |
| Acceptability in socio-Cultural aspects | Acceptability in socio-cultural aspects refers to the acceptability of changes occurred in the society or organization for introducing ICT. It is very important to break the old system. |
| Cost of service | A cost is composed of three elements – Material, Labor and Expenses. Each of these three elements can be direct and indirect, i.e., direct materials and indirect materials, direct labor and indirect labor, direct expenses and indirect expenses. For sustainable and successful e-Governance cost of ICT services should be in reach of citizen. |
| Availability of service | Availability of service, in the context of ICT, refers to the ability of a user to access information or resources in a specified location and in the correct format. If ICT service is not easily available, citizen will be discouraged to use that service. |
| Quality of service | Quality of service (QoS) of ICT refers to manage data traffic to reduce packet loss, latency and jitter on a network or any other quality related issues. |
| Cyber Security | Cyber security is the application of technologies, processes and controls to protect systems, networks, programs, devices and data from cyber-attacks. It aims to reduce the risk of cyber-attacks and protect against the unauthorized exploitation of systems, networks and technologies. It is necessary both for the system and for the users. |
| Personal Information Security | Personal information security is a measure to protect from breaching the personal information which are given in online platform. |

| | |
|---|---|
| Legal protection | Legal protection refers to secure or preserve someone's right against encroachment, infringement, restriction, or violation in case of ICT usage. |
| Environmental Hazard | Environmental Hazard is referring to the environmental damage occurs due to the use of ICT and its infra-structure. |
| Resource Consumption | Resource consumption refers to the consumption of resources for introducing ICT and its platform in society, organization or country. |
| Resource Conservation | Resource conservation refers to the conservation of resources for introducing ICT in society organization or country. By introducing ICT and e-Governance, resource consumption can be reduced significantly and thus can get the benefit of resource conservation. |

## 2.7 Delphi Method: Theoretical and conceptual frame work

One of the outcomes of defense research may be said to be the Delphi idea. Beginning in the early 1950s, Rand corporation research on the application of expert opinion was funded by the Air Force and known as "Project Delphi" (Dalkey and Helmer, 1963). In the initial study, the goal was to "get the most trustworthy consensus of opinion of a group of experts via a series of intensive surveys interspersed with controlled opinion feedback".

However, it took a subsequent initiative to bring Delphi to the attention of people beyond the defense industry due to the issue of this first significant Delphi study. The study's report was titled "Report on a Long-Range Forecasting Study" (Gordon and Helmer, 1964). The study's objective was to evaluate "the long-term trends, with a focus on science and technology, and their likely impacts on our society and the globe at large." The range of ten to fifty years was referred to as "long-range." The study was conducted to get meaningful results as well as to investigate the methodological facets of the approach. As far as tried-and-true methods of long-range forecasting are concerned, the authors discovered themselves in "a near-vacuum." Six issues were covered by the study: population control, automation, space exploration, war prevention, and armament systems. Individual respondents were asked to make predictions about potential developments in the future, and the group was then asked to determine the year by which there would be a 50% chance that the development would occur.

Many of the methods used in the Delphi are still used in the current pure forecasting Delphi's. In the early and mid-1960s, this study and a superb linked philosophical paper that provided a Lockean-type rationale for the Delphi technique served as the inspiration for a number of people to start experimenting with Delphi on non-defense topics (Helmer and Rescher,1960).

The Delphi Method seeks expert opinions on a challenging research issue for which there is a lack of exact data (Linstone and Turoff, 2011). In order to attain an acceptable convergence of opinion from a group of experts, the method places emphasis on systematizing group communication processes (Linstone & Turoff, 2011; Gupta & Clarke, 1996). Typically, extensive questionnaires are used to gather the research data that represents expert opinion. This process generates a variety of qualitative and quantitative data that may be analyzed. The results of the analysis will then dictate the format and substance of succeeding questions, and so forth, until a convergent group opinion has been developed (Gupta and Clarke, 1996). Delphi Technique is used in various area, as:

• Compiling historical and present data that are not precisely known or available.

• Analyzing the importance of historical occurrences

• Looking at options for regional and urban planning

• Developing a plan for the campus and curriculum of a university

• Developing a plan for the campus and curriculum of a university

• Outlining the benefits and drawbacks of different policy choices

• Establishing links between complicated economic or social issues.

• Differentiating and elucidating actual and alleged human motivations

• Outlining the importance of social and personal aims and ideals

The Delphi method has some common features. The primary features of the Delphi are (Amidharmo, 2014):

1. G**roup response**: The questionnaires are created such that statistical and quantitative analysis of the responses is possible (Landeta, 2006). A ranking-type answer, such as the Likert sliding scale, can be used to do this. For this research study scale is sued from 1-15, where 1 is the most significant and 15 is the least significant.

2. **Delphi participant's Anonymity**: This prevents individuals from feeling pressured to adopt the group's prevailing viewpoint, allowing them to freely voice their own thoughts. (Skulmoski and Hartman, 2007). This method also prevents any opinions from being distorted as a result of experts confronting each other directly because of their status or personality. ((Okoli and Pawlowski, 2004, Landeta, 2006).

3. **Feedback is controlled**: A study group coordinator receives the research data created during data collecting, processes it, removes extraneous material, and creates new questions depending on the information learned. (Landeta, 2006). With the help of this crucial feature, the Delphi study can be expanded to include previously unknown parameters or adopt the focused strategy required to address a particular research issue. One of the distinctive characteristics of the Delphi technique is its flexibility in study design.

4. **Iterative data collection:** The participants have the chance to reevaluate their opinions in light of the information they learn from the other participants when the questionnaire rounds are repeated (Landeta, 2006). This is how iterative data collection makes it easier for group opinion to develop over time. The number of questionnaire rounds is determined by the consistency or convergence of the answers, not necessarily by consensus (Linstone & Turoff, 2011).

"The significance of the Delphi is not in providing high reliability consensus data, but rather in making the participants aware of how complicated the topics are by pressing them to think and by challenging their presumptions. This contrasts with a more conventional panel or forum where consensus is sought after and occasionally imposed, resulting in falsifications of study data" (Linstone & Turoff, 2011).

Despite its advantages, the Delphi technique has a number of drawbacks (Gupta & Clarke, 1996; Yousuf, 2007; Linstone & Turoff, 2011) as:

1. Inappropriate expert selection may result in inconsistent responses and inadequate convergence of viewpoints, as well as a tendency to give inaccurate results.

2. Experts' poor motivation to participate or their belief that the study is meaningless or lengthy may both contribute to low participation and response rates.

3. Badly constructed questionnaires can perplex specialists, which could lead to the experts providing ill-thought-out responses as a result of their ignorance of the research topic.

4. Since some experts would unavoidably offer comparable comments, the iterative data collection process could also irritate the experts.

5. Due to a poorly crafted closed-ended questionnaire and the inclination of the Delphi approach, the consensus reached in Delphi may not be a true consensus.

6. Because all interactions are conducted on paper, the approach depends on the researcher and the subject matter specialists having great written communication abilities.

7. The specialists' effort and dedication are needed to fully implement the Delphi approach.

The above generally acknowledged limitations of the approach are taken into consideration during the planning and execution of the Delphi method in this study endeavor. To overcome the limitation and address the limitation in planning stage there was a precaution as mentioned in section 3.7 of Delphi Methodological flow chart. And in execution stage also some mathematical measures were taken as mentioned in section 4.3.1 and 4.3.2 of this research study.

### 2.7.1 Delphi Technique: Conceptual Framework

The Delphi method is a well-liked and respected way to collect information from respondents within their area of knowledge. The method is intended to achieve consensus of view on a particular real-world topic through group dialogue. The Delphi method has been used to develop a full range of alternatives, explore or expose underlying assumptions, as well as correlate judgments on a topic spanning a wide range of disciplines, in a number of different fields of study, including program planning, needs assessment, policy determination, and resource utilization.

The concept mapping procedure produced a conceptual framework, which subsequently directed the design of the survey (Alavi and Leidner,2001). The conceptual framework allowed the researchers to precisely characterize the issue under investigation and the systems necessary for knowledge transfer and information management in strategic ICT management. When a group of specialists cannot easily be collected together in one location and when an issue does not lend itself to exact analytical procedures but instead could benefit from the subjective opinions of individuals on a collective basis, that case the Delphi technique can be used (Villiers et al., 2005).

The conceptual framework of Delphi method for this research work was developed by the researcher which is shown in **Figure 2.13.** This conceptual framework was used to examine the Critical success factors and the ranking of CSFs for framing out a new new model of strategic ICT management in regarding sustainable e-Governance in Bangladesh.

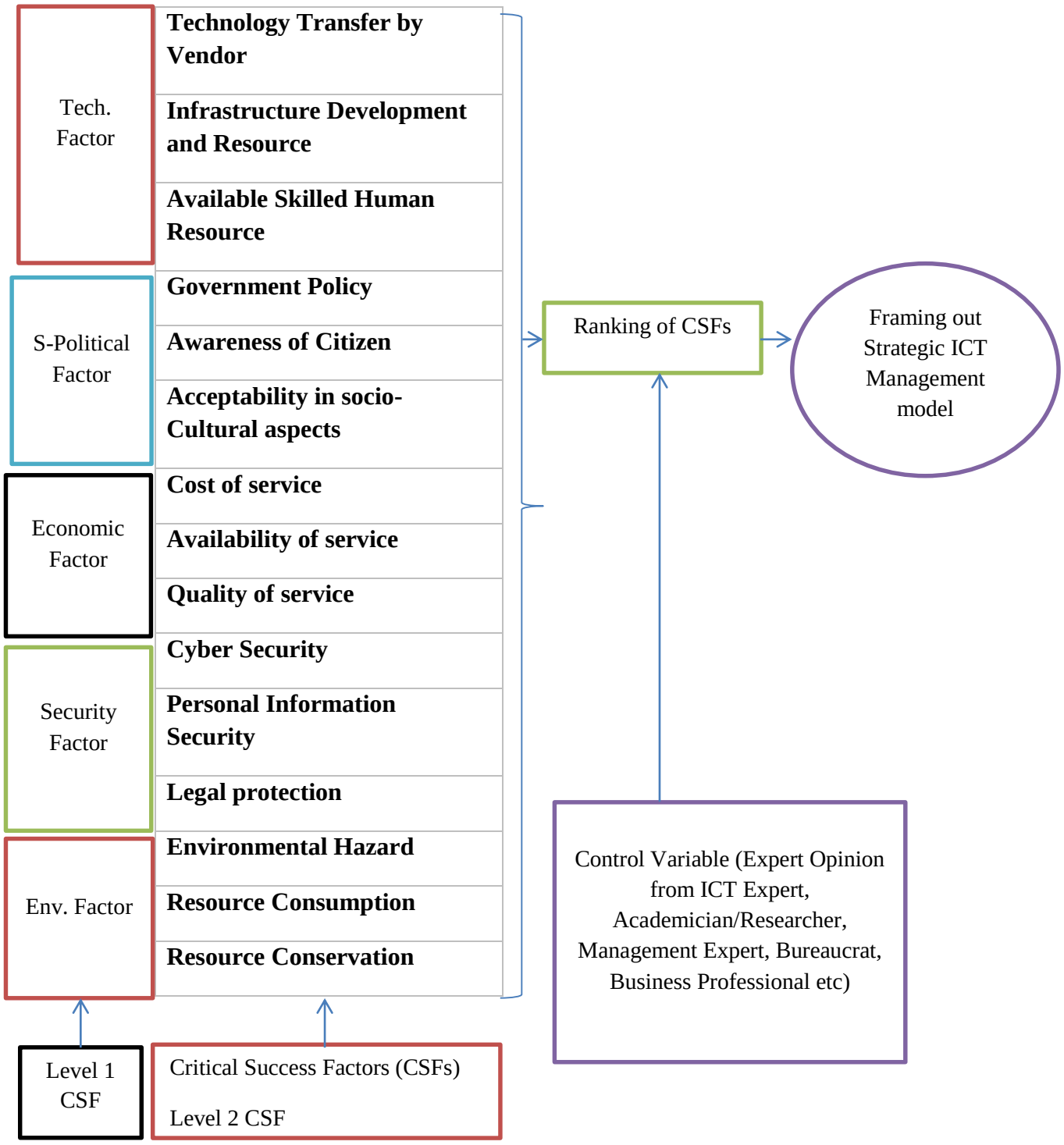



**Figure 2.15: Conceptual Framework of Delphi study (Source: The Researcher)**

## 2.8 Fuzzy AHP: Theoretical Framework

It was explored the theoretical conception and related terms of Fuzzy AHP technique in this section of this research work. The Analytical Hierarchical Process (AHP) is a mathematical technique for solving complex problems that gained popularity among management staff in the late 1990s and early 2000s. Fuzzy AHP is the advanced extended form of AHP.

Fuzzy logic allows humans to compute with words and it is as like as human reasoning (Zadeh, 1996). Fuzzy logic is used where the problem is complex but no precious data or knowledge is available to solve the problem. Fuzzy AHP approach is utilized for proper decision making when decision makers (DMs) must make a choice under uncertain conditions about a complex problem.

### 2.8.1 Technique of Decision Modeling

In this research project it is tried to frame out a strategic ICT management for long-term e-Governance success in Bangladesh. Using decision modelling, the unstructured chaos of a normal decision-making scenario can be brought under control (Saaty, 1989). A frame or model is a representation of some idea or a notion that facilitates understanding. The modelling method can be used to clearly communicate to one and to others, the main variables or factors influencing a decision as well as their significance of attributes (Baharul, Golam., 2016).

A model or frame can make it feasible to look some crucial deciding factors. The CSFs definition stimulates the search for acceptable, possibly ambiguous situation. The model or frame itself will stand the test of time as a reminder of the decision, which can be studied afterwards to see what worked well and what should be changed to improve subsequent decisions. It is possible to defend the decisions made and prevent them from being overturned by thoroughly detailing every element of the frame (Golam Baharul,2016).

### 2.8.2 Depiction of Terms

**MCDM Definition:** Multi-criteria decision making refers to the use of methods that help people make decisions in accordance with their preferences when confronted with a number of competing considerations (Catrinu, 2006).

**Decision Makers (DMs):** The aouthirity or person responsible for making decisions. The DM could be a single individual, a small, closely knit group with common goals, a substantial group representing several organizational components, a lot of incredibly diverse interest groups, or the highest level of government of a country (Baharul, Golam., 2016).

**Quantitative and Qualitative criteria:** The measurement of a CSF on a predetermined, unique, and quantifiable scale is known as quantitative analysis. A qualitative CSF is one that cannot be evaluated quantitatively. An alternative is to utilize an ordinal ranking scale or verbal measurement to measure quantitatively ( Baharul, Golam., 2016).

### 2.8.3 Technique of Making Decision

The basic optimization principle will not be very helpful when benefits of actions are uncertain and correlations between variables may not only be non-linear and stochastic but also really unknown. Exactly this is the circumstance that exists in the real world.

Making a choice based on a basis, standard, or other factor and determining its importance among a number of other variables are commonly referred to as decision-making. A decision could need to be made based on more than one factor, rather than just one. To accomplish the relative ranking of the elements with regard to the problem, it is necessary to examine numerous factors, evaluate those factors based on each component, and then combine those evaluations. The issue is made worse when there are several or more specialists/experts whose viewpoints must be considered while making a choice. Depending on the intuition, experience, and judgment of informed people known as expert's results from the absence of sufficient quantitative information.

The following actions comprise what we refer to as a general decision-making problem: (Bhushan, 2004):

►Situation Study
► CSFs organize
► CSFs Assessing
► CSFs Finalize
► incorporate the opinions of the experts
► Evaluate the level of significance/preference of each CSF
►CSFs ranking

### 2.8.4 Description of MCDM problem

Making decisions is a necessary part of life. However, in the current environment, making wise decisions is not always simple. This is mostly due to the fact that problems often have numerous contributing aspects (multiple criteria). Even worse, a lot of them have numerous goals (multiple inputs, multiple outputs). This indicates that the goals of the issues at hand can be in odds with one another. One benefit of handling these issues is that they may be seen from various angles. The best outcome can be obtained by evaluating a multi-attribute utility function in the manner outlined below, if all of the factors in decision-making process are quantitative in nature (Chan and Chan, 2004):

$$U_i\ (x_1; x_2; \ldots; x_m) = k_1 u_{i1}(x1) + K_2 u_{i2}(x_2) + \ldots k_m u_{im}(x_m);\ i = 1; 2;\ldots; n \qquad (2.1)$$

where $U_i(x1; x2; \ldots; x_m)$ is the utility function of m attributes (i.e. inputs) of the $i_{th}$ alternative, $x_i$ are attributes under consideration, $k_j$ is weighing of $j_{th}$ attributes or factors and sum up of $k_j$ is equal to 1 and $u_{ij}$ is the effect of $i_{th}$ alternative related to $j_{th}$ attribute, that is, $x_j$ .

The solution to such problems is thus the feasible option with the highest or smallest value of the utility function. With such conditions, it is pretty simple to keep the caliber of such solutions. The only issue would be figuring out how to measure each input scientifically

(i.e. $x_i$) and its effect (i.e. $u_{ij}$). It is important to achieve a proper balance between the set of weightings, as this may include making an opinion about the relative significance of one effect compared to the other effects.

On the contrary, many real-world issues are regrettably difficult to resolve. The main reason for this is that many of them include qualitative characteristics. That means, despite the above drawbacks, they cannot be mathematically modeled as in Eq. 2.1. Therefore, when tackling such multiple-criteria decision-making (MCDM) problems, how to quantify such qualitative factors is always a contentious, if not unsolvable matter. The subjective evaluation of the qualitative criteria, which always depends on the expertise of specialists and therefore is inconsistently reliable, is the main source of contention. Such evaluation obviously has an impact on the caliber of the outcome. In many instances, this is analogous to how weightings are assigned (Baharul, Golam., 2016).

Saaty created an innovative method to address these MCDM issues (Luckily and Saaty,1978, 1980). This was the analytic hierarchy process (AHP). The primary idea is to express these MCDM issues using a hierarchical structure with various criteria or factors and their sub-criteria. These requirements or requirements' sub-requirements may be qualitative or quantitative in nature. The weightings of the factors with respect to the problem can then be estimated by doing pair-wise comparisons among those factors/ criteria. Even while this process also calls for the expert judgment, there is at least a means to make sure that the judgment is consistent by looking at the consistency ratio. The best success factor can also be chosen using this method, depending on these weightings and their relative significance to each criterion.

### 2.8.5 AHP Review

Prof. Thomas L. Saaty developed the Analytic Hierarchy Process (AHP), which is strong multi-criteria decision-making tool. The Analytic Hierarchy Process (AHP) is a ground-breaking concept that makes it possible to integrate the subjective and the objective, as well as linked these to get intended goals. It is, in essence, a technique for obtaining ratio scales from paired comparisons. The input might come from objective opinion, such as

satisfaction sentiments and preference, or from objective measurement, such as price, weight, etc. As people are not always consistent, AHP permits some little judgmental inconsistency. The consistency index is obtained from the principal Eigen value, and the ratio scales are derived from the principal Eigen vectors. Trade-offs between different factors are always possible because there are several factors that might influence decisions involving multiple judging criteria (Tan, 2005).

Usually, the analysis of practical problems will encompass a number of goals, standards, or other considerations. Analytic Hierarchy Process is a practical method for assessing such intricate multiple criteria problems (Chan et al. 2006; Chan and Chan 2010; Wu et al. 2012). One of the popular methods for prioritizing or ranking various criteria or factor is Analytic Hierarchy Process (Saaty and Peniwati, 2008). Weighted rating systems are typically used to assess or choose an alternative or degree of rank of a factor, a design concept, or a solution. It is a combination of quantitative and qualitative methodologies in decision analysis (Baharul, Golam., 2016).

The concept of Analytical Hierarchical Process is an orderly hierarchical system by analyzing attributes or factors of complex problem with their mutual relations ( Saaty ,1980). Many MCDM challenges have benefited from the use of AHP, especially when qualitative criteria are included. AHP is a helpful method for comparing many factors along with two or more conflicting components. Using pairwise comparisons of the relevant variables or factors considered during the analysis, Analytic Hierarchy Process requires a decision maker to ascertain the relative importance of each criterion/factor. Since the development of AHP, it has been used to address MCDM issues.

Normally an MCDM practical issues and problems are analyzed by AHP using a hierarchy of general criteria (Level 1 factors) and more specific criteria (Level 2 Criteria), which may be quantitative or qualitative in nature. This can be accomplished by making pair-wise comparisons between the criteria or factors that are assessed by specialists/experts or professionals in the relevant field (Baharul, Golam., 2016).

### 2.8.6 Pair-wise Comparison

The importance or preference of one feature over another in relation to the objectives, variables or factors, and sub attributes or factors is determined via pair-wise comparison. The necessary pair-wise comparisons for n factors can be calculated as follows:

$$\text{Pair wise comparisons } = \frac{n(n+1)}{2} \quad (2.2)$$

### 2.8.7 Consistency Index and Consistency Ratio:

Consistency index (CI) and consistency ratio (CR) are computed to evaluate the consistency of the pairwise comparison matrix. If someone judges something qualitatively and says A > B and B > C, then A > C is the consistent opinion ( Baharul, Golam., 2016).

Professor Saaty demonstrated that the greatest Eigen value for a consistent reciprocal matrix is equal to the number of components or attributes, or $\lambda_{max}$ = n. Then, using the following formula, he provided a consistency index as deviation or degree of consistency can be measured by:

$$\text{CI} = = \frac{(\lambda max - n)}{n-1} \quad (2.3)$$

Prof. Saaty suggested that we apply the consistency index by contrasting it with the suitable one. Random Consistency Index is the proper Consistency index (RI). In order to determine whether the random consistency index is 10% or less, he randomly produced a reciprocal matrix using his scale. He then provided a table for RI.

**Table 2.4 RI Matrix Table**

| Size | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| RI | 0 | 0 | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

It is possible to compare Consistency Index and Random Consistency Index using RI to obtain Consistency Ratio (CR), as bellows:

$$CR = CI/RI \quad (2.4)$$

The contradiction is acceptable if the value of CR is 10% or below. If the consistency ratio is higher than 10%, the subjective assessment needs to be revised.

### 2.8.8 AHP Formulation or Steps

L. Saaty has developed of presenting the AHP's mathematical formulation. The AHP offers a way to divide the issue into a hierarchy of smaller issues that are simpler to understand and evaluate from a variety of perspectives. To rank each alternative on a numerical scale, the subjective evaluations are transformed into numerical values and analyzed ( Baharul, Golam., 2016). The AHP has a strong mathematical foundation and employs hierarchical decision models. A phenomenon is represented by a model. In an effort to identify the key impacts, the model might be altered, either physically if it is a physical model or mathematically if it is a hierarchical model. The following steps can be used to explain the AHP methodology:

Step 1: A hierarchy of the aim, criteria, sub-criteria, factors and alternatives is created. The most innovative and significant phase of decision-making is this. The foundation of the AHP approach is the hierarchical structuring of the decision issue. A hierarchy shows a connection between items on one level and those on the level just underneath it. Every element in the hierarchy is connected to every other element, at least indirectly, and this interaction that percolates down to the lowest levels of the hierarchy. A network can be more structured as a hierarchy. For structuring AHP, Saaty advises working down from the objective and then working up from the alternatives until the levels of the two processes are connected in such a way as to enable comparisons. A general hierarchical structure is shown in **Figure 2.14.**

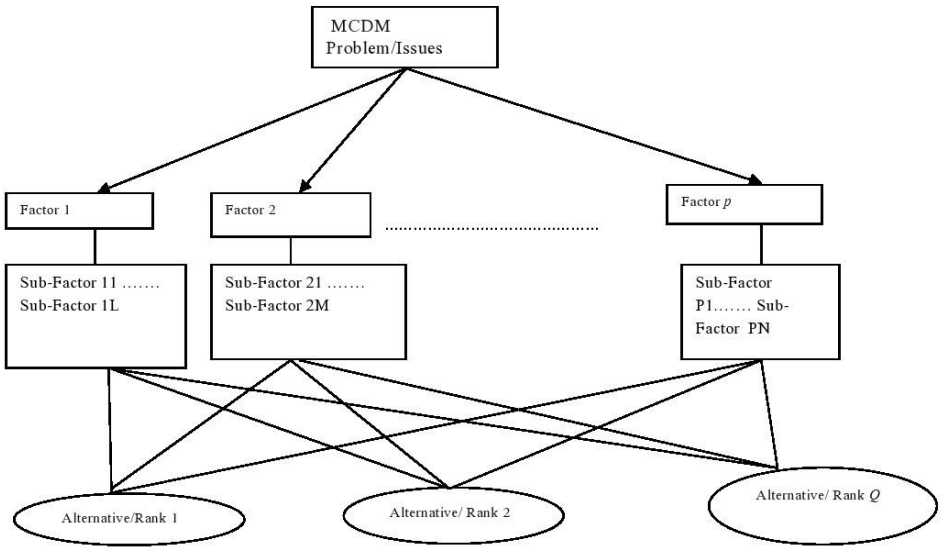



**Figure 2.16: Generic Hierarchic structure of AHP**

**Step 2:** In the pair-wise evaluation of options on a qualitative scale, information is gathered from experts in accordance with the hierarchical structure.

**Step 3:** The step two-generated pair-wise comparisons of various components are arranged into a square matrix. The matrix's diagonal members are 1 in number. If the value of element (i, j) is greater than 1, the criterion in the $i_{th}$ row is preferable to the criterion/factor in the $j_{th}$ column; otherwise, the $j_{th}$ column's criterion/factor is preferable to the $i_{th}$ row's criterion/factor. The reciprocal of the (i, j) element in the matrix is represented by the (j, i) element.

**Step 4:** The comparison matrix's major eigenvalue and the related normalized right eigenvector indicate the relative weights assigned to the various criteria/factor. With regard to the criteria or sub-criteria, the components of the normalized eigenvector are referred to as weights, and with regard to the alternatives, as rankings.

**Step 5:** The order and matrix's consistency is assessed.

**Step 6:** Local ratings with regard to each criterion are obtained by multiplying the rating or ranking of each alternative by the weights of the sub-criteria or factors. The weights of the criterion are then multiplied by the local ratings, which are then combined to determine the global weight.

**Step7:** The ranking of Alternatives/Factors can be determined using the Global Weight.

### 2.8.9 Fuzzy AHP

Vague information can be handled by fuzzy logic (Zadeh, 1965). It is generally acknowledged that most real-world judgments are made in environments where the precise knowledge of the goals and constraints is not possible due to the complexity of those environments and these issues are challenging to pinpoint (Baharul,Golam., 2016). Therefore, in order to deal with the kind of qualitative, inaccurate information or even poorly structured decision difficulties, these scenarios demand accurately portrayed crisp values. Fuzzy set theory is recommended for modeling method of complicated systems that people can manage but are difficult to precisely characterize (Bellman and Zadeh, 1960).

Some of the decision data can be accurately assessed in the majority of real-life scenarios, but others cannot. We can think of the fuzzy AHP approach as an enhanced analytical methodology that was developed from the original AHP. Despite the ease with which AHP can manage qualitative and quantitative criteria of multi-criteria decision making problems based on experts' judgments, many decision making problems' fuzziness and vagueness may cause decision experts' judgments in the conventional AHP process to be imprecise (Bouyssou, et.al, 2000). Numerous scholars who have examined fuzzy AHP have offered proof that it exhibits a more adequate and accurate representation of this type of decision-making (Chang 1996, Larrhovon and Pedrycz, 1983 and Boender et.al, 1989).

Fuzzy AHP fundamentals are simple to comprehend. In the pair-wise comparison procedure, judgments are done by linguistic parameters (such as more important, very significant), which are described by fuzzy membership functions, rather than assigning

deterministic values. When more than one expert is engaged in the evaluation process, a synthetic pair-wise comparison matrix is made by combining different matrices. The method of constructing and calculating the weights, the matrix that is most frequently used is the fuzzy geometric mean method. The matrix must then be defuzified after that. Although there are several ways to handle this process, the center of area technique is the one that is most frequently used. The subsequent steps are conventional AHP procedures ( Baharul, Golam., 2016).

The complex multi-tiered fuzzy decision-making method, was first proposed by using a fuzzy extent analysis (Chang, 1996). The Fuzzy judgement matrix is initially built, just like in fuzzy AHP. The synthetic degree value is then determined (instead of defuzzifying the matrix). Due to the fact that these values are also ambiguous, the technique is known as extent analysis.

The geometric means method of Buckley (Buckley et al., 2001; Cebeci, 2009) is another technique used for fuzzy AHP analysis and gives reliable result. The literature on fuzzy AHP describes a number of fuzzy AHP techniques. These approaches are compared in Table 2.5, despite the fact that their theoretical frameworks differ significantly. The merits and drawbacks of each approach are compared.

**Table 2.5: Comparison of Deferent Fuzzy AHP Mathematical Method**

| Source | The main Characteristic | Advantages (A) and Disadvantages (D) |
|---|---|---|
| Van Laarhoven and Pedrycz (1983) | -Direct extension of Saaty's AHP method with triangular fuzzy numbers<br>- Lootsma's logarithmic least square method is used to derive fuzzy weights and fuzzy performance scores | A) The opinions of multiple decision-makers can be modeled in the reciprocal matrix<br>(D) There is not always a solution to the linear equations<br>(D) The computational requirement is tremendous, even for a small problem<br>(D) It allows only triangular fuzzy numbers to be used |
| Buckley (1985) | -Extension of Saaty's AHP method With triangular/ trapezoidal fuzzy numbers<br>-Uses the geometric mean method to derive fuzzy weights and performance scores | (A) It is easy to extend to the fuzzy case<br>(A) It guarantees a unique solution to the reciprocal comparison matrix<br>(D) The computational requirement is tremendous |
| Chang (1996) | -Synthetically degree values<br>- Layer simple sequencing<br>-Composite total sequencing | (A) The computational requirement is relatively low<br>(A) It follows the steps of crisp AHP. It does not involve additional operations<br>(D) It allows only triangular fuzzy numbers to be used |
| Cheng (1996) | -Builds fuzzy standards<br>- Represents performance scores by membership functions<br>-Uses entropy concepts to calculate aggregate weights | (A) The computational requirement is not tremendous<br>(D) Entropy is used when Probability distribution is known. The method is based on both probability and possibility measures |

In this study, Fuzzy weights rank and performance ratings were derived by using Buckley's geometric mean method since it ensures a distinct solution to the reciprocal comparison matrix.

## 2.8.10 Conceptual Framework of Fuzzy AHP

From the discussion mentioned above, the researcher developed the following conceptual framework of Fuzzy AHP method shown in **Figure 2.15**. This conceptual framework was used to examine the Critical success factors and ranking the CSFs for strategic ICT management. In this case CSFs were classified in two steps, first is in broader aspect that is Level 1 CSFs with five Factors and the specific CSF in level 2, under level 1 each factor have three level 2 factors totaling Fifteen CSFs.

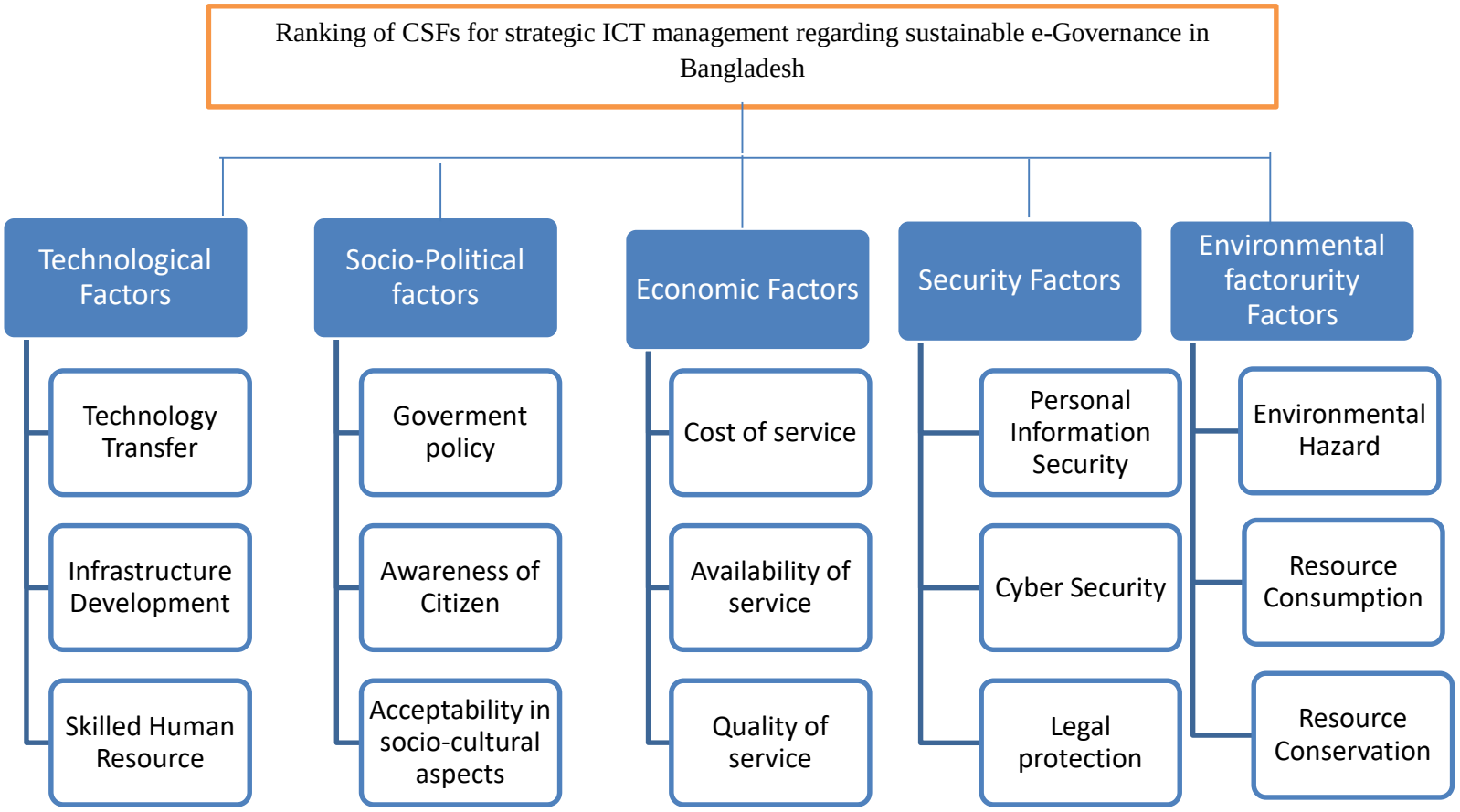



**Figure 2.17: Fuzzy AHP Conceptual Frame work (Developed by Researcher)**

# Chapter 3

## Research Methodology

### 3.1 Introduction

The most important part of a research project is Research methodology, as it is the scientific process to answer the research questions (Bryman & Bell, 2015); and explore knowledge, collect and interpret data; and develop an understanding on a research project (Walliman, 2011). Collis & Hussey (2003) argued that methodology is about data and how then it is analyzed. The overall research design of this research project has been depicted in the 'research onion' (Saunders et al. 2009) shown in **Figure 3.1**. The following discussion will come up with details how the research was carried out for making the research more convincing and significant.

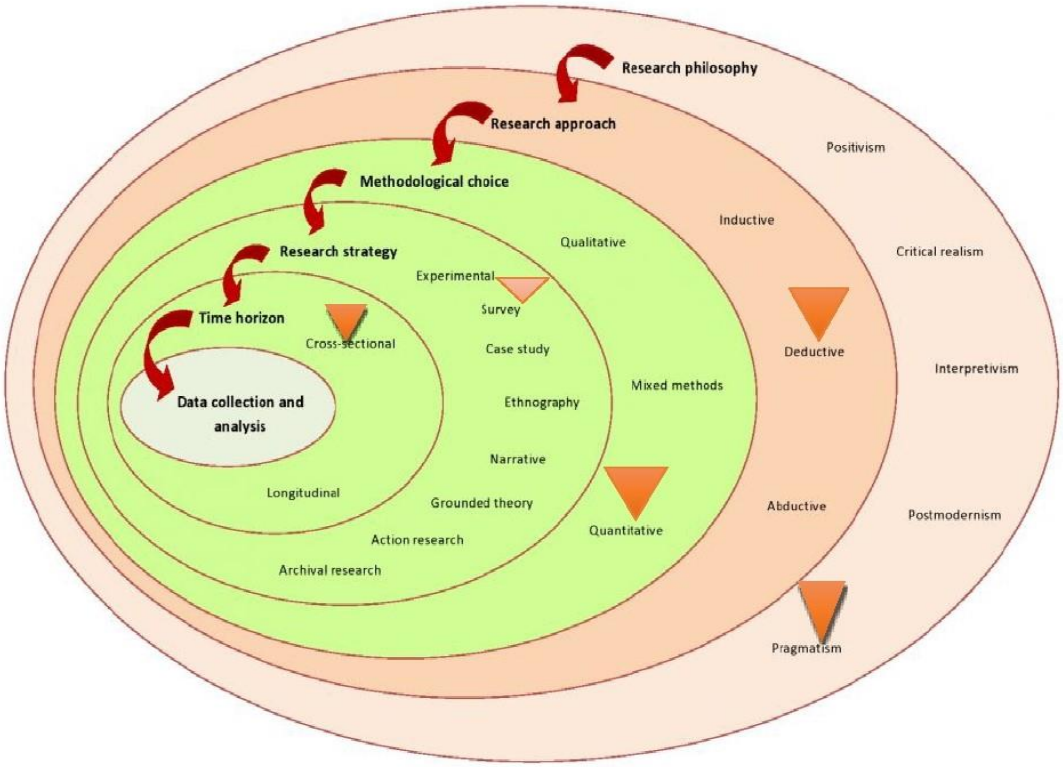



**Figure 3.1: Research Methodology (Source: Saunders et al., 2009)**

## 3.2 Philosophy of Research

It is a set of rules that relate to the worldview or character of reality from which the research is being conducted. It governs the collection, inference, and use of a certain set of data which is used in research study. The research philosophies positivism, interpretivism, realism, and pragmatism are commonly utilized.

Research philosophy of this study was guided by the principle of the researcher's intention to find out something new that is framing out a new new model of strategic ICT Management for sustainable e-Governance of Bangladesh's transition to e-Governance. The research philosophy is the development of knowledge; and the perception of philosophical attachment of the research work is important (Johnson & Clark, 2006, Saunders et al. 2009). This research was guided by pragmatism as this approach is most appropriate when researcher attempts to draw a conclusion by collecting and investigation data using some sorts of statistical tools (Bryman & Bell, 2015). Moreover, the statistical and Fuzzy AHP software allow the researcher to answer the developed research questions independently.

## 3.3 Research Approach

Deductive approach was taken for this research project as it avoids biasedness (Creswell, 2014) and promotes data quite close to the materiality and focuses on causal relationship of the variables (Saunders et al., 2009). The researcher should develop a conceptual ICT framework through collecting and analyzing empirical data in deductive approach (Collis & Hussey, 2003). Therefore, the researcher developed a conceptual framework which was shown in **Figure 2.7.**

## 3.4 Research Methodological Choice and Time Horizon

'Survey questionnaire' was used for this research project as research strategy. The reason behind this research strategy was that survey using a questionnaire is able to obtain a wide

range of opinion from the expert respondents (Bryman, 2015). Moreover, the survey questionnaire is easy to develop and administer for the researcher as well as more convenient for the experts respondents to give their opinion. For that, the researcher developed a questionnaire and it was administered using an excellent online survey platform namely **'Google Form'**. The time horizon of this research work was cross-sectional.

The 'Google Form' Questionnaire is given in **Appendix E.**

## 3.5 Research Method

As quantitative research method facilitates non biasness (Creswell, 2014) and focus on the quantification in collecting and analyzing data that entails deductive approach, pragmatism and objective reality. The quantitative research method was most appropriate for this research study to framing out a new new model of strategic ICT Management for sustainable e-Governance of Bangladesh's transition to e-Governance by assessing the CSFs. The research method has been described as bellow.

### 3.5.1 Selection of Expert by Judgmental Sampling

In this research work for selecting the expert, Judgmental sampling is used. A non-probability sampling technique known as authoritative sampling, purposive sampling, or judgmental sampling selects the sample members solely based on the researcher's expertise and judgment. There is likelihood that the results will be extremely accurate with a small margin of error because the researcher's knowledge is required to construct a sample in this sampling technique.

There are several uses for judgment sampling. Generally speaking, the purpose of judgment sampling is to carefully choose the units (in these cases, individual experts) that will best help researchers answer their research questions. When a population is of interest is very tiny or desired features of units are uncommon, this is frequently done (Frey, 2018).

The judgmental sample set of this research study consists of senior professionals, ICT experts, Academician/Researcher, Business Professional, Management Expert and Bureaucrat who are working in the field of ICT in Bangladesh and abroad.

The initial invitations were sent to 30 potential experts: 15 for Fuzzy AHP and 15 for Delphi study, to Participate in this research work of University of Dhaka. Among 15 invitees of each research method, 10 experts of each method: Fuzzy AHP and Delphi were agreed to participate in this study. In this research work, both in Delphi method and Fuzzy AHP method, 10 experts were participated that is total expert participation was 20.

The age of participants varies from 40 to 65, indicating the extensive experience they have in the ICT field. **A figure 3.2, 3.3 and 3.4 illustrate the demography of the Expert participants includes** all occupational presentation as it is a MCDM problem. Although the sample is relatively small, the Delphi panel and Fuzzy AHP are a fair representation of the related experts of Bangladesh.

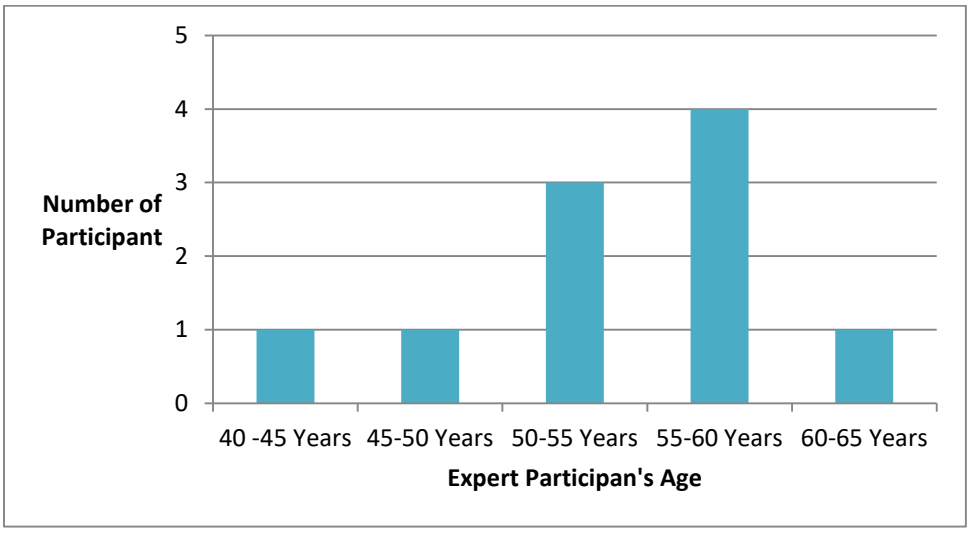



**Figure 3.2: Age of Expert Delphi Participant**

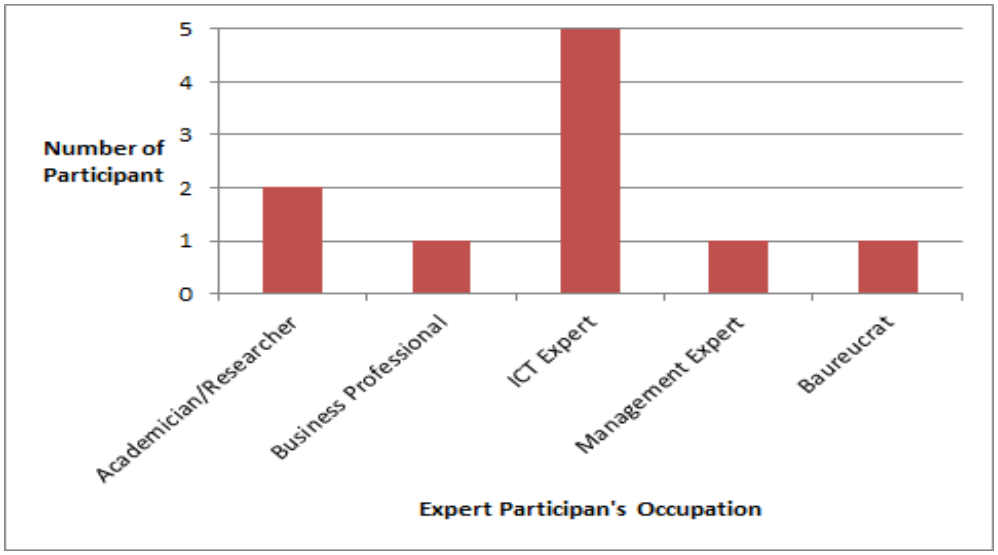



**Figure 3.3: Occupation of Expert Delphi Participant**

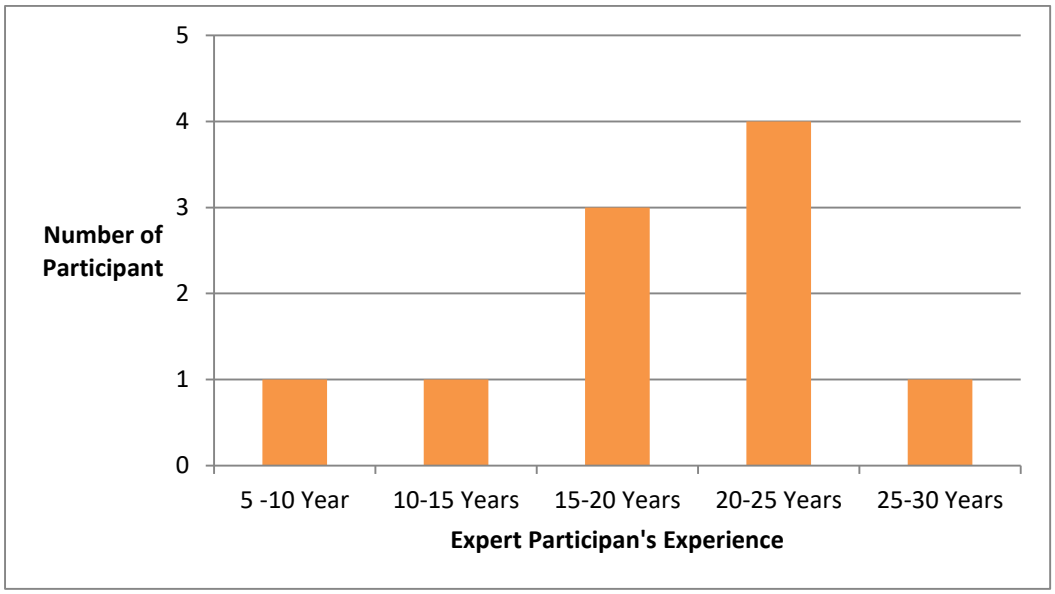



**Figure 3.4: Experience of Expert Delphi Participant**

Expert participants detail is given in **Appendix C.**

### 3.5.2 Piloting the Questionnaire

The success of the Delphi study, Fuzzy AHP study or any research study depends on the quality of the questionnaire. Since in a judgmental sample, the questionnaire takes longer time to complete than a conventional survey. It takes about 30 minutes to do one questionnaire. For this reason, a pilot study was conducted among the author's colleague who is highly skilled in ICT maintenance and management. A number of the author's colleagues who are highly skilled in ICT management and maintenance work were given the pilot questionnaire to complete in order to test the quality of the questionnaire and also asked to give any suggestion for improvement. From the result of piloting, the researcher removed the drawbacks, improved and finalized the questionnaire. To address the potential drawbacks of Delphi as previously outlined, before sending the questionnaire to the expert panel, the improvement and change was done as per feedback of piloting (Okoli, 2004).

### 3.5.3 Piloting the CSFs

A pilot study was conducted among the author's colleague who is highly experienced in ICT maintenance and management. A number of the author's colleagues who are highly experienced in ICT management and maintenance work were given the identified CSFs which were found from existing literature review, brain storming and experience and asked to select most important CSFs for Strategic ICT management of sustainable e-Governance in Bangladesh's transition to e-Governance. From the result of piloting, the researcher finalized 15 specific CSFs for this research study.

### 3.5.4 Data Collection

Primary data was the base of the research and it was collected using survey questionnaire via 'Google Form' online platform. The easily accessible online 'survey link' was send to the selected expert respondents through e-mail. No direct interaction was happened between researcher and expert respondents to ensure bias-free data collection. Typical

Likert scale and Fuzzy AHP scale was used to measure the significance/preference of CSF for strategic ICT management. The expert opinion which was collected from the experts through Goggle Form was tabulated for further calculation by Fuzzy AHP and Delphi method. The collected data was analyzed by using well-known statistical data analysis tool Excel and Fuzzy AHP Software: Fuzzy measure and sensitivity analysis calculation software by CGI (Takahagi, 2004).

### 3.5.5 Research Instrument

As stated earlier the instrument used for this research was an online survey questionnaire. Questions were Likert scale type and Fuzzy AHP scale type. The questionnaire was developed in English. The questionnaire was formulated by the researcher with the help of research supervisor and other research experts. However, the idea about most of the items was taken from existing literature as stated earlier sections.

The research instruments are comprised of two sets of question: one set for Delphi study and another set for Fuzzy AHP study. In Delphi study, for this research work, the only level 2 or specific CSFs are considered as in in case of Delphi there is no issue of global weight calculation of specific CSFs like Fuzzy AHP study. A sample of Delphi questionnaire (3 Question) which was developed by researcher is given bellow:

## Questionnaires for Delphi Method

(Please notice: Make sure that the sums of the rank values of 15 CSFs would be in data range contained ranked data. Since there is 15 CSFs (1 to 15) the sum of rankings of 15 CSF should be $1 + 2 + \cdots + 15 = 15 \cdot 16 / 2 = 120$)

1. Please rank the CSF, Technology Transfer by vendors at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale ( Baharul, Golam, 2016).

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

2. Please rank the CSF, Infrastructure Development and Resource Sharing at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

3. Please rank the CSF, Available Skilled Human Resource at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Full questionnaire of Delphi method is given in **Appendix A.**

A sample of Fuzzy AHP questionnaire (5 Question of Level 1 and Level 2)) which was developed by researcher is given bellow:

## Questionnaire for Fuzzy AHP

**Please Notice:**

AB: Absolutely more important/ More than Extremely Important (preferred), Scale: 9; VS: Very strongly more important (preferred) Scale: 7; ST: Strongly more important (preferred), Scale: 5; WK: Weakly more important (preferred), Scale: 3; EQ: Equally more important/ Just Equally Important (preferred), Scale: 1; and Scale 8,6,4,2 is intermediate value between two scales

### Questionnaires for Critical Success Factors (Level 1)

1. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: the Technological Factor (TF) or Socio-political Factor (PF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is

important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important (Baharul, Golam., 2016).

a) Technological Factor (TF) More Important b) Socio-political Factor (PF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | E.Item |
| TF | | | | | | | | | | | | | | | | | | PF |

2. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Technological Factor (TF) or Economic Factor (EF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important (Baharul, Golam., 2016).

a) Technological Factor (TF) More Important b) Economic Factor (EF) More Important

| | Left Item is more | | | | | | | | EQ | Right Item is more | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TF | | | | | | | | | | | | | | | | | | EF |

3. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: the Technological Factor (TF) or Security Factor (SF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Technological Factor (TF) More Important b) Security Factor (SF) More Important

| | Left Item is more Important | | | | | | | | E | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TF | | | | | | | | | | | | | | | | | | SF |

# Questionnaires for Critical Success Factors (Level 2)

## A) Technological Factors

4. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Technological F a c t o r (TF), which is more important as per your opinion: Technology Transfer by vendors (TFTT) or Infrastructure development and Resource Sharing (TFID)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important .

a) Technology Transfer by vendors (TFTT) More Important b) Infra-structure Development and Resource Sharing (TFID) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TFTT | | | | | | | | | | | | | | | | | | TFID |

5. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues ( Baharul, Golam., 2016), with respect to Technological F a c t o r (TF), which is more important as per your opinion: Technology Transfer by Vendors (TFTT) or Availability of Skilled Human Resource (TFHR)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Technology Transfer by Vendors (TFTT) More Important b) Availability of Skilled Human Resource (TFHR) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TFTT | | | | | | | | | | | | | | | | | | TFHR |

Full questionnaire of Fuzzy AHP method is given in **Appendix B.**

A set of Critical Success Factor/Variables (15 Factors here) for the respondents who are expert in relevant field was used to collect information about CSF level of significance on different factors. On a scale, respondents were asked to fairly score each of the aforementioned items as extremely important to least important, equally important. The 15 CSF was given in **Table 2.2.**

**Control Variables:** Individual expert opinion from different group representative such as Academician/Researcher, ICT Expert, and Management expert, Bureaucrat, Business Professional were used as control variables to measure the rank of CSFs for strategic ICT management regarding sustainable e-Governance.

## 3.6 Validity and Reliability

Reliability and Validity are the most crucial issues for a research study project (Patton 2002). The instrument used in this research was verified using rigorous reviews of researcher and feedback from them. The piloting of the questionnaire ensured that all the questions were applicable for this research work. And thus, the questions were related to the study confirmed the validity of the collected data. A Pilot study on the identified CSFs was also performed to select the appropriate CSFs for strategic ICT Management regarding sustainable e-Governance in the context of Bangladesh. This confirmed the validity of proper CSFs.

For quantitative research the reliability of data is crucial (Bryman 2015; Saunders et al., 2009). Participant's error and bias might cause reliability problem (Saunders et al., 2007). However, the target respondents were educated enough for the error free survey and researcher had no connection with the respondents to bias them. So, their fair responses to the survey strengthened the reliability of the research. Moreover, the data which was collected from expert participants were verified by using the tools like Kendall's coefficient of convergence (W) convergence in Delphi method and consistency of matrices in Fuzzy AHP method which ensured the reliability of data.

For validation of data, in case of Fuzzy AHP method, the Consistency Ratio (CR) of matrices was used. In case of Fuzzy AHP method, if for any matrix CR≥ 0.1 was found then the matrix is considered as inconsistent and sent for revised to the expert. And in case of Delphi method, Kendall's Coefficient of convergence (W) was used. If W≤ 0.7 was found then the data was not accepted and sent for revised to the experts.

## 3.7 Methodological Flowchart of Delphi Method

The Delphi Method seeks expert opinions on a challenging research issue for which there is a lack of exact data (Linstone & Turoff, 2011). In order to attain an acceptable convergence of opinion from a group of experts, the method places emphasis on systematizing group communication processes (Linstone & Turoff, 2011; Gupta & Clarke, 1996).

The statistical information (rankings) from each round of the Delphi survey was examined to determine the mean ranks and sample standard deviation SQDEV. According to Okoli's Delphi methodology, the convergence of opinions was assessed using Kendall's coefficient of convergence, W (Okoli, 2004). The range of W is 0 to 1, where 0 and 1 respectively represent no consensus and perfect consensus. (Schmidt,1997) proposed the interpretation of the value of W as:

For W < 0.3, there is only weak consensus, moderate consensus for W = 0.5, and strong agreement for W > 0.7. Once W > 0.7 was reached for the CSFs list, the Delphi rounds for this research project were to be ended.

From the discussion mentioned above, the research methodological flow chart was developed by the researcher, is shown in **Figure 3.5.**

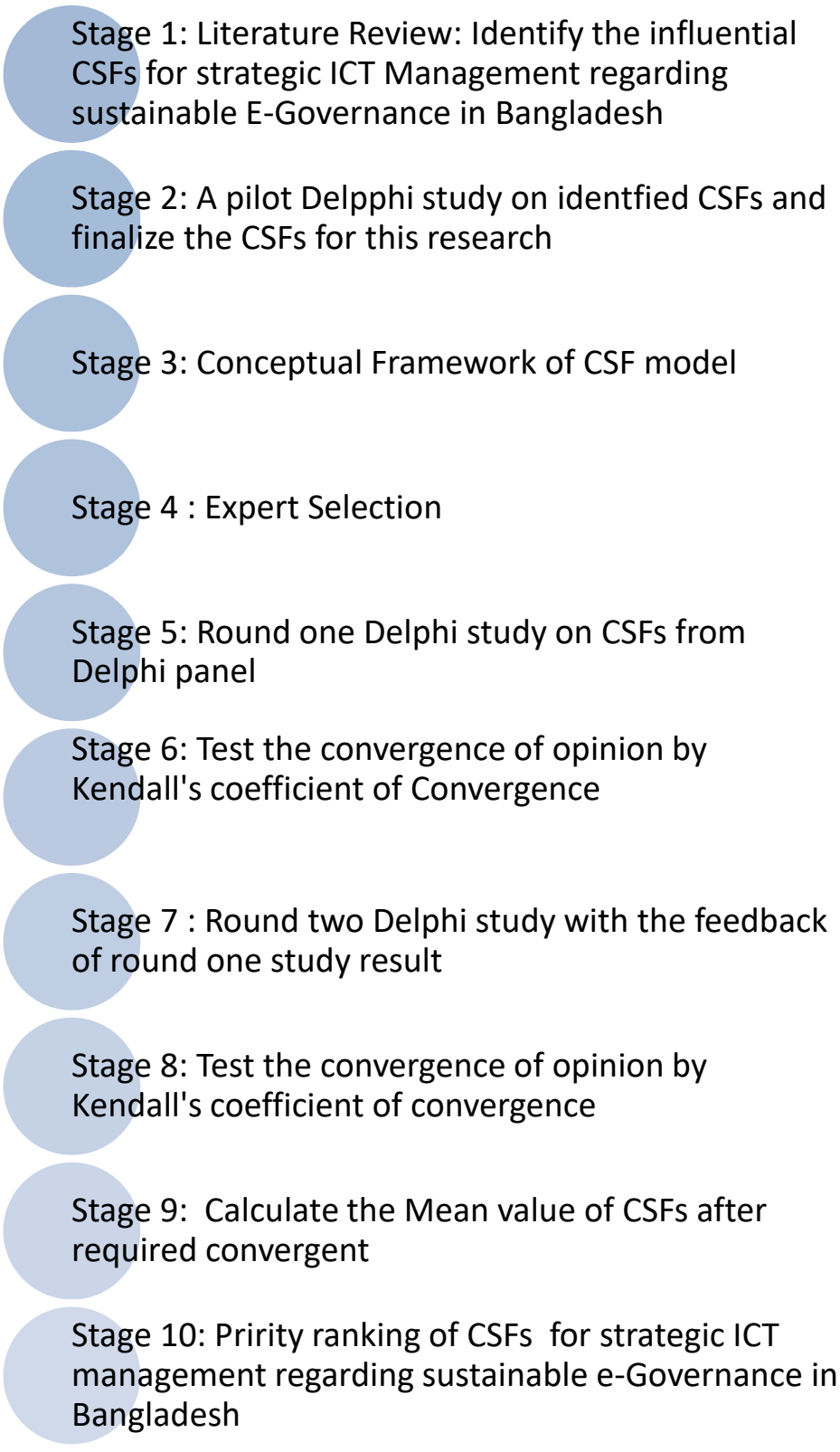



**Figure 3.5: Delphi Research Methodology Flow Chart (Source: The Researcher)**

## 3.8 Methodological Flowchart of Fuzzy AHP Method

From the discussion of Fuzzy AHP theoretical aspects, a Methodological flow chart or Algorithm flow chart was developed for this research which is shown in **Figure 3.6**

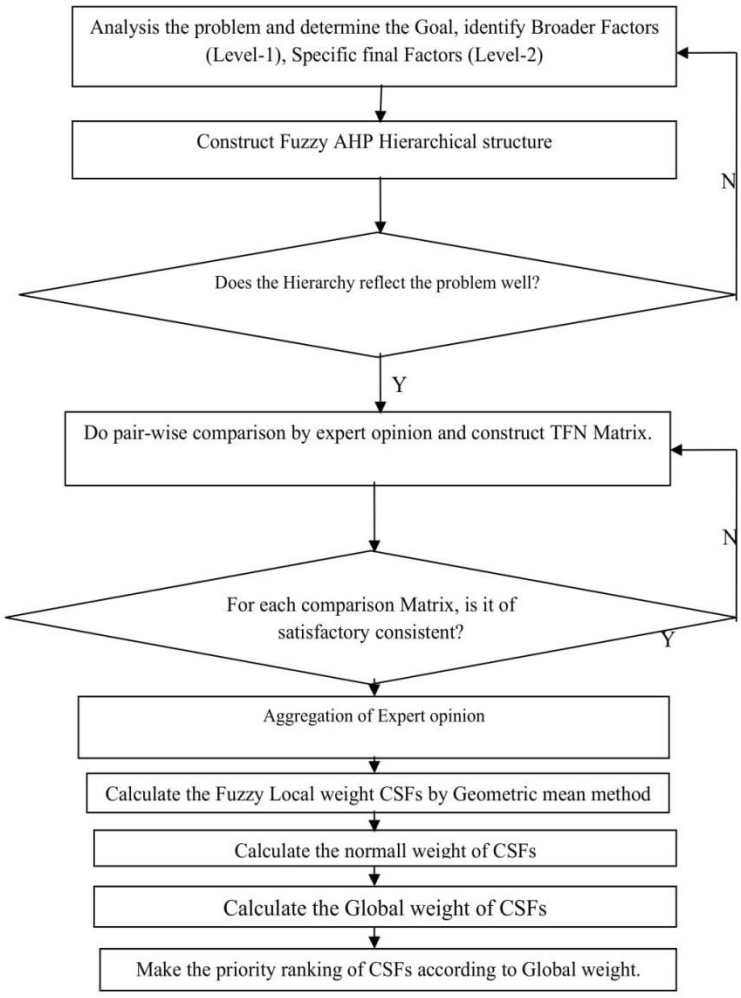



**Figure 3.6: Fuzzy Research Methodology Flow Chart (Source: The Researcher)**

## 3.9 Delphi Method Mathematical Operation

The statistical information (rankings) from each round of the Delphi survey was examined to determine the mean ranks and sample standard deviation SQDEV. According to Okoli's Delphi methodology, the convergence of opinions was assessed using Kendall's coefficient of convergence, W (Okoli, 2004). The range of W is 0 to 1, where 0 and 1

respectively represent no consensus and perfect consensus. (Schmidt,1997) proposed the interpretation of the value of W, as: For W < 0.3, there is only weak consensus, moderate consensus for W = 0.5, and strong agreement for W > 0.7. Once W > 0.7 was reached for the CSFs list, the Delphi rounds for this research project were to be ended.

For the purposes of statistical computation, if i be the CSF and $r_{i,j}$ be the rank given to $CSF_i$ by Expert j and if m be the number of expert and n be the total number of CSFs. Then Convergence of individual expert's rankings is measured by using Kendall's coefficient of concordance W, which can be calculated as follows:

$$W = \frac{12S}{m2(n3-n)} \quad 3.1$$

Where m is number of expert and n is number of variable or CSFs here, then S is the sum of squared deviations, defined as follows:

$$S = \sum_{i=1}^{n}(Ri - \bar{R})^2, \quad 3.2$$

Here, Ri = the total rank given to $CSF_i$ , and $\bar{R}$ is the mean of these total ranks and $R_i$ is as:

$$R_i = \sum_{j=1}^{m} ri,j; \text{ and } \bar{R} = \frac{m(n+1)}{2} \quad 3.3$$

## 3.10 Fuzzy AHP Mathematical Operation

In 1965, Zadeh introduced fuzzy set theory for the first time. It highlights how hazy human thinking, reasoning, and environmental cognition are. Many traditional quantitative analytic techniques are ineffective for such analyses. Fuzzy logic must be utilized to describe actual phenomena and to make up for the shortcomings of conventional theory sets that solely use binary logic to do so. The idea of a membership function is used in fuzzy logic to describe things in a way that matches human language. Fuzzy logic can also examine ambiguity and vagueness (Baharul, Golam., 2016). The fuzzy set is defined by the following Equation:

$$A = \{((x,\mu_A(x)) \mid x \in U) \} \quad (3.4)$$

Here, μA(x) is referred to as the membership function, A is a fuzzy set. The discourse universe is known as U. μA(x) ) has a range of any value from 0 to 1. That is degree of membership, compared to traditional binary logic, the fuzzy set is better at describing the attributes of things. The value of the membership function in typical crisp sets can only be either 0 or 1. Equation 3.5 bellow expresses its membership function:

Equations 3.6 to 3.9 outline the triangular fuzzy number's mathematical operation. To find a suitable point to represent the fuzzy number, the defuzzification process should be carried out in accordance with the three criteria of logic, ease of calculation, and continuity. The center of gravity approach, the mean of maximum method, and the center of area method are often used for defuzzification (Li and Huang,2008).

$$\mu_A(x) = \begin{cases} 0 & \text{if } x \le a \\ \frac{x-a}{b-a}, & \text{if } a \le x \le b \\ \frac{c-x}{c-b}, & \text{if } b \le x \le c \\ 0, & \text{if } x \ge c \end{cases} \quad (3.5)$$

Where a ≤ b ≤ c; If a= b = c, the Fuzzy number gets a crisp value. Here, a, b, and c are the lowest possible value, the middle possible value, and the largest possible value respectively. A TFN is represented as (a,b, c) as illustrated in **Figure 3.7.**

$$\mu_A(x) = \begin{cases} 0 & if\ x \le a \\ \frac{x-a}{b-a} & if\ a \le x \le b \\ \frac{c-x}{c-b} & if\ b \le x \le c \\ 0 & if\ x \ge c \end{cases}$$

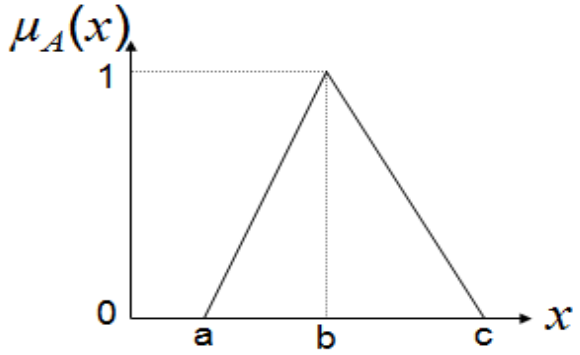



**Figure 3.7: Triangular Membership Number representation ( Nesrine, et al., 2012)**

For two positive Fuzzy Triangular Numbers as $A = (a_1, b_1, c_1)$ and $B = (a_2, b_2, c_2)$, the mathematical operation for this two Fuzzy number is as follows:

$$A \oplus B = (a_1 + a_2, b_1+b_2, c_1+c_2) \quad (3.6)$$

$$A \ominus B = (a_1-a_2, b_1-b_2, c_1-c_2) \quad (3.7)$$

$$A \otimes B = (a1\times a2, b1\times b2, c1\times c2) \quad (3.8)$$

$$A \oslash B = (a_1\div a_2, b_1\div b_2, c_1\div c_2)$$

$$A^{-1} = (a_1, b_1, c_1)^{-1} = (1/a_1, 1/b_1, 1/c_1) \quad (3.9)$$

In this research work, Fuzzy AHP is used in the prioritization of different Critical Success Factors for strategic ICT management regarding sustainable e-Governance in Bangladesh is the two level in a hierarchical structure between goal and final ranking of CSFs. Another benefit of this approach is the ability to provide more accurate information about decision makers' preferences due to the use of pair-wise comparisons. Additionally, this strategy aids decision-makers by enabling them to provide interval judgments rather than point assessments because they are typically unable to express their preferences explicitly due to the imprecise nature of the decision-making process.

### 3.10.1 Fuzzy AHP Calculation steps

**Step 1.** It has been developed a hierarchical decomposition structure of complex problem.

The hierarchical decomposition structure is constructed, Researcher found out the CSF from literature review and new three CFSs were proposed by researcher. The CSFs were classified in two levels; level 1 is in broader aspect and level 2 specific CSFs.

The CSFs which were identified from literature review and proposed by the researcher shown in **Table 2.2,** the Fuzzy AHP hierarchical decomposition structure was developed shown in **Figure 3.8.**

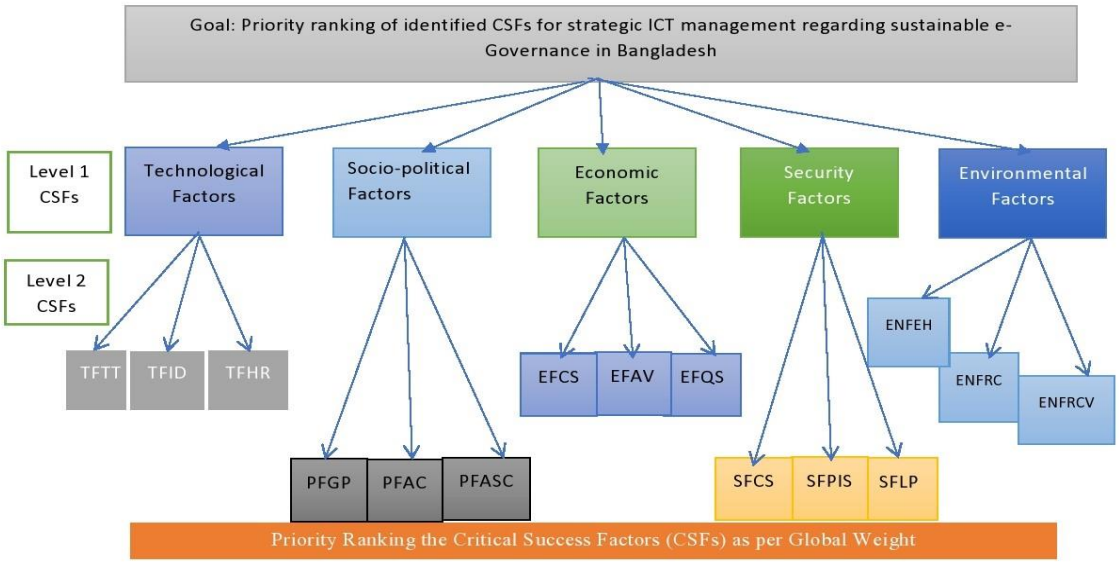



**Figure 3.8: The structure of Fuzzy AHP hierarchical model (The Researcher)**

**Step 2**: The questionnaire was designed based on the hierarchical structure mentioned above given in **Appendix B,** A pair wise comparison matrix is created by comparing variables and elements in the questionnaire to determine participants' thoughts in regard to higher-level features. The judging opinion of the expert is transformed using the TFN conversion scale that is presented in **Table 3.1.**

**Table 3.1: AHP to Triangular Scale for Triangular Fuzzy Number (TFN) Conversion**

**Source: ((Liu and Tsai, 2012)**

| Linguistic Scale | Intensity of AHP Conventional Scale | Triangular Fuzzy Number (TFN) | Reciprocal of TFN |
|---|---|---|---|
| Equally More Important/Just equally important (EQ) | 1 | (1,1,1) | (1, 1, 1) |
| Intermediate Value | 2 | (1,2,3) | (1/3, 1/2, 1) |
| Weakly more Important (WK) | 3 | (2, 3, 4) | (1/4, 1/3, 1/2) |
| Intermediate Value | 4 | (3, 4, 5) | (1/5, 1/4, 1/3) |
| Strongly more Important (ST) | 5 | (4, 5, 6) | (1/6, 1/5, 1/4) |
| Intermediate Value | 6 | (5, 6, 7) | (1/7, 1/6, 1/5) |
| Very Strongly More Important (VS) | 7 | (6, 7, 8) | (1/8, 1/7, 1/6) |
| Intermediate Value | 8 | (7, 8, 9) | (1/9, 1/8, 1/7) |
| Absolutely More Important/More than Extremely Important (AB) | 9 | (8, 9, 10) | (1/10, 1/9, 1/8) |

As per expert opinion the triangular Fuzzy matrix is formed as:

$$\tilde{A} = [\tilde{a}_{ij}] \quad (3.10)$$

Here $\tilde{a}_{ij} = (l_{ij}, m_{ij}, u_{ij}), l_{ij}, m_{ij}, u_{ij}$ are the lower limit, middle, and upper limit of the triangular fuzzy number, $\tilde{a}_{ij} = 1/\tilde{a}_{ji}$, when, i, j = 1,2, …, n.

**Step 4**: Equation 2.2 was used to check the consistency of each respondent's pair-wise comparison matrix; if the matrix was consistent, the process moved on to step 5; if not, the opinion of the corresponding respondent was revised.

S**tep5:** Geometric mean techniques were employed to aggregate participant opinions in this study (Davis, 1994). The following mathematical operation has been carried out:

$$\tilde{A}_{ij} = (\tilde{a}^1_{ij} \otimes \tilde{a}^2_{ij} \otimes \tilde{a}^3_{ij} \otimes \ldots\ldots\ldots\ldots\ldots \otimes \tilde{a}^n_{ij})^{1/n} \quad (3.11)$$

Here, $\tilde{a}ij$ is the triangular fuzzy number in the $i_{th}$ column and $j_{th}$ row of the fuzzy positive reciprocal matrix and $\tilde{a}^n_{ij}$ is the significance value of respondent n.

**Step 6**: The fuzzy weight was determined using the column geometric mean method.

$$\tilde{w}_i = r_i \otimes (r_1 \oplus r_2 \oplus r_3 \oplus \ldots\ldots\ldots\ldots\ldots \oplus r_n)^{-1} \quad (3.12)$$

$$\tilde{r}_i = (\tilde{a}_{i1} \times \tilde{a}_{i2} \times \tilde{a}_{i3} \times \ldots\ldots\ldots\ldots\ldots\ldots\ldots \times a_{in})^{1/n} \quad (3.13)$$

Here, $\tilde{w}_i$ is the fuzzy weight value of each column in the fuzzy positive reciprocal matrix and $\tilde{r}_i$ is the geometric mean of the triangular fuzzy number.

**Step 7**: Then defuzzified the Fuzzy number. Confirming (Opricovic and Tzeng ,2003) and a simple centroid method for this purpose was used ( Chang and Wang, 2009; Opricovic and Tzeng ,2003 ), as follows:

$$w_i = \frac{ai+bi+ci}{3} \quad (3.14)$$

**Step 8**: Normalization of weight was performed to obtain the weights for each factors and indicators as:

$W_i = Wi/\Sigma Wi$ (3.15)

**Step 9**: Calculate the global weights of all attributes or Critical Success Factors.

**Step 10**: Finally performed priority ranking of Critical success factors (CSFs) according to the global weight.

**Step 11**: Sensitivity analysis of the research findings.

## 3.11 Conclusion

To sum up, it can be said that the in this research work, it is attempted to make the research design and methodology suitable and appropriate for achieving the research aim and objectives following the guidance of research methodology. 'Positivism' was taken as research philosophy so that the collection of 'Expert opinion's data that is precise and based on that data, it was analyzed using statistical tools and which can be well matched for 'quantitative' research. To collect bias free responses easily and ensure the reliability of the data, the researcher launched the survey using 'Google Form' platform. Finally, data was analyzed by statistical tool and Fuzzy Measure software by CGI (Takahagi, 2004).

# Chapter 4

## Data Analysis and Presentation

### 4.1 Introduction

In this chapter the detail data analysis has been demonstrated to acquire the target result of ranking of Critical Success factor for strategic ICT management for sustainable e-Governance of Bangladesh's transition to e-Governance and farming out a new new model for strategic ICT management.

In this research work, the researcher has used two methods for this purpose, one of Fuzzy AHP method and another is Delphi method. First of all, Fuzzy AHP data analysis and presentation has been done and then presented the Delphi data analysis and presentation. Lastly, the result of Fuzzy AHP and Delphi has been compared and validated.

In this research study, for Fuzzy AHP calculation Fuzzy software by CGI was used to check consistency of the matrices and Excel was used to calculate the weight of CSFs by Fuzzy AHP in Geometric mean method and for Delphi calculation Excel was used with statistical equations.

#### 4.1.1 Data Screening

Data screening or cleaning is a critical issue for quantitative research to avoid incorrect measurement and results (Osborne, 2012). So, the dataset was screened very carefully in this research work.

Data was collected from 10 respondents who are expert in the relevant field. After exporting the data in Fuzzy AHP software, Consistence of each matrix was tested and no inconsistent matrix is considered to avoid the incorrect result. In case of Delphi method

study, after each round, the coefficient of convergence was calculated to get the correct result.

For data screening mathematical tools was used. In case of Fuzzy AHP method, the Consistency Ratio (CR) of matrices was used. In case of Fuzzy AHP method, if for any matrix CR≥ 0.1 was found then the matrix is considered as inconsistent and sent for revised to the expert. And in case of Delphi method, Kendall's Coefficient of convergence (W) was used. If W≤ 0.7 was found then the data was not accepted and sent for revised to the experts.

## 4.2 Fuzzy AHP calculation

The input template interface of Fuzzy AHP software has been given in **Figure 4.1.** Procedure of running this software is as follows (CGI, Takahagi, 2004):

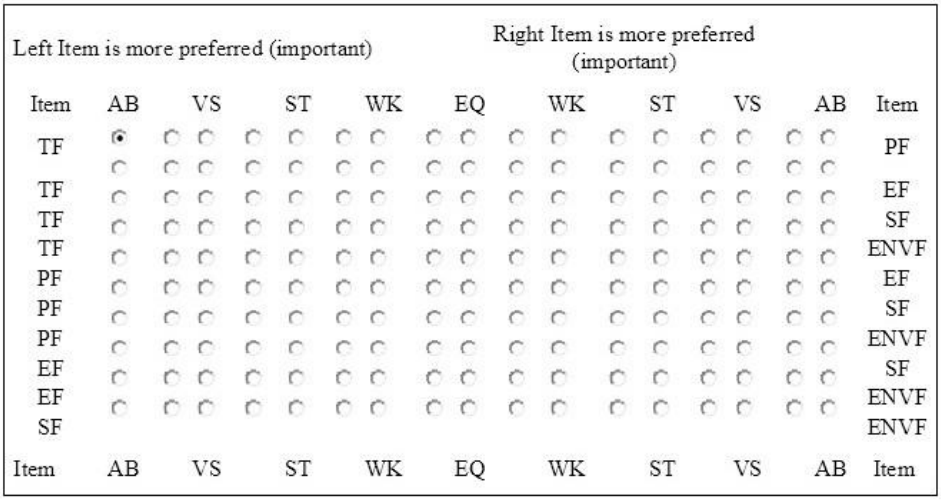



**Figure 4.1: Fuzzy AHP CGI software data input Interface**

Where:

AB: Absolutely more important/More than Extremely Important (preferred), Scale: 9

VS: Very strongly more important (preferred) Scale: 7

ST: Strongly more important (preferred), Scale: 5

WK: Weakly more important (preferred), Scale: 3

EQ: Equally more important/ Just equally Important (preferred), Scale: 1

Scale 8,6,4,2 is intermediate value between two scales.

This CGI software was used to test the consistency of matrices of different expert's opinion and Excel was used to calculate the Fuzzy AHP weight.

### 4.2.1 Fuzzy AHP Weight Calculation for Expert-1

It is needed to operations the matrix laws in order to find out the priorities of the fuzzy matrix. For that it is required to ensure two things: 1) to evaluate consistency matrix for each respondent expert and 2) to find the ways of aggregating the single pair-wise comparisons.

To assure quality level of a decision, to increase reliability and credibility the researcher analyzed the consistency of an evaluation matrix. For this purpose, consistency ratio (CR) has been calculated for confirming the consistency (Saaty,1995), which is defined as a ratio between the consistency of a given evaluation matrix (consistency index CI) and the consistency of a random matrix (RC).

When $CR \leq 0.1$, then matrix is acceptable

$CR \geq 0.1$ then matrix is not acceptable

The pair-wise comparison matrices depict the intensity or level of significance of each factor of experts' preference or importance among the individual pairs with respect to goal.

But In this research work all the matrix operations for consistency test were done by CGI software. The data which was collected by the researcher through "Google Form" from expert-1, academician/researcher, given input to the software to find out CI. Then by using the Buckley's Geometric mean method the weight factor of level 1 CSFs for Expert1 have been

calculated with the help of CGI software and Excel, the whole process is depicted in the following **Figure 4.2.**

From the figure 4.2, it is observed that first defuzified weight of level-1 five CSFs for expert-1 were calculated and from defuzzified weight the normalized weight of five level-1 CSFs was calculated and the weight sum (wt. Sum) that is summation of weights of five CSFs factors is one, that is the process and calculation is correct. The defuzified weight of level 1 CSFs for the opinion of Expert-1 are shown in **Table 4.1.**

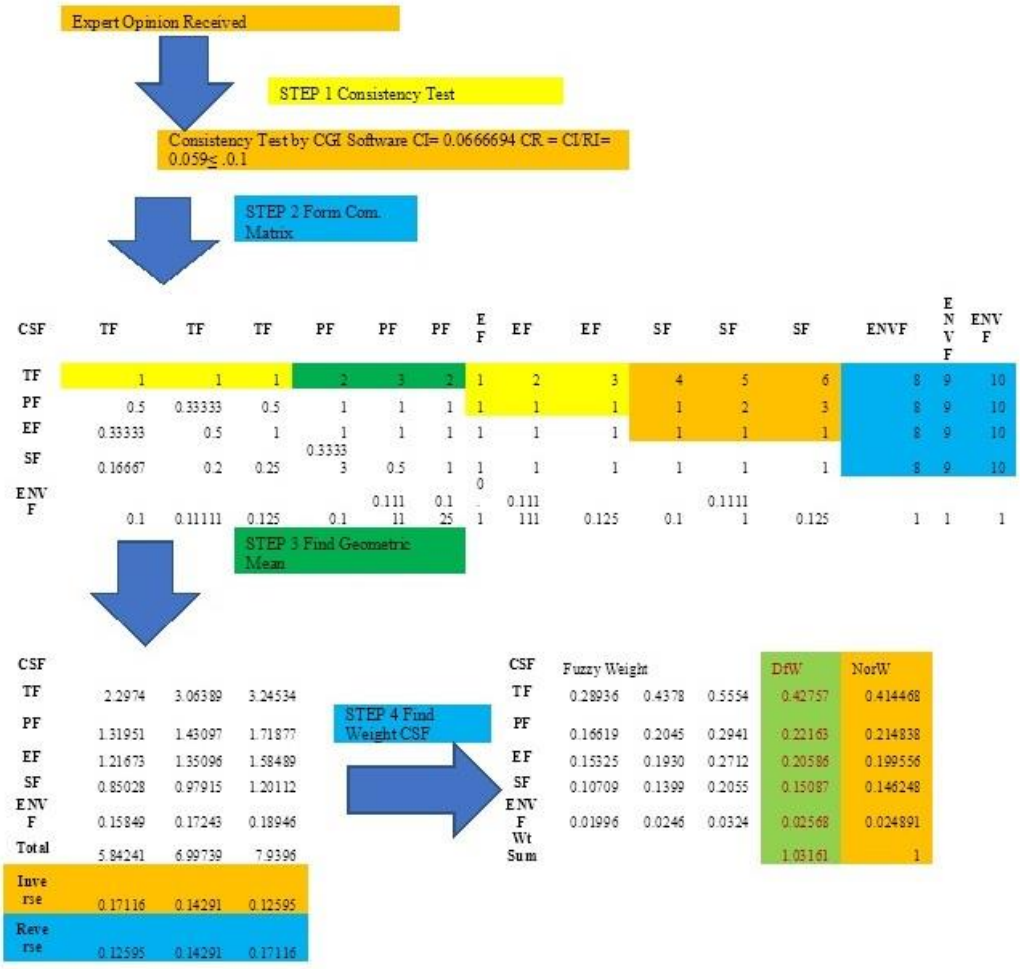



**Figure 4.2: Fuzzy AHP calculation steps by Excel**

From this result, it is observed that the matrix Consistency ratio (CR) is 0.059 which is less than 0.1 that means matrix is consistent, and sum of total local normalized weight is 1, so the result is validated.

**Table 4.1: Defuzified Weight For Expert-1, Level-1 CSFs**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4276 |
| **PF** | 0.2216 |
| **EF** | 0.2058 |
| **SF** | 0.1509 |
| **ENVF** | 0.0257 |

### 4.2.2 Final weight of level-1 CSFs by Fuzzy AHP

By following the similar process and steps, the defuzzified weight of other nine Experts was calculated on the basis of opinion of Expert. All tables have been given in **Appendix D** regarding this calculations and results.

Aggregation of 10 Expert's Opinion, defuzified weight, normalized weight and ranking the level-1 CSFs has been performed and shown in **Table 4.2.** The weight sum of normalized weight is 1, so the calculation process and result are validated.

**Table 4.2: Final Weight of Level-1 CSFs**

| CSF | Exp-1 | Exp-2 | Exp-3 | Exp-4 | Exp-5 | Exp-6 | Exp-7 | Exp-8 | Exp-9 | Exp-10 | Aggr. Defuzi-fied Weight | Final Normalized weight | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TF** | 0.4276 | 0.4434 | 0.4443 | 0.4474 | 0.4432 | 0.4424 | 0.4423 | 0.4452 | 0.4433 | 0.4434 | 0.4423 | 0.4422 | 1 |
| **PF** | 0.2216 | 0.1974 | 0.1925 | 0.1991 | 0.1973 | 0.1981 | 0.1954 | 0.1983 | 0.1972 | 0.1993 | 0.1996 | 0.1996 | 2 |
| **EF** | 0.2058 | 0.1899 | 0.1859 | 0.1883 | 0.1884 | 0.1864 | 0.1849 | 0.2033 | 0.1809 | 0.1838 | 0.1898 | 0.1897 | 3 |
| **SF** | 0.1509 | 0.1407 | 0.1402 | 0.1423 | 0.1408 | 0.1409 | 0.1408 | 0.1374 | 0.1409 | 0.1419 | 0.1417 | 0.1417 | 4 |
| **ENVF** | 0.0257 | 0.0278 | 0.0268 | 0.0254 | 0.0249 | 0.0274 | 0.0268 | 0.0258 | 0.0279 | 0.0294 | 0.0268 | 0.0268 | 5 |
| **Weight Sum** | | | | | | | | | | | 1.0001 | 1.0000 | |

So, Final ranking of Level-1 CSF with Final weight, rank and importance as percentage of preference was as **Table 4.3**:

**Table 4.3: Local Weight for Expert-1, Level-2, PF**

| CSF Level 1 | Final Weight | Rank | Percent of Preference |
|---|---|---|---|
| **TF** | 0.4422 | 1 | 44.22% |
| **PF** | 0.1996 | 2 | 19.96% |
| **EF** | 0.1897 | 3 | 18.97 % |
| **SF** | 0.1417 | 4 | 14.17% |
| **ENVF** | 0.0268 | 5 | 2.68% |

### 4.2.3 Fuzzy AHP Weight Calculation for Level-2 CSF

In this research work all the matrix operations for consistency test were done by CGI software. The data which was collected by the researcher through "Google Form" from expert-1, academician/researcher, given input to the software to find out CI. Then by using the Buckley's Geometric mean method the weight factor of level 2 CSFs for Expert-1 have been calculated with the help of CGI software and Excel, the whole process is depicted in the following **Figure 4.3.**

From the figure 4.3, it is observed that the defuzzified weight of level-2 CSF for expert-1 with respect to TF were calculated by using Buckley's Geometric mean method and from defuzzified weight the normalized weight of five level-2 CSFs with respect to TF was calculated and the weight sum (wt. Sum) that is summation of weights of three level-2 CSFs factors with respect to TF is one, that is the process and calculation is correct. The defuzified weight of level-2 CSFs with respect to TF, for the opinion of Expert-1 are shown in **Table 4.4.**

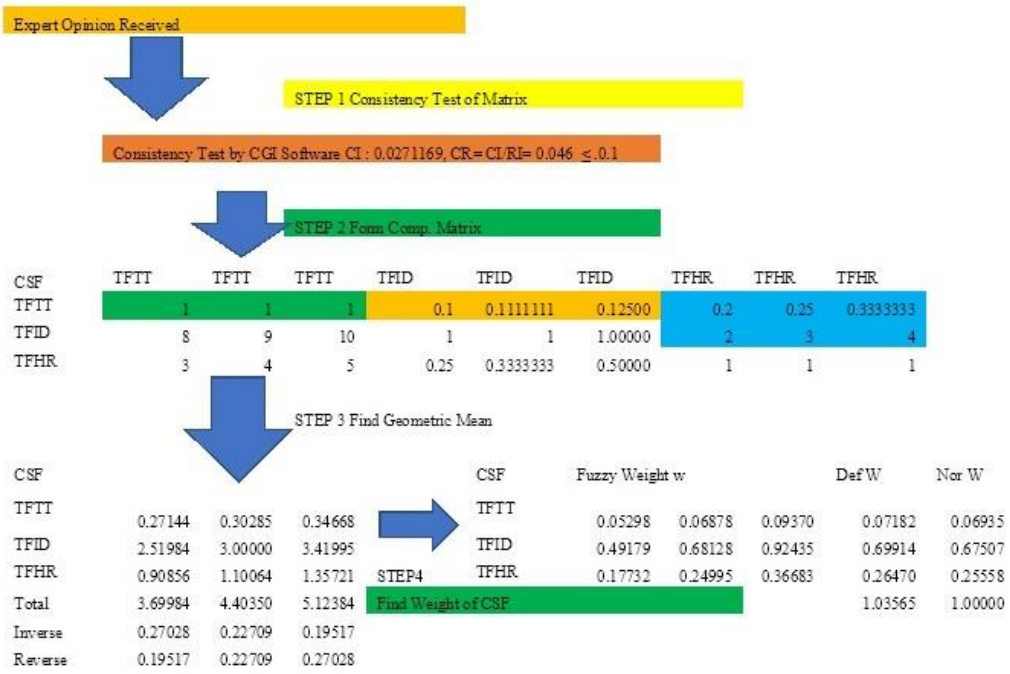



**Figure 4.3: Fuzzy AHP calculation steps by Excel level-2 CSF**

From this result, it is observed that the matrix Consistency ratio (CR) is 0.046 which is less than 0.1 that means matrix is consistent, and sum of total local weight is 1, so the result is validated. Global weight has been calculated as for Technology Transfer by Vendors, TFTT= weight of TF* weight of TFTT= 0.4423*0.07182=0.03177.

**Table 4.4: Defuzified Weight for Expert-1, Level-2 CSF of TF**

| CSF Level-1 | Final Defuzified | CSF Level 2 | Defuzified local weight | Defuzified global weight |
|---|---|---|---|---|
| TF | 0.4423 | TFTT | 0.07182 | 0.03177 |
| | | TFID | 0.69914 | 0.30923 |
| | | TFHR | 0.26470 | 0.11708 |

Similarly, for expert-1 defuzzied global weight of other level 2 CSFs with respect to PF, EF, SF and ENVF have been calculated and from defuzzified global weight the normalized global weight was calculated as shown in **Table 4.5:**

**Table 4.5: Defuzified and Normalized Weight for Expert-1 of All Level-2 CSF**

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.07182 | 0.03177 | 0.03127 |
| TFID | 0.69914 | 0.30923 | 0.30437 |
| TFHR | 0.2647 | 0.11708 | 0.11524 |
| PFGP | 0.7305 | 0.14581 | 0.14352 |
| PFAC | 0.1885 | 0.03762 | 0.03703 |
| PFASC | 0.081 | 0.01617 | 0.01591 |
| EFCS | 0.2684 | 0.05094 | 0.05014 |
| EFAS | 0.6144 | 0.11661 | 0.11478 |
| EFQS | 0.1172 | 0.02224 | 0.02189 |
| SFCYS | 0.2785 | 0.03946 | 0.03884 |
| SFPIS | 0.663 | 0.09395 | 0.09247 |
| SFLP | 0.0585 | 0.00829 | 0.00816 |
| ENFEH | 0.6483 | 0.01737 | 0.01710 |
| ENFRC | 0.2296 | 0.00615 | 0.00606 |
| ENFRCV | 0.122 | 0.00327 | 0.00322 |
| Weight Sum | | | 1.00000 |

By following the similar process and steps, the defuzzified global weight and normalized global weight of other nine Experts for level-2 CSFs were calculated on the basis of opinion of Expert. All tables of ten expert's opinion result have been given in **Appendix D** regarding these calculations.

### 4.2.4 Aggregation of weight by Fuzzy AHP of Level-2 CSF

On the basis of ten expert's opinion, the aggregation of CSF factors global weight were performed and found the final global weight of all level-2 CSFs which is shown in **Table 4.6.**

**Table 4.6: Aggregated Final Global Weight of Level-2 CSFs**

| CSF | Expert 1 | Expert E2 | Expert E3 | Expert E4 | Expert E5 | Expert E6 | Expert E7 | Expert E8 | Expert E9 | Expert E10 | Final Normalized Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TFTT | 0.0313 | 0.0259 | 0.0259 | 0.0322 | 0.0260 | 0.0322 | 0.0260 | 0.0260 | 0.0322 | 0.0322 | 0.0290 |
| TFID | 0.3044 | 0.2932 | 0.2932 | 0.2904 | 0.2945 | 0.2904 | 0.2945 | 0.2945 | 0.2904 | 0.2904 | 0.2936 |
| TFHR | 0.1152 | 0.1232 | 0.1232 | 0.1248 | 0.1237 | 0.1248 | 0.1237 | 0.1237 | 0.1248 | 0.1248 | 0.1232 |
| PFGP | 0.1435 | 0.1567 | 0.1567 | 0.1454 | 0.1549 | 0.1454 | 0.1549 | 0.1549 | 0.1454 | 0.1454 | 0.1503 |
| PFAC | 0.0370 | 0.0297 | 0.0297 | 0.0375 | 0.0294 | 0.0375 | 0.0294 | 0.0294 | 0.0375 | 0.0375 | 0.0335 |
| PFASC | 0.0159 | 0.0132 | 0.0132 | 0.0161 | 0.0130 | 0.0161 | 0.0130 | 0.0130 | 0.0161 | 0.0161 | 0.0146 |
| EFCS | 0.0501 | 0.0509 | 0.0509 | 0.0500 | 0.0510 | 0.0500 | 0.0510 | 0.0510 | 0.0500 | 0.0500 | 0.0505 |
| EFAS | 0.1148 | 0.1166 | 0.1166 | 0.1144 | 0.1167 | 0.1144 | 0.1167 | 0.1167 | 0.1144 | 0.1144 | 0.1156 |
| EFQS | 0.0219 | 0.0222 | 0.0222 | 0.0218 | 0.0223 | 0.0218 | 0.0223 | 0.0223 | 0.0218 | 0.0218 | 0.0220 |
| SFCYS | 0.0388 | 0.0395 | 0.0395 | 0.0395 | 0.0392 | 0.0395 | 0.0392 | 0.0392 | 0.0395 | 0.0395 | 0.0393 |
| SFPIS | 0.0925 | 0.0939 | 0.0939 | 0.0941 | 0.0933 | 0.0941 | 0.0933 | 0.0933 | 0.0941 | 0.0941 | 0.0936 |
| SFLP | 0.0082 | 0.0083 | 0.0083 | 0.0083 | 0.0082 | 0.0083 | 0.0082 | 0.0082 | 0.0083 | 0.0083 | 0.0083 |
| ENFEH | 0.0171 | 0.0147 | 0.0157 | 0.0165 | 0.0152 | 0.0165 | 0.0163 | 0.0152 | 0.0165 | 0.0165 | 0.0160 |
| ENFRC | 0.0061 | 0.0071 | 0.0062 | 0.0058 | 0.0073 | 0.0058 | 0.0065 | 0.0073 | 0.0058 | 0.0058 | 0.0064 |
| ENFRCV | 0.0032 | 0.0051 | 0.0049 | 0.0031 | 0.0053 | 0.0031 | 0.0051 | 0.0053 | 0.0031 | 0.0031 | 0.0041 |

| Weight Sum | 1.0000 |
|---|---|

### 4.2.5 Aggregation of global weight and ranking of Level-2 CSF

Finally, the global weight of level-2 CSFs, their ranking and percent of preference has been shown in **Table 4.7.**

**Table 4.7: Rank and Percent of Preference of Level-2 CSFs**

| CSF | Final Weight | Rank | Preference Level |
|---|---|---|---|
| TFID | 0.2936 | 1 | 29.36% |
| PFGP | 0.1503 | 2 | 15.03% |
| TFHR | 0.1232 | 3 | 12.32% |
| EFAS | 0.1156 | 4 | 11.56% |
| SFPIS | 0.0936 | 5 | 9.37% |
| EFCS | 0.0505 | 6 | 5.05% |
| SFCYS | 0.0393 | 7 | 3.93% |
| PFAC | 0.0335 | 8 | 3.35% |
| TFTT | 0.0290 | 9 | 2.90% |
| EFQS | 0.0220 | 10 | 2.20% |
| ENFEH | 0.0160 | 11 | 1.60% |
| PFASC | 0.0146 | 12 | 1.46% |
| SFLP | 0.0083 | 13 | 0.83% |
| ENFRC | 0.0064 | 14 | 0.64% |
| ENFRCV | 0.0041 | 15 | 0.41% |

### 4.2.6 Result analysis acquired by Fuzzy AHP method

After the result calculations by Fuzzy AHP, based on the expert opinion 0f 10 experts: Academician/Researcher, ICT professional, Management Expert, Bureaucrat, Business professional, it was observed that CSF ICT Infra-structure development and resource sharing has the highest importance of Rank-1 for strategic ICT management regarding sustainable e-governance of Bangladesh.

The second, third, fourth and fifth highest importance (Rank-2, 3, 4, 5) was found in CSF as Government Policy, Available Skilled Human Resource, Availability of service,

Personal Information Security respectively for strategic ICT management regarding sustainable e-governance of Bangladesh.

The 6th t0 10th important CSF (Rank-6, 7, 8, 9, 10) are Cost of service, Cyber Security, Awareness of Citizen, Technology Transfer by Vendor, Quality of service for strategic ICT management regarding sustainable e-governance of Bangladesh.

The 11th to 15th CSF (Rank-11, 12, 13, 14, and 15) was found as Environmental Hazard, Acceptability in socio-Cultural aspects, Legal protection, Resource Consumption, Resource Conservation for strategic ICT management regarding sustainable e-governance of Bangladesh. All the CSF.s rank and weight has been shown in **Figure 4.2.**

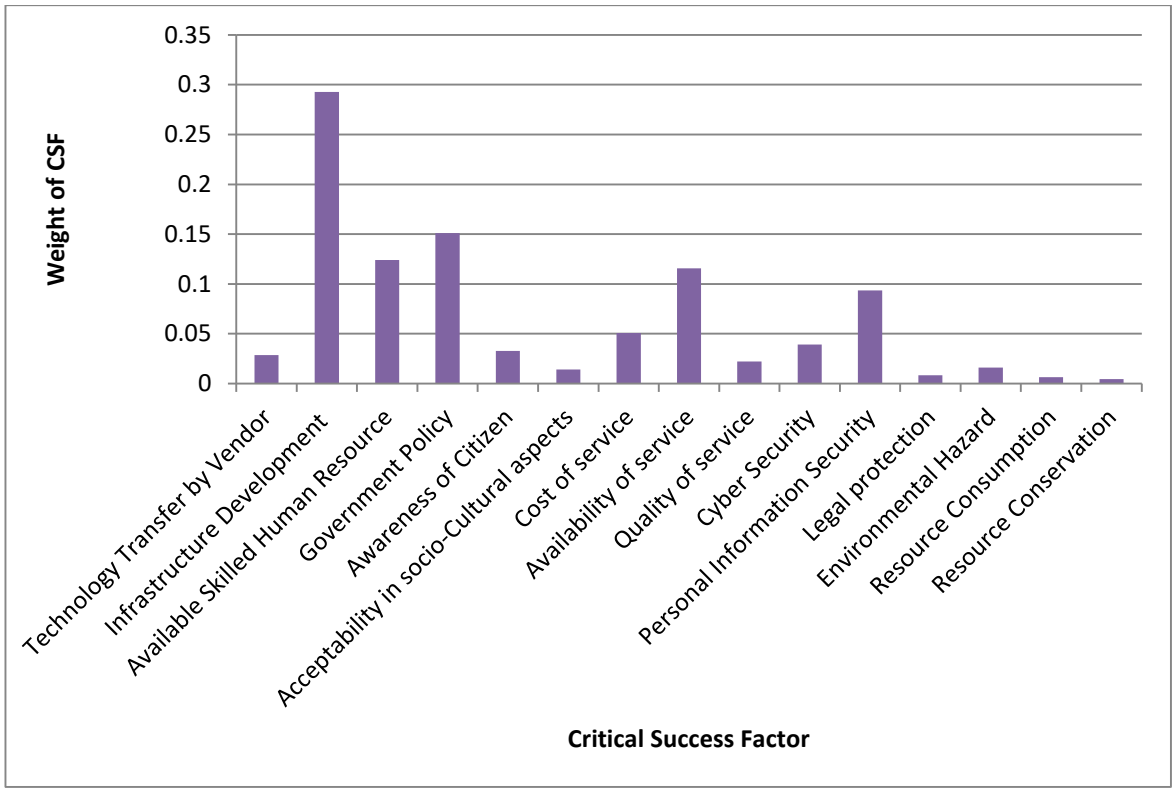



**Figure 4.4: Critical Success Factors and weight by Fuzzy AHP**

## 4.3 CSF assessment by Delhi Method

In this part, the significance and rank of 15 CSFs of level-2 or specific identified Critical Success Factors (CSFs) were calculated from the data which was collected by Delphi method from the opinion of Expert panel. In Delphi method, the level 2 specific CSFs are considered for calculation and assessment as in Delphi method there is no issue of calculation of global weight of level 2 CSFs and get the value directly.

### 4.3.1 Round One Delphi study

The result which was found from round one Delphi study is summarized in **Table 4.9**. For this Delphi study 15 points Likert scale was used by the researcher for collecting survey data from Delphi expert panel. In 15 points scale, 1 is being the most significant and 15 is being the least significant. The linguistic scale was used for the convenience of respondents as shown in **Table 4.8.** In this research work for Fuzzy AHP 16 points scale was used and for Delphi method 15 points scale was used to get more precise result which is also validated with Fuzzy AHP result.

**Table 4.8: Linguistic Likert Scale for Delphi Study**

| Scale | Level of Significance |
|---|---|
| 1 | Absolutely Extremely Significant |
| 2 | In between 15 and 13 |
| 3 | Extremely Significant |
| 4 | In between 13 and 11 |
| 5 | Very Significant |
| 6 | In between 11 and 9 |
| 7 | Somewhat Significant |
| 8 | Significant |
| 9 | Less Significant |
| 10 | In Between 7 and 5 |
| 11 | More Less Significant |
| 12 | In between 5 and 3 |
| 13 | Very Less Significant |
| 14 | In Between 1 and 3 |
| 15 | Least Significant |

The full questionnaire for Delphi data collection is given in **Appendix A.**

From the round one Delphi study data was collected from the 10 experts of Delphi panel through **"Google Form"**. After getting the data, the convergence of opinion of Delphi experts was calculated through Kendall's Coefficient of convergence (W). All the data and calculation of round one Delphi survey has been shown in **Table 4.9.** For round one Delphi study, 15 points Likert scale was used by the researcher for collecting survey data from Delphi expert panel. In 15 points scale, 1 is being the most significant and 15 is being the least significant.

**Table 4.9: Coefficient of Convergence of Round One Delphi Study**

| Calculation of Kendall's Coefficient of concordance W | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Experts$_j$ | | | | | | | | | | | Mean Rank | | | |
| $CSF_i$ | Ex1 | Ex2 | Ex3 | Ex4 | Ex5 | Ex6 | Ex7 | Ex8 | Ex9 | Ex10 | $R_i$ | | $\bar{R}$ | $(Ri-\bar{R})^2$ | W |
| Technology Transfer by Vendor | 7 | 5 | 4 | 8 | 4 | 5 | 6 | 9 | 7 | 8 | 63 | 6.3 | 80 | 289 | |
| Infrastructure Development and Resource Sharing | 2 | 1 | 3 | 3 | 2 | 1 | 4 | 4 | 6 | 3 | 29 | 2.9 | 80 | 2601 | |
| Available Skilled Human Resource | 5 | 2 | 4 | 1 | 3 | 1 | 4 | 5 | 1 | 5 | 31 | 3.1 | 80 | 2401 | |
| Government Policy | 3 | 3 | 1 | 6 | 4 | 7 | 3 | 6 | 5 | 4 | 42 | 4.2 | 80 | 1444 | |
| Awareness of Citizen | 5 | 9 | 8 | 5 | 7 | 10 | 6 | 7 | 6 | 10 | 73 | 7.3 | 80 | 49 | |
| Acceptability in socio-Cultural aspects | 12 | 11 | 12 | 12 | 12 | 8 | 13 | 9 | 12 | 10 | 111 | 11.1 | 80 | 961 | |
| Cost of service | 5 | 6 | 7 | 4 | 6 | 5 | 6 | 6 | 5 | 6 | 56 | 5.6 | 80 | 576 | 0.590 |
| Availability of service | 5 | 5 | 7 | 9 | 9 | 7 | 4 | 7 | 6 | 6 | 65 | 6.5 | 80 | 225 | |
| Quality of Service | 8 | 10 | 10 | 7 | 8 | 11 | 8 | 9 | 9 | 4 | 84 | 8.4 | 80 | 16 | |
| Cyber Security | 12 | 14 | 10 | 14 | 12 | 10 | 12 | 8 | 13 | 9 | 114 | 11.4 | 80 | 1156 | |
| Personal Information Security | 7 | 5 | 4 | 6 | 5 | 8 | 5 | 8 | 5 | 10 | 63 | 6.3 | 80 | 289 | |
| Legal protection | 11 | 10 | 11 | 10 | 9 | 7 | 11 | 11 | 7 | 9 | 96 | 9.6 | 80 | 256 | |
| Environmental Hazard | 11 | 11 | 12 | 9 | 11 | 15 | 13 | 7 | 11 | 10 | 110 | 11 | 80 | 900 | |
| Resource Consumption | 12 | 14 | 14 | 11 | 14 | 12 | 10 | 11 | 14 | 14 | 126 | 12.6 | 80 | 2116 | |
| Resource Conservation | 15 | 14 | 13 | 15 | 14 | 13 | 15 | 13 | 13 | 12 | 137 | 13.7 | 80 | 3249 | |
| SQDEV | | | | | | | | | | | | | | 16528 | |
| Sum of Total Rank will be 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | | | | | |

Here, Kendall's Coefficient of Convergence:

$W=12S/m^2(n^3-n)$, where S=SQDEV, $\bar{R}= m(n+1)/2= (10*16)/2=80$ (as m= 10 and n=15)

From the above table it was observed that the convergence of Delphi Expert opinion is nearly moderate, but not strong as Kendall's coefficient of convergence was 0.59. So, researcher decided to go for the second round Delphi study. In the second round Delphi study, the feedback of the first round was given to each expert mentioning his own ranking of the CSF in relation to the Delphi group's mean rank. The sample set consists for 10 respondents. The feedback has given in a tubular format to the respondent as shown in **Table 4.10.**

**Table 4.10: Feedback of round one Delphi study to respondents**

| CSF | Summary of Round One Delphi Study | | |
|---|---|---|---|
| | Your Ranking | Group Mean Ranking | % of Expert who gave ranking on this CFS ≤ 8 |
| Technology Transfer by Vendor | 6 | 6.3 | 90% |
| Infrastructure Development and Resource Sharing | 4 | 2.9 | 100% |
| Available Skilled Human Resource | 4 | 3.1 | 100% |
| Government Policy | 3 | 4.2 | 100% |
| Awareness of Citizen | 6 | 7.3 | 70% |
| Acceptability in socio-Cultural aspects | 13 | 11.1 | 10% |
| Cost of service | 6 | 5.6 | 100% |
| Availability of service | 4 | 6.5 | 80% |
| Quality of Service | 8 | 8.4 | 50% |
| Cyber Security | 12 | 11.4 | 10% |
| Personal Information Security | 5 | 6.3 | 80% |
| Legal protection | 11 | 9.6 | 20% |
| Environmental Hazard | 13 | 11 | 10% |
| Resource Consumption | 10 | 12.6 | 0% |
| Resource Conservation | 15 | 13.7 | 0% |

### 4.3.2 Round two Delphi study

For the Round two Delphi study, the result of round one sent to the expert participant with the following information.

**Research topic:** Strategic ICT Management in Bangladesh's transition to e-Governance: Framing out a realistic sustainable approach.

I appreciate you taking the time to respond to our Round One Delphi survey. After providing their ranking on the CSFs, ten out of the ten members of the Delphi panel returned the questionnaire. The researcher has made the decision to conduct a Round 2 Delphi survey. In this round, I'll evaluate the degree of group consensus by comparing your rankings to those of the Delphi group. After that, you will be required to rank newly the CSFs while carefully considering the views of your fellow group members. If your CSF ranks significantly deviate from the group mean rating, please carefully compare your rankings to the group's rankings as indicated in **Table 4.10.**

The result which was found from Round two Delphi study is summarized in **Table 4.11**. For this Delphi study, 15 points Likert scale used by the researcher for exploring survey data from Delphi expert panel. In 15 points scale, 1 is being the most significant and 15 is being the least significant.

**Table 4.11: Coefficient of convergence of round two Delphi study**

| Calculation of Kendall's Coefficient of concordance W | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Experts' | | | | | | | | | | $R_i$ | Mean | $\bar{R}$ | $(Ri-\bar{R})^2$ | W |
| $CSF_i$ | Ex1 | Ex2 | Ex3 | Ex4 | Ex5 | Ex6 | Ex7 | Ex8 | Ex9 | Ex10 | | Rank | | | |
| Technology Transfer by Vendor | 7 | 10 | 6 | 8 | 8 | 7 | 6 | 7 | 8 | 8 | 75 | 7.5 | 80 | 25 | |
| Infrastructure Development and Resource Sharing | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 20 | 2 | 80 | 3600 | |
| Available Skilled Human Resource | 3 | 2 | 4 | 3 | 3 | 1 | 2 | 3 | 3 | 2 | 26 | 2.6 | 80 | 2916 | |
| Government Policy | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 22 | 2.2 | 80 | 3364 | |
| Awareness of Citizen | 6 | 7 | 6 | 5 | 7 | 7 | 6 | 7 | 6 | 8 | 65 | 6.5 | 80 | 225 | |
| Acceptability in socio-Cultural aspects | 13 | 11 | 12 | 12 | 12 | 11 | 13 | 10 | 12 | 13 | 119 | 11.9 | 80 | 1521 | |
| Cost of service | 5 | 6 | 7 | 4 | 6 | 6 | 6 | 6 | 5 | 6 | 57 | 5.7 | 80 | 529 | **0.939** |
| Availability of service | 5 | 4 | 3 | 4 | 6 | 4 | 4 | 5 | 4 | 6 | 45 | 4.5 | 80 | 1225 | |
| Quality of Service | 8 | 10 | 10 | 9 | 8 | 9 | 8 | 9 | 9 | 8 | 88 | 8.8 | 80 | 64 | |
| Cyber Security | 12 | 13 | 13 | 14 | 12 | 13 | 12 | 13 | 13 | 12 | 127 | 12.7 | 80 | 2209 | |
| Personal Information Security | 6 | 5 | 4 | 6 | 5 | 5 | 5 | 4 | 5 | 5 | 50 | 5 | 80 | 900 | |
| Legal protection | 11 | 10 | 11 | 10 | 9 | 10 | 11 | 12 | 11 | 9 | 104 | 10.4 | 80 | 576 | |
| Environmental Hazard | 11 | 11 | 13 | 12 | 11 | 13 | 13 | 12 | 11 | 11 | 118 | 11.8 | 80 | 1444 | |
| Resource Consumption | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 14 | 14 | 14 | 139 | 13.9 | 80 | 3481 | |
| Resource Conservation | 15 | 14 | 15 | 15 | 14 | 15 | 15 | 13 | 15 | 14 | 145 | 14.5 | 80 | 4225 | |
| | SQDEV | | | | | | | | | | | | | 26304 | |
| Sum of Total Rank (Should be 120) | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | | | | | |

Here:

Kendall's Coefficient of Convergence: $W=12S/m^2(n^3-n)$, where S=SQDEV,

$\bar{R}$= m (n+1)/2= (10*16)/2=80 (as m= 10 and n=15)

From the above **Table 14.11** it is revealed that the convergence of Delphi Expert opinion is very strong, as Kendall's coefficient of convergence was found W= 0.939. If Kendall's Coefficient of convergence is W>0.7, then strong convergence among experts exists. The mean rank and final rank each of Critical Success Factors after round two Delphi study is shown in **Table 4.12.**

**Table 4.12: Mean Rank and Final Rank of CSF**

| CSF | Ex1 | Ex2 | Ex3 | Ex4 | Ex5 | Ex6 | Ex7 | Ex8 | Ex9 | Ex10 | Total Score | Mean Rank | Final Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Infrastructure Development and Resource Sharing | 2 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 20 | 2 | 1 |
| Government Policy | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 22 | 2.2 | 2 |
| Available Skilled Human Resource | 3 | 2 | 4 | 3 | 3 | 1 | 2 | 3 | 3 | 2 | 26 | 2.6 | 3 |
| Availability of service | 5 | 4 | 3 | 4 | 6 | 4 | 4 | 5 | 4 | 6 | 45 | 4.5 | 4 |
| Personal Information Security | 6 | 5 | 4 | 6 | 5 | 5 | 5 | 4 | 5 | 5 | 50 | 5 | 5 |
| Cost of service | 5 | 6 | 7 | 4 | 6 | 6 | 6 | 6 | 5 | 6 | 57 | 5.7 | 6 |
| Awareness of Citizen | 6 | 7 | 6 | 5 | 7 | 7 | 6 | 7 | 6 | 8 | 65 | 6.5 | 7 |
| Technology Transfer by Vendor | 7 | 10 | 6 | 8 | 8 | 7 | 6 | 7 | 8 | 8 | 75 | 7.5 | 8 |
| Quality of Service | 8 | 10 | 10 | 9 | 8 | 9 | 8 | 9 | 9 | 8 | 88 | 8.8 | 9 |
| Legal protection | 11 | 10 | 11 | 10 | 9 | 10 | 11 | 12 | 11 | 9 | 104 | 10.4 | 10 |
| Environmental Hazard | 11 | 11 | 13 | 12 | 11 | 13 | 13 | 12 | 11 | 11 | 118 | 11.8 | 11 |
| Acceptability in socio-Cultural aspects | 13 | 11 | 12 | 12 | 12 | 11 | 13 | 10 | 12 | 13 | 119 | 11.9 | 12 |
| Cyber Security | 12 | 13 | 13 | 14 | 12 | 13 | 12 | 13 | 13 | 12 | 127 | 12.7 | 13 |
| Resource Consumption | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 14 | 14 | 14 | 139 | 13.9 | 14 |
| Resource Conservation | 15 | 14 | 15 | 15 | 14 | 15 | 15 | 13 | 15 | 14 | 145 | 14.5 | 15 |

## 4.4 Result Validation of Fuzzy AHP and Delphi Method

In this research study two research methods were used, one is Fuzzy AHP and another one is Delphi method. By using these two research tools, we have found out the CSFs ranking which was mentioned in the above tables. In this section, findings of two methods result will be compared and validated.

### 4.4.1 Comparison of Ranking

The ranking of CSF of strategic ICT management for sustainable e-Governance found in in Fuzzy AHP has been shown in column 1 of Table 4.13, Delphi method ranking shown in column 2 of Table 4.13 and remarks about findings shown in column 3 of same table.

**Table 4.13: Comparison between Fuzzy AHP and Delphi Ranking**

| Validation Of Fuzzy AHP and Delphi Method | Column1 | Column2 | Column3 |
|---|---|---|---|
| Name of CSF | Fuzzy AHP Rank | Delphi Rank | Remarks |
| Infrastructure Development and Resource Sharing | 1 | 1 | Rank Same |
| Government Policy | 2 | 2 | Rank Same |
| Available Skilled Human Resource | 3 | 3 | Rank Same |
| Availability of service | 4 | 4 | Rank Same |
| Personal Information Security | 5 | 5 | Rank Same |
| Cost of service | 6 | 6 | Rank Same |
| Cyber Security | 7 | 13 | Rank 6 Step higher in Fuzzy |
| Awareness of Citizen | 8 | 7 | Rank 1 Step higher in Delphi |
| Technology Transfer by Vendor | 9 | 8 | Rank 1 Step higher in Delphi |
| Quality of service | 10 | 9 | Rank 1 Step higher in Delphi |
| Environmental Hazard | 11 | 11 | Rank Same |
| Acceptability in socio-Cultural aspects | 12 | 12 | Rank Same |
| Legal protection | 13 | 10 | Rank 3 Step higher in Delphi |
| Resource Consumption | 14 | 14 | Rank Same |
| Resource Conservation | 15 | 15 | Rank Same |

From the **table 4.13,** it reveals that CSF ranking from 1-6 : 1-6: Infrastructure Development and Resource Sharing, Government Policy, Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service are same in both Fuzzy AHP and Delphi method.

CSF Awareness of Citizen rank is 8 in Fuzzy AHP and 7 in Delphi method that means CSF Awareness has acquired one step higher rank in Delphi. CSF Technology Transfer by Vendor rank is 9 in Fuzzy AHP and 8 in Delphi method that means CSF Technology Transfer by Vendor has acquired one step higher rank in Delphi. CSF Quality of service is 10 in Fuzzy AHP and 9 in Delphi method that means CSF Quality of service acquired one step higher rank in Delphi. CSF Environmental Hazard and CSF Acceptability in socio-Cultural aspects acquired same rank 11 and 12 respectively in both Fuzzy AHP and Delphi method. CSF Resource Consumption and CSF Acceptability in Resource Conservation acquired same rank 14 and 15 respectively in both Fuzzy AHP and Delphi method.

Two CSF Cyber Security and Legal protection had a little bit higher difference in ranking of Fuzzy AHP and Delphi method. From **Table 4.13** it is revealed that Cyber security acquired rank 7in Fuzzy AHP method, but in Delphi method it was 13 that mean Cyber security got 6 step higher ranks in Fuzzy AHP method than Delphi method. Another CSF Legal protection acquired rank 13 in Fuzzy AHP method and 10 in Delphi method that means got 3 step higher ranks in Delphi method. The cause of this deviation discussed in result discussion section. The comparison of result of findings of 15 CSFs by two different methods has been shown in **Figure 4.5.**

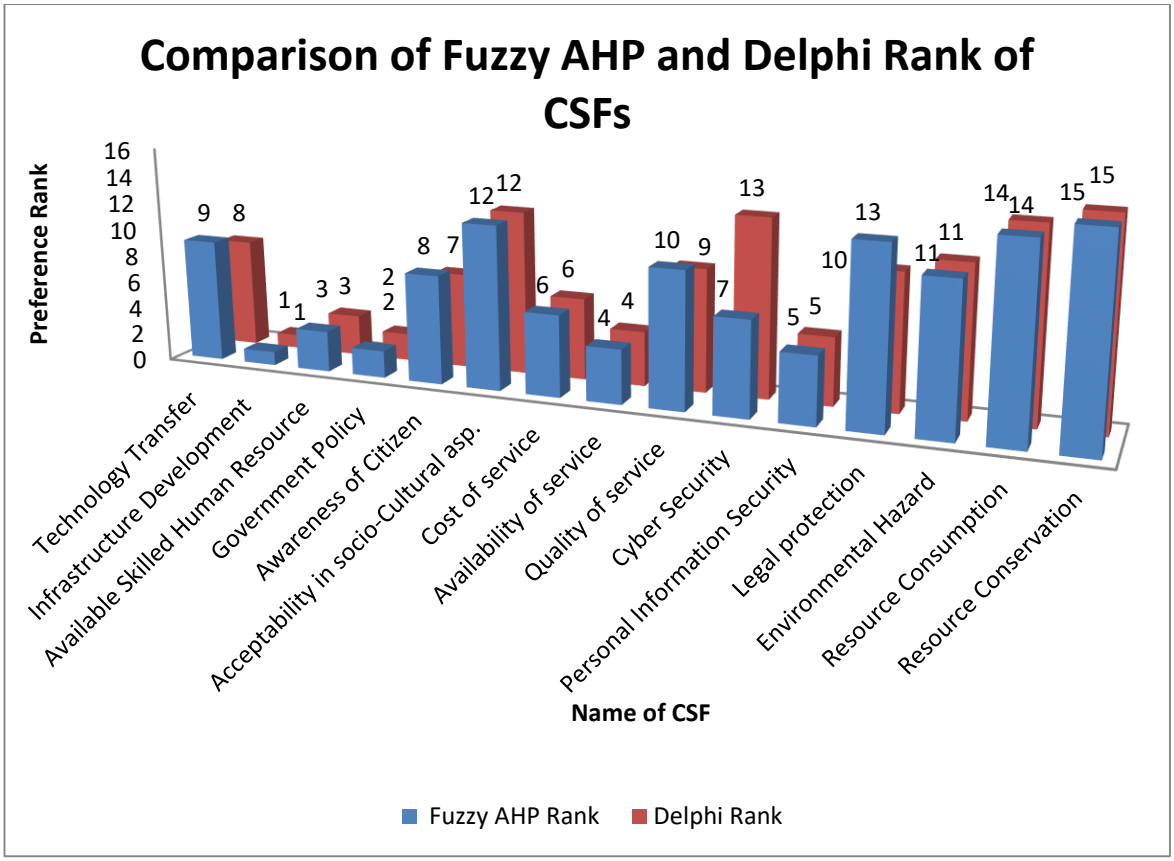



**Figure 4.5: Comparison of Fuzzy AHP and Delphi Rank**

From the **Figure 4.5** it reveals that 10 CSF including top 6 CSF has acquired same rank in both Fuzzy AHP and Delphi method, 4 CSF has almost same ranks (difference only 1) in both methods, and only 2 CSFs has acquired a little bit higher difference in ranking. So, the ranking of CSF found in both methods are almost same. The result of two methods is well matched and validated.

### 4.4.2 Key Findings of this Research

The Critical Success Factors accountable for strategic ICT management of sustainable e-Governance regarding Bangladesh are identified through massive literature review. Based on the frequency of CSF in literature review and piloting on the identified and proposed CSFs, 15 CSFs are finalized for this research. Based on literature review and pilot study, 15 Critical Success Factors are finalized, these are : Infrastructure Development and Resource Sharing, Government Policy, Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service, Cyber Security, Awareness of

Citizen, Technology Transfer by Vendor, Quality of service, Environmental Hazard considered, Acceptability in socio-Cultural aspects, Legal protection, Resource Consumption, Resource Conservation.

On the basis of expert opinion, by using two methods, Fuzzy AHP and Delphi method and doing rigorous mathematical calculation the priority rank of 15 CSFs was performed. The major findings of this study summarized as:

In this analytical research work, the identified 15 Factors were assessed by Fuzzy AHP and Delphi method. The data for the study is collected from 10 Experts. The findings of the evaluation by using Fuzzy AHP and Delphi have been shown in **Table 4.13.**

From the analysis, it is fond that Infrastructure Development and Resource Sharing is the most important CSF for strategic ICT management of sustainable e-Governance in both Fuzzy AHP and Delphi method. Government Policy is the second most important CSF found in both methods. Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service ranked the $3^{rd}$, $4^{th}$, $5^{th}$, $6^{th}$ important CSF in both Fuzzy AHP and Delphi method which is revealed in this study for strategic ICT management of sustainable e-Governance.

CSF Awareness of Citizen rank found $8^{th}$ in Fuzzy AHP and $7^{th}$ in Delphi method, Technology Transfer by Vendor rank is $9^{th}$ in Fuzzy AHP and $8^{th}$ in Delphi method ,Quality of service is $10^{th}$ in Fuzzy AHP and $9^{th}$ in Delphi method, Environmental Hazard and Acceptability in socio-Cultural aspects acquired same rank $11^{th}$ and $12^{th}$ respectively in both Fuzzy AHP and Delphi method. CSF Resource Consumption and CSF Resource Conservation acquired same rank $14^{th}$ and $15^{th}$ in both Fuzzy AHP and Delphi method. CSF Cyber security acquired rank $7^{th}$ in Fuzzy AHP method, but in Delphi method it was $13^{th}$ and CSF Legal protection acquired rank $13^{th}$ in Fuzzy AHP method and $10^{th}$ in Delphi method.

### 4.4.3 Discussion on Findings

The study was set out to achieve one specific objective and five main specific objectives. The first objective was to explore the Critical Success Factors for strategic ICT management of sustainable e-Governance in Bangladesh's perspective. The results of this study revealed that 15 CSFs were identified which have significant influence on strategic ICT management.

The second objectives of this research were to assess the identified CSFs and ranking them by Fuzzy AHP research tool which is very reliable for MCDM research problems. It was found that in Fuzzy AHP assessment, Infrastructure Development and Resource Sharing is the most important CSF for strategic ICT management of sustainable e-Governance. Government Policy ranked the second important CSF for strategic ICT management of sustainable e-Governance. Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service ranked the 3$^{rd}$, 4$^{th}$, 5$^{th}$, 6$^{th}$ important CSF for strategic ICT management of sustainable e-Governance.

CSF Cyber security acquired rank 7$^{th}$ in, Awareness of Citizen rank is 8$^{th}$, Technology Transfer by Vendor ranked the 9$^{th,}$ Quality of service ranked 10$^{th}$, Environmental Hazard and Acceptability in Socio-Cultural aspects acquired same rank 11$^{th}$ and 12$^{th}$ respectively, Legal protection ranked 13$^{th}$, Resource Consumption and Resource Conservation acquired rank 14$^{th}$ and 15$^{th}$ respectively by Fuzzy AHP method.

The third objective of this study was to assess the identified CSFs and ranking them by Delphi method, a popular research tool for strategic management. The study found that in Delphi method assessment, Infrastructure Development and Resource Sharing is the most important CSF for strategic ICT management of sustainable e-Governance. Government Policy ranked the second important CSF for strategic ICT management of sustainable e-Governance. Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service ranked the 3$^{rd}$, 4$^{th}$, 5$^{th}$, 6$^{th}$ important CSF for strategic ICT management of sustainable e-Governance.

CSF Cyber security acquired rank 13th in, Awareness of Citizen rank is 7th, Technology Transfer by Vendor ranked the 8th, Quality of service ranked 9th, Environmental Hazard and Acceptability in socio-Cultural aspects acquired same rank 11th and 12th respectively, Legal protection ranked 10th, Resource Consumption and Resource Conservation acquired rank 14th and 15th respectively by Delphi method.

The fourth objective was to compare the result found in Fuzzy AHP and Delphi methods and validates the result of two methods. The final rank of 15 CSF and their Global weight and rank in Fuzzy AHP and Mean value and rank in Delphi has been given in **Table 4.14.**

**Table 4.14: Comparison of CSFs ranking in two methods**

| Name of CSF | Fuzzy AHP Rank | Fuzzy Global Weight | Delphi Rank | Delphi Mean Value |
|---|---|---|---|---|
| Infrastructure Development and Resource Sharing | 1 | 0.2936 | 1 | 2 |
| Government Policy | 2 | 0.1503 | 2 | 2.2 |
| Available Skilled Human Resource | 3 | 0.1232 | 3 | 2.6 |
| Availability of service | 4 | 0.1156 | 4 | 4.5 |
| Personal Information Security | 5 | 0.0936 | 5 | 5 |
| Cost of service | 6 | 0.0505 | 6 | 5.7 |
| Cyber Security | 7 | 0.0393 | 13 | 6.5 |
| Awareness of Citizen | 8 | 0.0335 | 7 | 7.5 |
| Technology Transfer by Vendor | 9 | 0.0290 | 8 | 8.8 |
| Quality of service | 10 | 0.0220 | 9 | 10.4 |
| Environmental Hazard | 11 | 0.0160 | 11 | 11.8 |
| Acceptability in socio-Cultural aspects | 12 | 0.0146 | 12 | 11.9 |
| Legal protection | 13 | 0.0083 | 10 | 12.7 |
| Resource Consumption | 14 | 0.0064 | 14 | 13.9 |
| Resource Conservation | 15 | 0.0041 | 15 | 14.5 |
| Total Global weight and mean value sum | | 1.0000 | | 120 |

Two CSF Cyber Security and Legal protection had a little bit higher difference in ranking of Fuzzy AHP and Delphi method. From **Table 4.14** it is revealed that Cyber security acquired rank 7th in Fuzzy AHP method, but in Delphi method it was 13th that means Cyber security got 6 step higher ranks in Fuzzy AHP method than Delphi method. Another CSF Legal protection acquired rank 13th in Fuzzy AHP method and 10th in Delphi method that means got 3 step higher ranks in Delphi method. The cause of this deviation is described as:

a. Delphi method deals with the crisp value, but fuzzy deals with any value within the range which forms Fuzzy Triangular Number (TFN) and forms pair-wise comparison matrices for each CSF. The Fuzzy AHP triangular fuzzy number matrices were formed in Level-1 (Broader aspects of CSF) and Level-2 (Specific CSF).

b. The global weight of each CSF calculated considering all matrices of Level-1 and Level-2. For this reason, the ranking of some CSFs differs with Fuzzy AHP and Delphi method.

c. The Expert panel of Fuzzy AHP and Delphi method was separate, so the judgmental opinion of different Experts also differ the rank of some CSFs.

From the **Table 4.14,** it reveals that 10 CSF including top 6 CSF has acquired same rank in both Fuzzy AHP and Delphi method, 3 CSFs has almost same ranks (difference only 1) in both methods, and only 2 CSFs has acquired a little bit higher difference in ranking, which reason is described above. So, the CSF ranking in both methods found satisfactorily same. The result of two methods is well matched and validated.

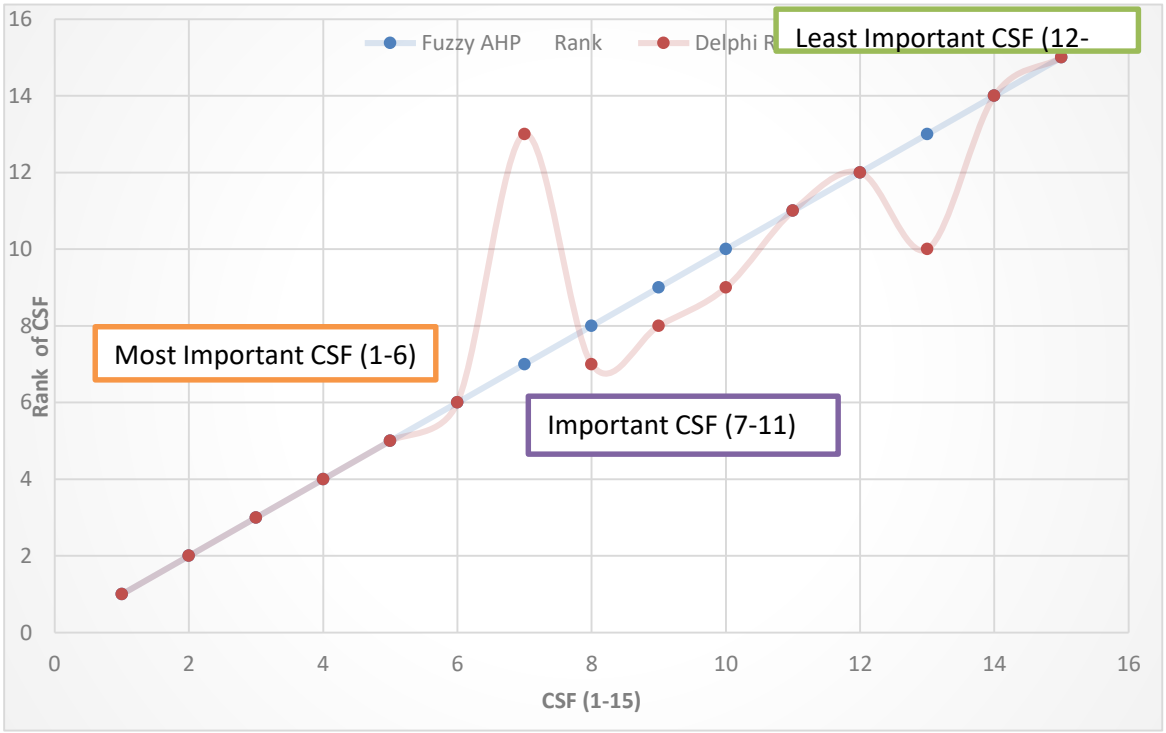



**Figure 4.6: Fuzzy AHP and Delphi Rank and Importance of CSF**

### 4.4.4 Strategic ICT Management Model

The specific objective of this research study was: Framing out a new new model of strategic ICT management for sustainable e-Governance in Bangladesh's transition to e-Governance.

From this research work it is summarized that the CSF ranked 1-6: Infrastructure Development and Resource Sharing, Government Policy ranked the second important, Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service are the most Important CSF for strategic ITC management of sustainable e-Governance. CSF ranked 7-11 (Fuzzy): Cyber security, Awareness of Citizen, Technology Transfer by Vendor, Quality of service, Environmental Hazard are important for strategic ITC management of sustainable e-Governance. CSF ranked 12-15 (Fuzzy): Acceptability in Socio-Cultural aspects, Legal protection, Resource Consumption, Resource Conservation.

Finally, from the findings of this research work, Frame of new strategic ICT management model has been outlined with top level importance, middle level importance and least level importance CSFs for strategic ICT management regarding sustainable e-Governance of Bangladesh as shown in **Figure 4.7.**

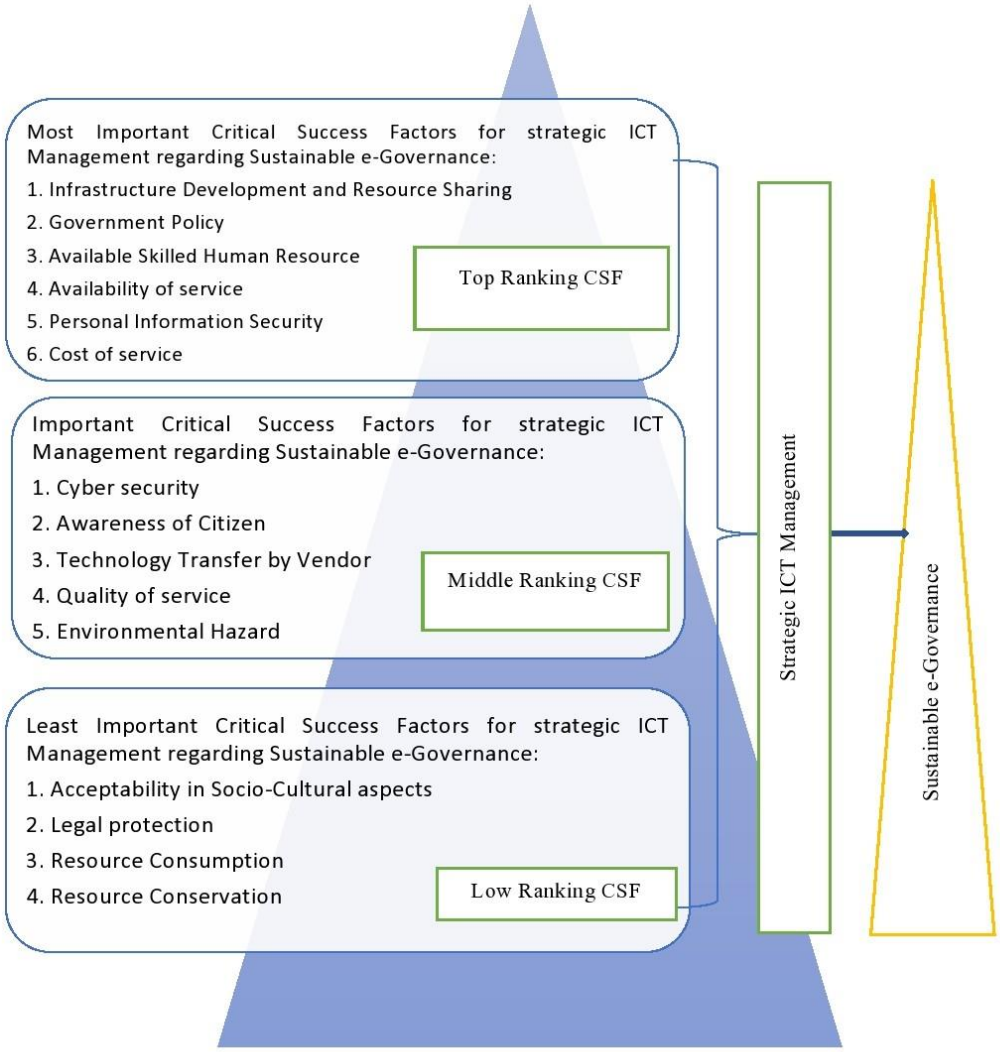



**Figure 4.7: Frame of Strategic ICT Management Model for sustainable e-Governance**

## 4.5 Sensitivity Analysis of Research findings

Sensitivity analysis which was the fifth objectives of this research work is an essential step in determining whether the model developed by using fuzzy AHP is robust and implementable. It is an act in ways for better forecasting, which will lead to more reliable future planning (Moslem, Farooq and Karasan, 2021). Sensitivity analysis is required for the following purposes:

1) Decision quality is described via sensitivity analysis.

2) The robustness and stability of the ranking with regard to the weights of the criteria, which in this case are CSFs, must be checked through sensitivity analysis. That means at what percentage of error of research ranking is correct.

3) Sensitivity analysis focuses on enhancing the outcome of qualitative and quantitative results of any particular model and gives the sensitivity involved in decision-making owing to unclear input values.

### 4.5.1 Sensitivity Analysis of the Fuzzy AHP Research Findings

In this research project, the final Global weight of different CSFs was calculated on the basis of expert opinion by applying the Fuzzy AHP and Delphi method which are strong tool for taking decision of MCDM problem. The final research findings about CSFs regarding e-governance sustainability in Bangladesh are shown in **Table 4.15 and 4.16.**

**Table 4.15: Final Research Findings of Level-1 CSFs**

| CSF | Final Weight | Rank |
|---|---|---|
| TF | 0.4422 | 1 |
| PF | 0.1996 | 2 |
| EF | 0.1897 | 3 |
| SF | 0.1417 | 4 |
| ENF | 0.0268 | 5 |

**Table 4.16: Final Research Findings of Level-2 CSFs**

| CSF | Final Weight | Rank |
|---|---|---|
| TFID | 0.2936 | 1 |
| PFGP | 0.1503 | 2 |
| TFHR | 0.1232 | 3 |
| EFAS | 0.1156 | 4 |
| SFPIS | 0.0936 | 5 |
| EFCS | 0.0505 | 6 |
| SFCYS | 0.0393 | 7 |
| PFAC | 0.0335 | 8 |
| TFTT | 0.0290 | 9 |
| EFQS | 0.0220 | 10 |
| ENFEH | 0.0160 | 11 |
| PFASC | 0.0146 | 12 |
| SFLP | 0.0083 | 13 |
| ENFRC | 0.0064 | 14 |
| ENFRCV | 0.0041 | 15 |

For the sensitivity test of this research work Weighted Sum Model (WSM) was used. The selected calculation process for the sensitivity analysis is based on changing a weight factor of one CSF, which is subject to the analysis to see the changes on other factors. When a value of a weight factor of one CSF is changed by the sensitivity analysis, other weight factors are decreased or increased by proportional changes of the weight factor. The total sum of the weight factors must always be equal to one (1). Proportional adjustments for other weight factors are calculated by following **Equation 4.1**. In this research work, the sensitivity test of research findings was performed on the basis of the result of Fuzzy AHP, as the findings of both Fuzzy AHP and Delphi is almost similar and the result Fuzzy AHP is more reliable.

$$Wf_{adj.i} = \frac{(Wf_{chng.j} - Wf_j)}{(1 - Wf_j)} * Wf_i \qquad 4.1$$

Where,

$Wf_{adj.i}$ = adjusted other CSF weight factors except sensitivity analysis weight factor,

$Wf_{chng.j}$= changed CSF weight factor of sensitivity analysis,

$Wf_j$= originally given CSF weight factor of sensitivity analysis, and

$Wf_i$= original CSF weight factors except sensitivity analysis weight factor

**Sensitivity Test for 5% weight change of CSF:**

**Case 1**: Weight Factor of TF of Level-1 CSF is increased by 5%, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.17**, **4.18** done by **Equation 4.1.**

**Table 4.17: Sensitivity Test For 5% Increase of TF Weight Level-1 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4643 | 1 | TF | 0.4422 | 1 | 0.0221 | No change |
| PF | 0.1917 | 2 | PF | 0.1996 | 2 | -0.0079 | No change |
| EF | 0.1822 | 3 | EF | 0.1897 | 3 | -0.0075 | No change |
| SF | 0.1361 | 4 | SF | 0.1417 | 4 | -0.0056 | No change |
| ENF | 0.0257 | 5 | ENF | 0.0268 | 5 | -0.0011 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table 4.18 Sensitivity test for 5% increase of TF weight Level-2 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.3058 | 1 | TFID | 0.2936 | 1 | 0.0122 | No change |
| PFGP | 0.1453 | 2 | PFGP | 0.1503 | 2 | -0.0050 | No change |
| TFHR | 0.1283 | 3 | TFHR | 0.1232 | 3 | 0.0051 | No change |
| EFAS | 0.1119 | 4 | EFAS | 0.1156 | 4 | -0.0037 | No change |
| SFPIS | 0.0902 | 5 | SFPIS | 0.0936 | 5 | -0.0034 | No change |
| EFCS | 0.0488 | 6 | EFCS | 0.0505 | 6 | -0.0017 | No change |
| SFCYS | 0.0379 | 7 | SFCYS | 0.0393 | 7 | -0.0014 | No change |
| PFAC | 0.0323 | 8 | PFAC | 0.0335 | 8 | -0.0012 | No change |
| TFTT | 0.0302 | 9 | TFTT | 0.0290 | 9 | 0.0012 | No change |
| EFQS | 0.0214 | 10 | EFQS | 0.0220 | 10 | -0.0006 | No change |
| ENFEH | 0.0155 | 11 | ENFEH | 0.0160 | 11 | -0.0005 | No change |
| PFASC | 0.0141 | 12 | PFASC | 0.0146 | 12 | -0.0005 | No change |
| SFLP | 0.0080 | 13 | SFLP | 0.0083 | 13 | -0.0003 | No change |
| ENFRC | 0.0063 | 14 | ENFRC | 0.0064 | 14 | -0.0001 | No change |
| ENFRCV | 0.0040 | 15 | ENFRCV | 0.0041 | 15 | -0.0001 | No change |
| Weight Sum | 1.0000 | | | 1.0000 | | | |

**Case 2**: Weight Factor of PF of Level-1 CSF is increased by 5%, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.19**, **4.20** done by **Equation 4.1.**

**Table 4.19 Sensitivity Test For 5% Increase of PF Weight Level-2 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4367 | 1 | TF | 0.4422 | 1 | -0.0055 | No change |
| PF | 0.2096 | 2 | PF | 0.1996 | 2 | 0.0100 | No change |
| EF | 0.1873 | 3 | EF | 0.1897 | 3 | -0.0024 | No change |
| SF | 0.1399 | 4 | SF | 0.1417 | 4 | -0.0018 | No change |
| ENF | 0.0265 | 5 | ENF | 0.0268 | 5 | -0.0003 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table 4.20 Sensitivity Test For 5% Increase of PF Weight Level-2 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.2876 | 1 | TFID | 0.2936 | 1 | -0.0060 | No change |
| PFGP | 0.1588 | 2 | PFGP | 0.1503 | 2 | 0.0085 | No change |
| TFHR | 0.1207 | 3 | TFHR | 0.1232 | 3 | -0.0025 | No change |
| EFAS | 0.1151 | 4 | EFAS | 0.1156 | 4 | -0.0005 | No change |
| SFPIS | 0.0928 | 5 | SFPIS | 0.0936 | 5 | -0.0008 | No change |
| EFCS | 0.0503 | 6 | EFCS | 0.0505 | 6 | -0.0002 | No change |
| SFCYS | 0.0390 | 7 | SFCYS | 0.0393 | 7 | -0.0003 | No change |
| PFAC | 0.0354 | 8 | PFAC | 0.0335 | 8 | 0.0019 | No change |
| TFTT | 0.0284 | 9 | TFTT | 0.0290 | 9 | -0.0006 | No change |
| EFQS | 0.0220 | 10 | EFQS | 0.0220 | 10 | 0.0000 | No change |
| ENFEH | 0.0158 | 11 | ENFEH | 0.0160 | 11 | -0.0002 | No change |
| PFASC | 0.0154 | 12 | PFASC | 0.0146 | 12 | 0.0008 | No change |
| SFLP | 0.0082 | 13 | SFLP | 0.0083 | 13 | -0.0001 | No change |
| ENFRC | 0.0064 | 14 | ENFRC | 0.0064 | 14 | 0.0000 | No change |
| ENFRCV | 0.0041 | 15 | ENFRCV | 0.0041 | 15 | 0.0000 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Case 3:** Weight Factor of EF of Level-1 CSF is increased by 5%, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.21**, **4.22** done by **Equation 4.1.**

**Table 4.21 Sensitivity Test For 5% Increase of EF Weight Level-1 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4370 | 1 | TF | 0.4422 | 1 | -0.0052 | No change |
| PF | 0.1973 | 3 | PF | 0.1996 | 2 | -0.0023 | PF Rank decrease |
| EF | 0.1992 | 2 | EF | 0.1897 | 3 | 0.0095 | EF rank increase |
| SF | 0.1400 | 4 | SF | 0.1417 | 4 | -0.0017 | No change |
| ENF | 0.0265 | 5 | ENF | 0.0268 | 5 | -0.0003 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table 4.22 Sensitivity Test For 5% Increase of EF Weight Level-2 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.2879 | 1 | TFID | 0.2930 | 1 | -0.0057 | No change |
| PFGP | 0.1495 | 2 | PFGP | 0.1511 | 2 | -0.0008 | No change |
| TFHR | 0.1207 | 4 | TFHR | 0.1241 | 3 | -0.0025 | TFHR rank decrease from 3 to 4 |
| EFAS | 0.1224 | 3 | EFAS | 0.1158 | 4 | 0.0068 | EFAS rank increase from 4 to |
| SFPIS | 0.093 | 5 | SFPIS | 0.0936 | 5 | -0.0008 | No change |
| EFCS | 0.0525 | 6 | EFCS | 0.0506 | 6 | 0.0030 | No change |
| SFCYS | 0.0391 | 7 | SFCYS | 0.0393 | 7 | -0.0003 | No change |
| PFAC | 0.0324 | 8 | PFAC | 0.0326 | 8 | -0.0002 | No change |
| TFTT | 0.0282 | 9 | TFTT | 0.0285 | 9 | -0.0006 | No change |
| EFQS | 0.0229 | 10 | EFQS | 0.0221 | 10 | 0.0014 | No change |
| ENFEH | 0.0149 | 11 | ENFEH | 0.0159 | 11 | -0.0001 | No change |
| PFASC | 0.0142 | 12 | PFASC | 0.0142 | 12 | -0.0001 | No change |
| SFLP | 0.0082 | 13 | SFLP | 0.0082 | 13 | -0.0001 | No change |
| ENFRC | 0.0061 | 14 | ENFRC | 0.0065 | 14 | 0.0000 | No change |
| ENFRCV | 0.0041 | 15 | ENFRCV | 0.0044 | 15 | 0.0000 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Case 4:** Weight Factor of SF of Level-1 CSF is increased by 5%, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.23**, **4.24** done by **Equation 4.1.**

**Table 4.23 Sensitivity Test For 5% Increase of SF Weight Level-1 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4385 | 1 | TF | 0.4422 | 1 | -0.0037 | No change |
| PF | 0.1980 | 2 | PF | 0.1996 | 2 | -0.00165 | No change |
| EF | 0.1881 | 3 | EF | 0.1897 | 3 | -0.00154 | No change |
| SF | 0.1488 | 4 | SF | 0.1417 | 4 | 0.0071 | No change |
| ENF | 0.0266 | 5 | ENF | 0.0268 | 5 | -0.00021 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table 4.24 Sensitivity Test For 5% Increase of SF Weight Level-2 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.2889 | 1 | TFID | 0.2936 | 1 | -0.0047 | No change |
| PFGP | 0.1500 | 2 | PFGP | 0.1503 | 2 | -0.0003 | No change |
| TFHR | 0.1212 | 3 | TFHR | 0.1232 | 3 | -0.0020 | No change |
| EFAS | 0.1156 | 4 | EFAS | 0.1156 | 4 | 0.0000 | No change |
| SFPIS | 0.0986 | 5 | SFPIS | 0.0936 | 5 | 0.0050 | No change |
| EFCS | 0.0505 | 6 | EFCS | 0.0505 | 6 | 0.0000 | No change |
| SFCYS | 0.0414 | 7 | SFCYS | 0.0393 | 7 | 0.0021 | No change |
| PFAC | 0.0334 | 8 | PFAC | 0.0335 | 8 | -0.0001 | No change |
| TFTT | 0.0285 | 9 | TFTT | 0.0290 | 9 | -0.0005 | No change |
| EFQS | 0.0220 | 10 | EFQS | 0.0220 | 10 | 0.0000 | No change |
| ENFEH | 0.0160 | 11 | ENFEH | 0.0160 | 11 | 0.0000 | No change |
| PFASC | 0.0145 | 12 | PFASC | 0.0146 | 12 | -0.0001 | No change |
| SFLP | 0.0088 | 13 | SFLP | 0.0083 | 13 | 0.0005 | No change |
| ENFRC | 0.0065 | 14 | ENFRC | 0.0064 | 14 | 0.0001 | No change |
| ENFRCV | 0.0041 | 15 | ENFRCV | 0.0041 | 15 | 0.0000 | No change |
| Weight Sum | 1.0000 | | | 1.0000 | | | |

**Case 5:** Weight Factor of ENVF of Level-1 CSF is increased by 5%, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.23**, **4.24** done by **Equation 4.1.**

**Table 4.25 Sensitivity Test For 5% Increase of ENVF Weight Level-1 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4416 | 1 | TF | 0.4422 | 1 | -0.0037 | No change |
| PF | 0.1993 | 2 | PF | 0.1996 | 2 | -0.00165 | No change |
| EF | 0.1894 | 3 | EF | 0.1897 | 3 | -0.00154 | No change |
| SF | 0.1415 | 4 | SF | 0.1417 | 4 | 0.0071 | No change |
| ENF | 0.0281 | 5 | ENF | 0.0268 | 5 | -0.00021 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table 4.26 Sensitivity Test For 5% Increase of ENVF Weight Level-2 CSF**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.2909 | 1 | TFID | 0.2936 | 1 | -0.0027 | No change |
| PFGP | 0.1511 | 2 | PFGP | 0.1503 | 2 | 0.0008 | No change |
| TFHR | 0.1220 | 3 | TFHR | 0.1232 | 3 | -0.0012 | No change |
| EFAS | 0.1164 | 4 | EFAS | 0.1156 | 4 | 0.0008 | No change |
| SFPIS | 0.0938 | 5 | SFPIS | 0.0936 | 5 | 0.0002 | No change |
| EFCS | 0.0508 | 6 | EFCS | 0.0505 | 6 | 0.0003 | No change |
| SFCYS | 0.0394 | 7 | SFCYS | 0.0393 | 7 | 0.0001 | No change |
| PFAC | 0.0336 | 8 | PFAC | 0.0335 | 8 | 0.0001 | No change |
| TFTT | 0.0287 | 9 | TFTT | 0.0290 | 9 | -0.0003 | No change |
| EFQS | 0.0222 | 10 | EFQS | 0.0220 | 10 | 0.0002 | No change |
| ENFEH | 0.0169 | 11 | ENFEH | 0.0160 | 11 | 0.0009 | No change |
| PFASC | 0.0147 | 12 | PFASC | 0.0146 | 12 | 0.0001 | No change |
| SFLP | 0.0083 | 13 | SFLP | 0.0083 | 13 | 0.0000 | No change |
| ENFRC | 0.0068 | 14 | ENFRC | 0.0064 | 14 | 0.0004 | No change |
| ENFRCV | 0.0044 | 15 | ENFRCV | 0.0041 | 15 | 0.0003 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Sensitivity Test for 10% weight factor change:**

**Case 1:** Weight Factor of TF of Level-1 CSF is increased by 10%, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.26**, **4.27** done by **Equation 4.1.**

**Table4.27: Sensitivity Analysis of Level-1 CSFs By Increasing TF 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4864 | 1 | TF | 0.4422 | 1 | 0.0442 | No change |
| PF | 0.1838 | 2 | PF | 0.1996 | 2 | -0.0158 | No change |
| EF | 0.1747 | 3 | EF | 0.1897 | 3 | -0.0150 | No change |
| SF | 0.1305 | 4 | SF | 0.1417 | 4 | -0.0112 | No change |
| ENF | 0.0247 | 5 | ENF | 0.0268 | 5 | -0.0021 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table4.28: Sensitivity Analysis of Level-2 CSFs For Increasing Weight Factor of TF by 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.3204 | 1 | TFID | 0.2930 | 1 | 0.0268 | No change |
| PFGP | 0.1393 | 2 | PFGP | 0.1511 | 2 | -0.0110 | No change |
| TFHR | 0.1344 | 3 | TFHR | 0.1241 | 3 | 0.0112 | No change |
| EFAS | 0.1073 | 4 | EFAS | 0.1158 | 4 | -0.0083 | No change |
| SFPIS | 0.0865 | 5 | SFPIS | 0.0936 | 5 | -0.0071 | No change |
| EFCS | 0.0469 | 6 | EFCS | 0.0506 | 6 | -0.0036 | No change |
| SFCYS | 0.0363 | 7 | SFCYS | 0.0393 | 7 | -0.0030 | No change |
| PFAC | 0.031 | 9 | PFAC | 0.0326 | 8 | -0.0025 | PFAC Rank decreased from 8 to 9 |
| TFTT | 0.0316 | 8 | TFTT | 0.0285 | 9 | 0.0026 | TFTT Rank increased from 9 to 8 |
| EFQS | 0.0201 | 10 | EFQS | 0.0221 | 10 | -0.0015 | No change |
| ENFEH | 0.0139 | 11 | ENFEH | 0.0159 | 11 | -0.0012 | No change |
| PFASC | 0.0132 | 12 | PFASC | 0.0142 | 12 | -0.0011 | No change |
| SFLP | 0.0076 | 13 | SFLP | 0.0082 | 13 | -0.0007 | No change |
| ENFRC | 0.0057 | 14 | ENFRC | 0.0065 | 14 | -0.0003 | No change |
| ENFRCV | 0.0038 | 15 | ENFRC | 0.0044 | 15 | -0.0003 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Case 2**: Weight Factor of PF of Level-1 CSF is increased by 10 %, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.28**, **4.29** done by **Equation 4.1.**

**Table4.29: Sensitivity Analysis of Level-1 CSFs by Increasing PF 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4312 | 1 | TF | 0.4422 | 1 | -0.0110 | No change |
| PF | 0.2196 | 2 | PF | 0.1996 | 2 | 0.0200 | No change |
| EF | 0.1850 | 3 | EF | 0.1897 | 3 | -0.0047 | No change |
| SF | 0.1382 | 4 | SF | 0.1417 | 4 | -0.0035 | No change |
| ENF | 0.0261 | 5 | ENF | 0.0268 | 5 | -0.0007 | No change |
| Weight Sum | 1.0000 | | | 1.0000 | | | |

**Table4.30: Sensitivity Analysis of Level-2 CSFs for Increasing Weight Factor of PF by 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.284 | 1 | TFID | 0.2936 | 1 | -0.0096 | No change |
| PFGP | 0.1664 | 2 | PFGP | 0.1503 | 2 | 0.0161 | No change |
| TFHR | 0.1191 | 3 | TFHR | 0.1232 | 3 | -0.0041 | No change |
| EFAS | 0.1136 | 4 | EFAS | 0.1156 | 4 | -0.0020 | No change |
| SFPIS | 0.0916 | 5 | SFPIS | 0.0936 | 5 | -0.0020 | No change |
| EFCS | 0.0496 | 6 | EFCS | 0.0505 | 6 | -0.0009 | No change |
| SFCYS | 0.0385 | 7 | SFCYS | 0.0393 | 7 | -0.0008 | No change |
| PFAC | 0.037 | 8 | PFAC | 0.0335 | 8 | 0.0035 | No change |
| TFTT | 0.028 | 9 | TFTT | 0.0290 | 9 | -0.0010 | No change |
| EFQS | 0.0217 | 10 | EFQS | 0.0220 | 10 | -0.0003 | No change |
| ENFEH | 0.0157 | 12 | ENFEH | 0.016 | 11 | -0.0003 | Rank decrease from 11 to 12 |
| PFASC | 0.0161 | 11 | PFASC | 0.0146 | 12 | 0.0015 | Rank increase from 11 to 12 |
| SFLP | 0.0082 | 13 | SFLP | 0.0083 | 13 | -0.0001 | No change |
| ENFRC | 0.0064 | 14 | ENFRC | 0.0064 | 14 | 0.0000 | No change |
| ENFRCV | 0.0041 | 15 | ENFRCV | 0.0041 | 15 | 0.0000 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Case 3:** Weight Factor of EF of Level-1 CSF is increased by 10 %, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.30**, **4.31** done by **Equation 4.1.**

**Table4.31: Sensitivity Analysis of Level-1 CSFs by Increasing EF 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4318 | 1 | TF | 0.4422 | 1 | -0.01023 | No change |
| PF | 0.1949 | 3 | PF | 0.1996 | 2 | -0.00455 | PF decreased from 2 to 3 |
| EF | 0.2087 | 2 | EF | 0.1897 | 3 | 0.01862 | EF rank increased from 3 to 2 |
| SF | 0.1384 | 4 | SF | 0.1417 | 4 | -0.00324 | No change |
| ENF | 0.0262 | 5 | ENF | 0.0268 | 5 | -0.00058 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table4.32: Sensitivity Analysis of Level-2 CSFs for Increasing Weight Factor of EF by 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.2845 | 1 | TFID | 0.2936 | 1 | -0.0091 | No change |
| PFGP | 0.1477 | 2 | PFGP | 0.1503 | 2 | -0.0026 | No change |
| TFHR | 0.1193 | 4 | TFHR | 0.1232 | 3 | -0.0039 | TFHR rank decreased from 3 to 4 |
| EFAS | 0.1282 | 3 | EFAS | 0.1156 | 4 | 0.0126 | EFAS rank increased from 4 to 3 |
| SFPIS | 0.0917 | 5 | SFPIS | 0.0936 | 5 | -0.0019 | No change |
| EFCS | 0.0560 | 6 | EFCS | 0.0505 | 6 | 0.0055 | No change |
| SFCYS | 0.0385 | 7 | SFCYS | 0.0393 | 7 | -0.0008 | No change |
| PFAC | 0.0329 | 8 | PFAC | 0.0335 | 8 | -0.0006 | No change |
| TFTT | 0.0281 | 9 | TFTT | 0.0290 | 9 | -0.0009 | No change |
| EFQS | 0.0245 | 10 | EFQS | 0.0220 | 10 | 0.0025 | No change |
| ENFEH | 0.0157 | 11 | ENFEH | 0.0160 | 11 | -0.0003 | No change |
| PFASC | 0.0143 | 12 | PFASC | 0.0146 | 12 | -0.0003 | No change |
| SFLP | 0.0081 | 13 | SFLP | 0.0083 | 13 | -0.0002 | No change |
| ENFRC | 0.0064 | 14 | ENFRC | 0.0064 | 14 | 0.0000 | No change |
| ENFRCV | 0.0041 | 15 | ENFRCV | 0.0041 | 15 | 0.0000 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Case 4:** Weight Factor of SF of Level-1 CSF is increased by 10 %, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.32**, **4.33** done by **Equation 4.1.**

**Table4.33: Sensitivity Analysis of Level-1 CSFs by Increasing SF 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4349 | 1 | TF | 0.4422 | 1 | -0.0074 | No |
| PF | 0.1963 | 2 | PF | 0.1996 | 2 | -0.00329 | No |
| EF | 0.1866 | 3 | EF | 0.1897 | 3 | -0.00308 | No |
| SF | 0.1559 | 4 | SF | 0.1417 | 4 | 0.01419 | No |
| ENF | 0.0264 | 5 | ENF | 0.0268 | 5 | -0.00042 | No |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table4.34: Sensitivity Analysis of Level-2 CSFs for Increasing Weight Factor of SF by 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.0283 | 1 | TFID | 0.2936 | 1 | -0.2653 | No change |
| PFGP | 0.2865 | 2 | PFGP | 0.1503 | 2 | 0.1362 | No change |
| TFHR | 0.1202 | 3 | TFHR | 0.1232 | 3 | -0.0030 | No change |
| EFAS | 0.1488 | 4 | EFAS | 0.1156 | 4 | 0.0332 | No change |
| SFPIS | 0.0331 | 5 | SFPIS | 0.0936 | 5 | -0.0605 | No change |
| EFCS | 0.0144 | 6 | EFCS | 0.0505 | 6 | -0.0361 | No change |
| SFCYS | 0.0501 | 7 | SFCYS | 0.0393 | 7 | 0.0108 | No change |
| PFAC | 0.1146 | 8 | PFAC | 0.0335 | 8 | 0.0811 | No change |
| TFTT | 0.0219 | 9 | TFTT | 0.0290 | 9 | -0.0071 | No change |
| EFQS | 0.0434 | 10 | EFQS | 0.0220 | 10 | 0.0214 | No change |
| ENFEH | 0.1033 | 11 | ENFEH | 0.0160 | 11 | 0.0873 | No change |
| PFASC | 0.0091 | 12 | PFASC | 0.0146 | 12 | -0.0055 | No change |
| SFLP | 0.0159 | 13 | SFLP | 0.0083 | 13 | 0.0076 | No change |
| ENFRC | 0.0064 | 14 | ENFRC | 0.0064 | 14 | 0.0000 | No change |
| ENFRCV | 0.0041 | 15 | ENFRCV | 0.0041 | 15 | 0.0000 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

**Case 5:** Weight Factor of ENVF of Level-1 CSF is increased by 10%, so the changed weight factors of Level-1 and Level-2's other CSFs are shown in **Table 4.34**, **4.35** done by **Equation 4.1.**

**Table 4.35: Sensitivity Analysis of Level-1 CSFs by Increasing SF 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of Weight | Change of Rank |
|---|---|---|---|---|---|---|---|
| TF | 0.4410 | 1 | TF | 0.4422 | 1 | -0.0012 | No |
| PF | 0.1991 | 2 | PF | 0.1996 | 2 | -0.0005 | No |
| EF | 0.1892 | 3 | EF | 0.1897 | 3 | -0.0005 | No |
| SF | 0.1413 | 4 | SF | 0.1417 | 4 | -0.0004 | No |
| ENF | 0.0295 | 5 | ENF | 0.0268 | 5 | 0.0027 | No |
| Weight | 1.0000 | | | 1.0000 | | | |

**Table 4.36: Sensitivity Analysis of Level-2 CSFs for Increasing Weight Factor of SF by 10 %**

| CSF | Changed Weight | Rank | CSF | Original weight | Rank | Change of | Change of Rank |
|---|---|---|---|---|---|---|---|
| TFID | 0.2905 | 1 | TFID | 0.2936 | 1 | -0.0031 | No change |
| PFGP | 0.1509 | 2 | PFGP | 0.1503 | 2 | 0.0006 | No change |
| TFHR | 0.1218 | 3 | TFHR | 0.1232 | 3 | -0.0014 | No change |
| EFAS | 0.1162 | 4 | EFAS | 0.1156 | 4 | 0.0006 | No change |
| SFPIS | 0.0937 | 5 | SFPIS | 0.0936 | 5 | 0.0001 | No change |
| EFCS | 0.0508 | 6 | EFCS | 0.0505 | 6 | 0.0003 | No change |
| SFCYS | 0.0394 | 7 | SFCYS | 0.0393 | 7 | 0.0001 | No change |
| PFAC | 0.0336 | 8 | PFAC | 0.0335 | 8 | 0.0001 | No change |
| TFTT | 0.0287 | 9 | TFTT | 0.0290 | 9 | -0.0003 | No change |
| EFQS | 0.0222 | 10 | EFQS | 0.0220 | 10 | 0.0002 | No change |
| ENFEH | 0.0175 | 11 | ENFEH | 0.0160 | 11 | 0.0015 | No change |
| PFASC | 0.0146 | 12 | PFASC | 0.0146 | 12 | 0.0000 | No change |
| SFLP | 0.0083 | 13 | SFLP | 0.0083 | 13 | 0.0000 | No change |
| ENFRC | 0.0072 | 14 | ENFRC | 0.0064 | 14 | 0.0008 | No change |
| ENFRCV | 0.0046 | 15 | ENFRCV | 0.0041 | 15 | 0.0005 | No change |
| Weight | 1.0000 | | | 1.0000 | | | |

From sensitivity analysis test, it is found that for applied modification in level-1 CSF of 5% increase in all CSFs as TF, PF, EF, SF, ENF, shows that for TF, PF, SF and ENF, had no change in the factor rank or order in Level-1 CSFs and also in Level-2 CSFs.

But in case of EF, the rank of level-1 CSF, PF decreases from rank 2 to 3 and the rank of EF increases from rank 3 to 2. But the difference of weight is 0.0023 and 0.0095 which is very insignificant. That means both the factor PF and EF are almost equally important factor for strategic ICT management regarding sustainable e-Governance in Bangladesh. In level-2 CSF, TFHR rank decreases from 3 to 4 and EFAS rank increases from 4 to 3 with the weight difference 0.0025 and 0.0068 respectively. Factor weight difference here is also very insignificant. For 5% weight increase, the final results of CSFs for Level 1 are shown in **Table 4.37** and **Figure 4.8,** for level 2 shown in **Table 4.38** and **Figure 4.9.**

**Table 4.37: Sensitivity Analysis Result: Level-1 CSFs for Increasing Weight Factor by 5 %**

| CSF | Original | Changed Rank | | | | |
|---|---|---|---|---|---|---|
| | | TF Increased | PF Increased | EF Increased 5 | SF Increased 5 % | ENVF Increased 5% |
| TF | 1 | 1 | 1 | 1 | 1 | 1 |
| PF | 2 | 2 | 2 | 3 | 2 | 2 |
| EF | 3 | 3 | 3 | 2 | 3 | 3 |
| SF | 4 | 4 | 4 | 4 | 4 | 4 |
| ENF | 5 | 5 | 5 | 5 | 5 | 5 |

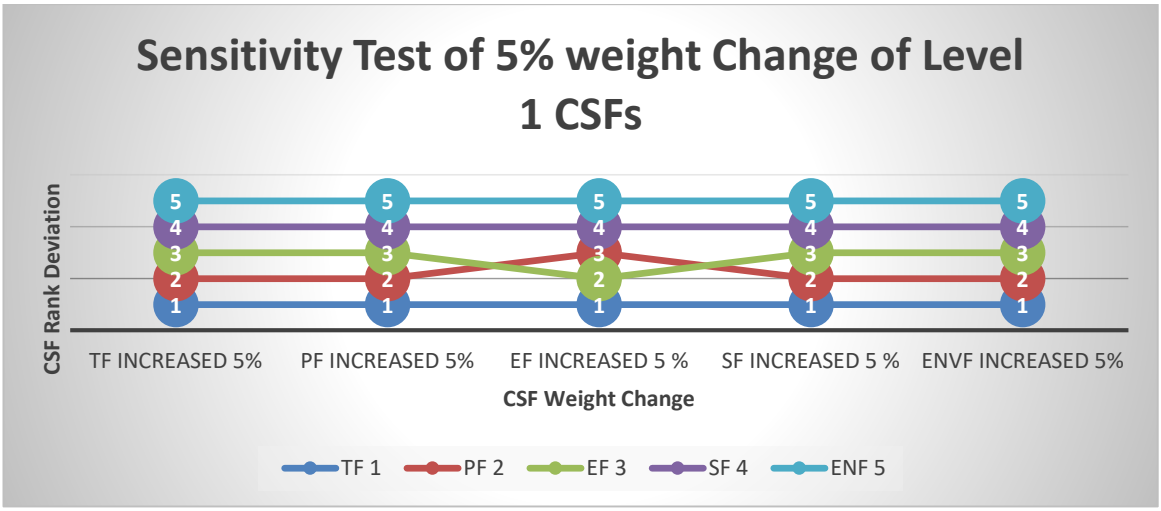



**Figure 4.8: Sensitivity analysis of 5% weight change of Level 1 CSF**

**Table 4.38: Sensitivity Analysis Result: Level-2 CSFs for Increasing Weight Factor by 10 %**

| | Original | Changed Rank | | | | |
|---|---|---|---|---|---|---|
| CSF | | TF Increased 5% | PF Increased 5% | EF Increased 5% | SF Increased 5% | ENVF Increased 5% |
| TFID | 1 | 1 | 1 | 1 | 1 | 1 |
| PFGP | 2 | 2 | 2 | 2 | 2 | 2 |
| TFHR | 3 | 3 | 3 | 4 | 3 | 3 |
| EFAS | 4 | 4 | 4 | 3 | 4 | 4 |
| SFPIS | 5 | 5 | 5 | 5 | 5 | 5 |
| EFCS | 6 | 6 | 6 | 6 | 6 | 6 |
| SFCYS | 7 | 7 | 7 | 7 | 7 | 7 |
| PFAC | 8 | 8 | 8 | 8 | 8 | 8 |
| TFTT | 9 | 9 | 9 | 9 | 9 | 9 |
| EFQS | 10 | 10 | 10 | 10 | 10 | 10 |
| ENFEH | 11 | 11 | 11 | 11 | 11 | 11 |
| PFASC | 12 | 12 | 12 | 12 | 12 | 12 |
| SFLP | 13 | 13 | 13 | 13 | 13 | 13 |
| ENFRC | 14 | 14 | 14 | 14 | 14 | 14 |
| ENFRCV | 15 | 15 | 15 | 15 | 15 | 15 |

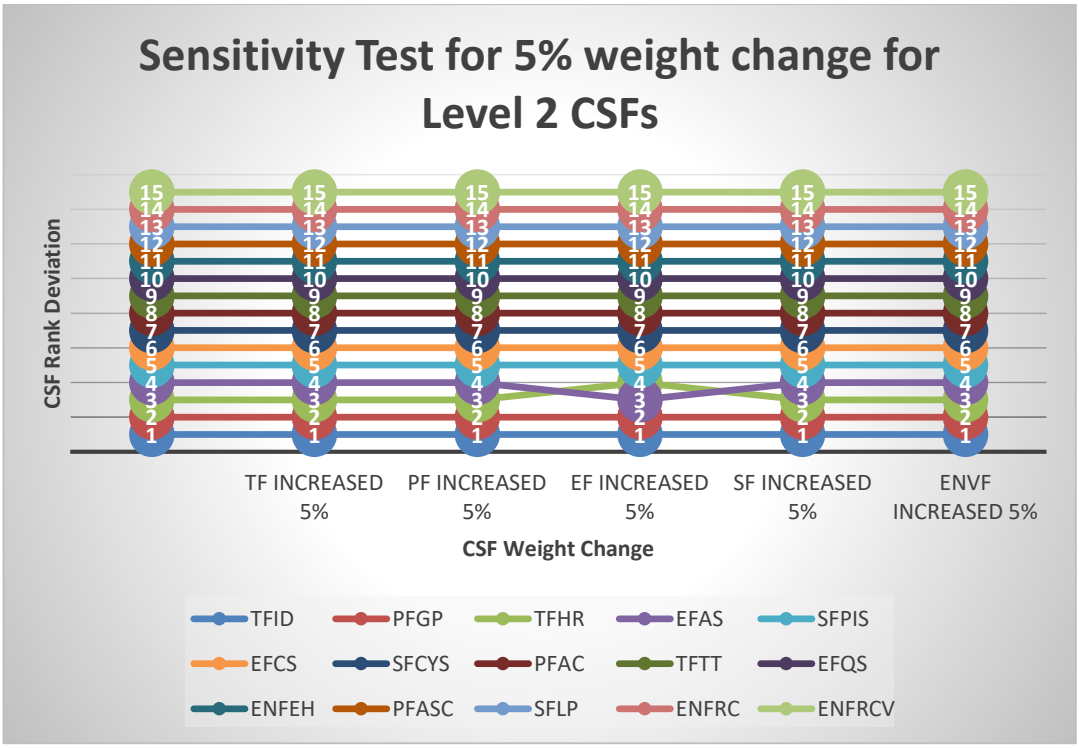



**Figure 4.9: Sensitivity analysis of 5 % weight change of Level 1 CSF**

From sensitivity analysis test, it is found that applied modification in level-1 CSF of 10 % increase in all CSFs as TF, PF, EF, SF, ENF shows that for TF, PF, SF and ENF, had no change in the factor rank or order in Level-1 CSFs.

But in case of EF, the rank of level-1 CSF, PF decreases from rank 2 to 3 and the rank of EF increases from rank 3 to 2. But the difference of weight is 0.00455 and 0.01862 which is very insignificant. That means both the factor PF and EF are almost equally important factor for strategic ICT management regarding sustainable e-Governance in Bangladesh. In level-2 CSF, TFHR rank decreases from 3 to 4 and EFAS rank increases from 4 to 3 with the weight difference 0.0039 and 0.0126 respectively. Factor weight difference here is also very insignificant.

And in Level-2 CSF, for the 10% increase of weight of TF, ENFEH rank decrease from 11 to 12 PFASC rank increases from 11 to 12, but the factor weight difference is 0.0003 and 0.0015 respectively, which is very insignificant. For 5% weight increase, the final

results of CSFs for Level 1 are shown in **Table 4.39** and **Figure 4.10,** for level 2 shown in **Table 4.40** and **Figure 4.11.**

**Table 4.39: Sensitivity Analysis Result: Level-1 CSFs for Increasing Weight Factor by 10 %**

| CSF | Original | Changed Rank | | | | |
|---|---|---|---|---|---|---|
| | | TF Increased | PF Increased | EF Increased 10 % | SF Increased | ENVF Increased |
| TF | 1 | 1 | 1 | 1 | 1 | 1 |
| PF | 2 | 2 | 2 | 3 | 2 | 2 |
| EF | 3 | 3 | 3 | 2 | 3 | 3 |
| SF | 4 | 4 | 4 | 4 | 4 | 4 |
| ENF | 5 | 5 | 5 | 5 | 5 | 5 |

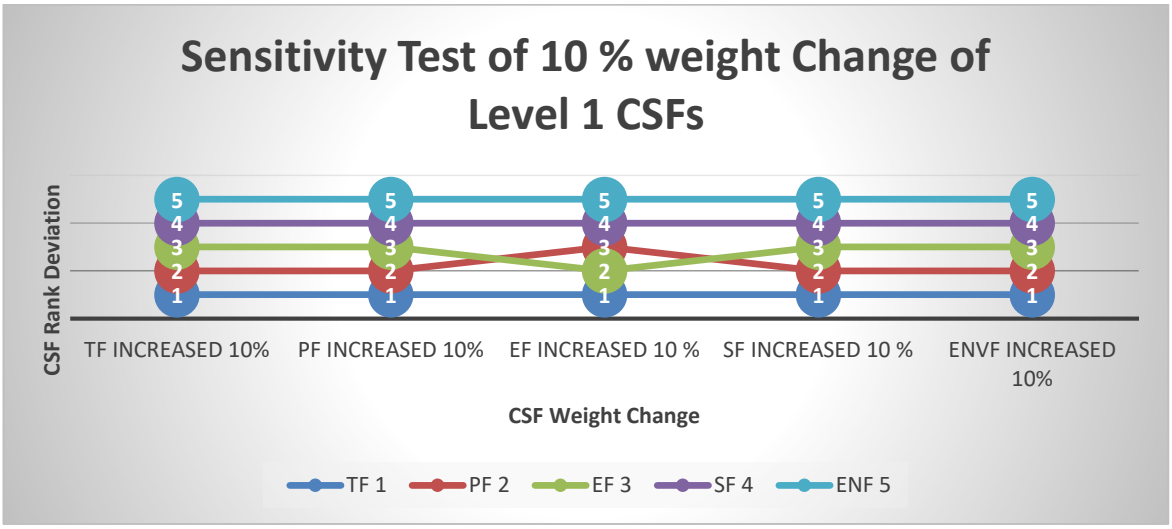



**Figure 4.10: Sensitivity analysis of 10 % weight change of Level 1 CSF**

**Table 4.40: Sensitivity analysis result of Level-1 CSFs for increasing weight factor by 10 %**

| | Original | Changed Rank | | | | |
|---|---|---|---|---|---|---|
| CSF | | TF Increased 10% | PF Increased 10 % | EF Increased 10% | SF Increased 10% | ENVF Increased 10% |
| TFID | 1 | 1 | 1 | 1 | 1 | 1 |
| PFGP | 2 | 2 | 2 | 2 | 2 | 2 |
| TFHR | 3 | 3 | 3 | 4 | 3 | 3 |
| EFAS | 4 | 4 | 4 | 3 | 4 | 4 |
| SFPIS | 5 | 5 | 5 | 5 | 5 | 5 |
| EFCS | 6 | 6 | 6 | 6 | 6 | 6 |
| SFCYS | 7 | 7 | 7 | 7 | 7 | 7 |
| PFAC | 8 | 9 | 8 | 8 | 8 | 8 |
| TFTT | 9 | 8 | 9 | 9 | 9 | 9 |
| EFQS | 10 | 10 | 10 | 10 | 10 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| ENFEH | 11 | 11 | 12 | 11 | 11 | 11 |
| PFASC | 12 | 12 | 11 | 12 | 12 | 12 |
| SFLP | 13 | 13 | 13 | 13 | 13 | 13 |
| ENFRC | 14 | 14 | 14 | 14 | 14 | 14 |

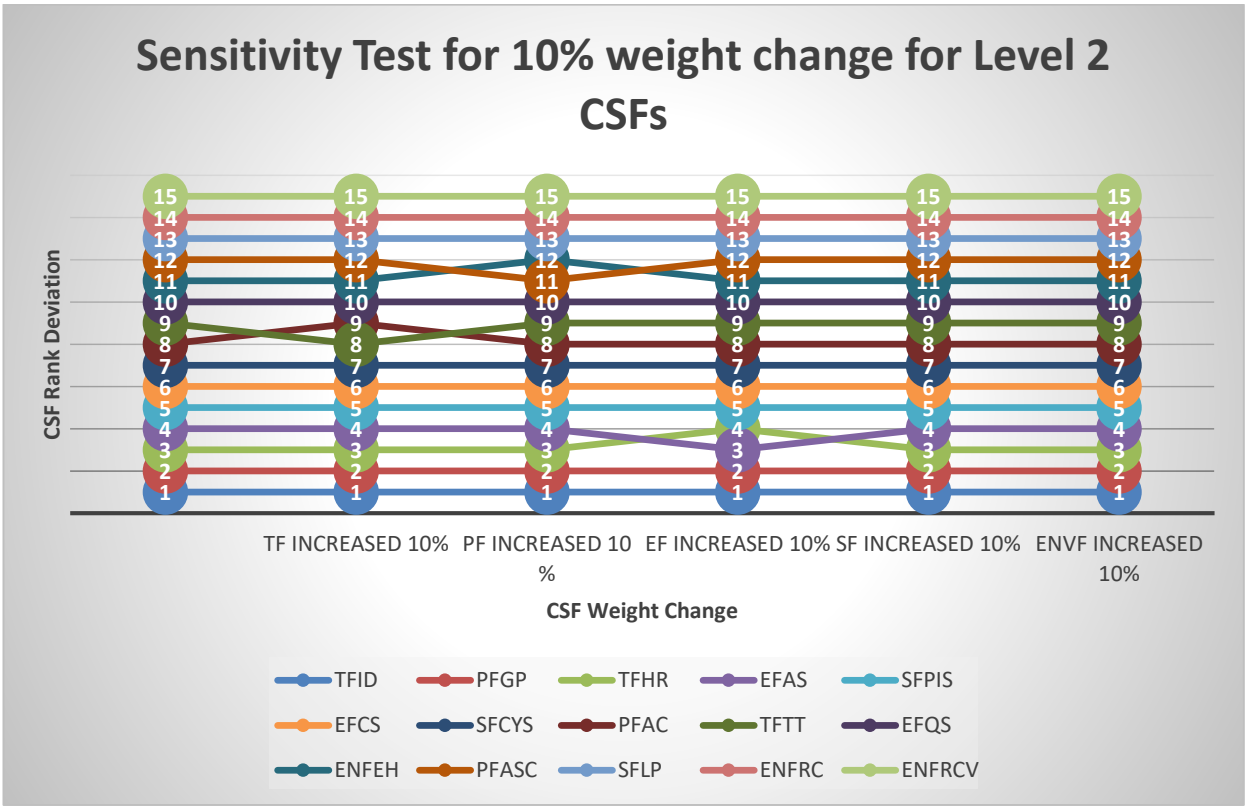



**Figure 4.11: Sensitivity analysis of 10 % weight change of Level 2 CSF**

If the Value of each Level-1 CSFs increased by 5%: For TF, PF, SF and ENF, no effect in the results. But for EF, Rank of HR changed from 3rd to 4th and AS changed from 4th to 3rd position. But the weight difference is very less; 0.0025 and 0.0068 respectively, which is insignificant.

If the Value of each Level-1 CSFs increased by 10 %: For PF, SF, ENF, no effect in the results. But for EF and TF, there are some effects as: for EF, HR rank changed from 3rd to 4th and AS rank changed from 4th to 3rd with the weight difference 0.0039 and 0.0126 respectively which is very insignificant. For TF:EH rank decrease from 11 to 12 ASC rank increases from 11 to 12, but the factor weight difference is 0.0003 and 0.0015

respectively, which is very insignificant.AC rank changed from $8^{th}$ to $9^{th}$ position and TT changed from $9^{th}$ to $8^{th}$ position 0.0025 and 0.0026 respectively which is very less.

From the sensitivity analysis it is observed that, for 10% error of Expert's opinion the research findings do not have remarkable effect. So, the research findings of this study are very robust, stable reliable.

# Chapter 5

## Findings, Recommendations and Conclusion

### 5.1 Introduction

The aim of the research was to explore and identify the Critical Success Factors (CSFs) and ranking the CSFs and developed a new new model of strategic ICT management regarding sustainable e-Governance of Bangladesh's transition to e-Governance. In order to do this the researcher first identified the important CSFs for strategic ICT management from extensive literature review, brain storming and experience followed by a pilot study. Then an conceptual model was developed for ranking the identified important CSFs for strategic ICT management. Two research tools, Fuzzy AHP method and Delphi method were used to assess the importance of identified CSFs. The ranking of CSF was performed as per global weight found by this research in Fuzzy AHP method and as per mean value found by this research in Delphi method. Then the findings of this research by two methods were compared and validated.

In this chapter, it is presented the important areas covered in the research work and finally drawing conclusions as per research objectives, literature review, findings and developed conceptual new model for strategic ICT management. It is also described the theoretical and practical contributions to the body of knowledge in the perspective of sustainable e-Governance. The research limitations, recommendations and further research on strategic ICT management for successful and sustainable e-Governance implementation in Bangladesh also focus in this chapter.

### 5.2 Research Overview

Chapter 1 of this research work explains the brief background of this study and discussed the rationale and motivation to take the research on Strategic ICT management for sustainable e-Governance of Bangladesh's transition to e-Governance. This chapter also

presents the research objectives and concentrated on 2 (Two) research questions to achieve the research aim:

1. What are the necessary CSFs for strategic ICT management regarding sustainable e-Governance in Bangladesh?

2. What is the level of significance or rank of each identified CSFs, necessary for future strategic ICT planning?

Research design flow diagram and validation of research methodology are also presented in chapter 1.

In chapter 2, the literature review and background of e-governance in Bangladesh, brief focus on e-Governance present services, ICT related acts and policies are presented. The identification of Critical Success Factors, Research Gap, theoretical and conceptual framework of Fuzzy AHP and Delphi are also developed and presented in this chapter.

In chapter 3, the research methodology, research philosophy, Fuzzy AHP and Delphi methodological flow chart, Fuzzy AHP hierarchical model are constructed. The full survey questionnaires, mathematical operation formula are also described in this chapter.

Chapter 4 describes the expert selection, data collection, data analysis and presentation. Discussion on research findings from data analysis are also presented in this chapter. Validation of results which are found by two methods and sensitivity test of research findings also presented in chapter 4. Finally, framing out a new new model for strategic ICT management for sustainable e-Governance of Bangladesh's transition to e-Governance was also presented in this chapter.

## 5.3 Research Findings

The key findings and the innovative contribution this research study are significant and will contribute a lot for strategic ICT planning for sustainable e-Governance given as follows:

**Findings 1:** From the review of literature in conjunction to the Critical Success Factors that influencing the e-Governance implementation are normally generalized, with no unified theoretical models. This research work explores the important CSFs and finally identified 15 CSFs for further assessment through literature review, piloting and from relevant experience for strategic ICT management of sustainable e-Governance in Bangladesh.

The identified 15 CSFs are: Infrastructure Development and Resource Sharing, Government Policy, Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service, Cyber security, Awareness of Citizen, Technology Transfer by Vendor, Quality of service, Environmental Hazard, Acceptability in Socio-Cultural aspects, Legal protection, Resource Consumption, Resource Conservation.

**Findings 2:** In addition to understanding and identifying the Critical Success Factors for sustainable e-Governance implementation, CSFs are also assessed and ranking these CSFs as per preference level. The findings are in that assessment given bellow:

**Top Ranking CSFs:**

1. Infrastructure Development and Resource Sharing
2. Government Policy
3. Available Skilled Human Resource
4. Availability of service
5. Personal Information Security
6. Cost of service

**Middle Ranking CSFs:**

1. Cyber security
2. Awareness of Citizen
3. Technology Transfer by Vendor
4. Quality of service
5. Environmental Hazard

**Low Ranking CSFs:**

1. Acceptability in Socio-Cultural aspects,
2. Legal protection
3. Resource Consumption
4. Resource Conservation.

**Findings 3:** The Research findings which were derived by the Fuzzy AHP method and Delphi method is validated and the result found was quite satisfactory.

**Findings 4:** The CSFs for standard practice guidelines that forms the ICT framework for sustainable e-Government implementation of all other countries is not readily available in past research. It is also not possible a standard ICT frame as the practical situation of different countries is not same. Based on the identified CSFs and their assessment the researcher was able to frame out a new new model for strategic ICT management for sustainable e-Governance which can be used as a frame of reference for decision makers and planners in Bangladesh, as shown in **Figure 4.7.**

**Findings 5:** From the sensitivity test of findings of the research are also performed and found the result quite robust, stable and reliable.

## 5.4 Research Contribution to the Knowledge Body

a. From the extensive literature review, brainstorming and relevant experience the researcher has identified 15 CSFs for strategic ICT management regarding sustainable e-Governance in the perspective of Bangladesh.

b. This research work contribute to the knowledge body as the researcher identifies or proposes three new specific CSFs for strategic ICT management of sustainable e-Governance and assesses these accordingly, as environmental issues are very important for any development for the betterment of Earth and human, the CSFs are:

1. Environmental Hazard
2. Resource Consumption
3. Resource Conservation.

c. Two CSFs such as Infrastructure development and Resource Sharing are mentioned separately in different literature review. But in this research work, the researcher considered it as one CSF: Infrastructure Development and Resource Sharing to the Bangladesh context and assessed accordingly as this two CSFs are interdependent for successful operation in the multi-operator situation of Bangladesh.

d. Based on the identified CSFs and their assessment, the researcher was able to frame out a new model for strategic ICT management for sustainable e-Governance which was a specific outcome of this research study. This will contribute to the knowledge body for future study of Strategic ICT management for sustainable e-Governance.

## 5.5 Recommendation for Policy Makers

Recommendations on policy implications are mainly discussed on the findings of this research study, especially in the perspective of Bangladesh. These are assembled bellow:

a. The findings of this study are important for Decision Makers, ICT planners, e-Governance implementers, practitioners and the highest authorities of country. This study reported the critical success factors and a new model of strategic ICT management for sustainable e-Governance in Bangladesh's perspectives. Overall, the important critical success factors were identified for and developed a strategic ICT management model. But information about only CSFs is crucial for the Decision Makers to understand the level of importance or significance of each CSF for strategic ICT management. To make the CSF's level of importance easily understandable, ranking of CSFs were done and finally developed a Strategic ICT management model for sustainable e-Governance.
The Decision Makers, ICT planners, e-Governance implementers, practitioners and the highest authorities of country may use this model for future ICT management planning.

b. In this research, it is revealed that Infrastructure Development and Resource Sharing, Government Policy, Available Skilled Human Resource, Availability of service, Personal Information Security, cost of service are the most Important CSF that is Top-Ranking CSF for strategic ITC management of sustainable e-Governance, these should be addressed at the top most priority during the planning of e-Governance plans and projects.

c. Cyber security, Awareness of Citizen, Technology Transfer by Vendor, Quality of service and Environmental Hazard are important CSFs or Mid Ranking CSFs for strategic ITC management of sustainable e-Governance. These should be addressed by Decision Makers accordingly.

d. Acceptability in Socio-Cultural aspects, Legal protection, Resource Consumption and Resource Conservation are less important CSFs that is Low Ranking CSFs for strategic ITC management of sustainable e-Governance in Bangladesh perspective. This factors should also be addressed during policy planning of sustainable e-Governance.

e. This information which was found by this research work can be important base for Policy Formulators, Decision Makers, ICT planners, e-Governance implementers, practitioners and the highest authorities of country to formulate an ICT strategy for sustainable e-Governance in Bangladesh's perspective. The findings of this research have a vital implication for Decision Makers, ICT planners, e-Governance implementers, practitioners and the highest authorities of country to take necessary measure as per degree of importance or preference level of CSFs and implement on urgent basis. Otherwise, Sustainable e-Governance may be hampered in Bangladesh and many e-Governance initiatives and projects will fail.

f. The conceptualized and derived model of strategic ICT management through this research would help Decision Makers, Planners, Policy formulators and academicians to understand the step-by-step guide for strategic ICT Management of sustainable e-Governance in Bangladesh. Overall, this research can be used as guideline while taking ICT projects, ICT service introduction, decision criteria, action plan to improve e-Governance services for the citizen and sustainability of e-Governance.

g. From the research findings, it is revealed that the CSF Technology Transfer by Vendors has achieved less preference which is 2.90 %. For the take off stage of e-Governance, it may consider, but from now it has been addressed seriously to increase the Technology Transfer for reducing the technology dependency on foreign Tech companies. Decision Makers should think about this factor seriously.

Based on above, an action plan for strategic ICT management can be formulated and acts in accordance with the guidelines of action plan and thus sustainable e-Governance can be achieved in Bangladesh.

## 5.6 General Recommendations

General Recommendations are mainly derived based on the findings of this research study, especially in the perspective of Bangladesh. These are assembled bellow:

a. The findings of this research revealed that Infrastructure Development and Resource Sharing is the most important CSF for strategic ICT management of sustainable e-Governance. The decision Makers, specially, the ICT planners and e-Governance implementers should give highest attention as this was the top most important factor for strategic ICT management of sustainable e-Governance. In Bangladesh different NTTN operators, Telco's are developing the infrastructure all over the country in some cases individually and unplanned way, but they are not doing the network in coordinated way. Government should enforce the NTTN operators and Telco's to do infrastructure and other network infrastructure development work in a coordinated way which will save the asset, reduce the cost and improve the Service.

b. Government has taken initiative and drafted "Telecommunication Network Policy, 2023". This Policy should implement immediately. Government also should take initiative to pass "ICT Infrastructure development and Resource sharing policy" for proper and optimum operations of Telecommunications infrastructure. ICT infrastructure Route

should be unified, all NTTN operators and Telco's will use that unified Route. Otherwise ICT Infrastructure will be developed haphazardly and destroy the infrastructure during different development work which is the present reality of Bangladesh. Government can form a high-powered Expert committee to find out the way and plan for unified Route for all ICT infrastructures.

c. As per expert opinion Government Policy was placed as second most important Critical success factor for strategic ICT management of sustainable e-Governance, so special care should be taken in this factor that Government Policy and Act formulation. In this regard, different government policy and Act, specially ICT related policy and Act like "ICT policy", "Telecommunications policy", "e-governance policy", "Telecommunication Network Policy", "Broad Band Policy" and other related policy should be ICT and e-Governance friendly.

d. The present ICT, Network, Telecommunication and Broad Band Policy of Bangladesh are formulated many years ago, these Acts and Policies should be modernized as per present demand.

e. The Available Skilled Human Resource was the third important critical success factor for strategic ICT management of sustainable e-Governance in Bangladesh. The Decision Maker and appropriate authority should manage this issue by introducing the strategic policy for making skilled ICT personnel for maintaining the developed infrastructure and e-Governance service delivery smoothly and properly. Universities can play vital role by creating opportunities of ICT professional courses and training facilities, developing professional network and knowledge sharing expert, to introduce more ICT job opportunities and supporting ICT career development. Government should take immediate initiatives to establish ICT Training Institute in each district and upzila for creating ICT skilled personnel.

f. Availability of service was the fourth important critical success factor for strategic ICT management of sustainable e-Governance in Bangladesh. To remove the digital divide and uninterrupted ICT service, the service should be available all the time in everywhere for

encouraging the citizen to avail e-Governance services. Lack of availability of ICT services to all citizens especially in the urban areas will not give the fruitful result of e-Governance.

g. The fifth important critical success factor was Personal Information Security, it is also very important to ensure the personal information security. If the Personal Information Security is not ensured, citizen will not be encouraged to give their information in online platform. Government should make laws in this regard.

h. Cost of service was the sixth important critical success factor for strategic ICT management of sustainable e-Governance in Bangladesh. Government should fix the price the ICT services in such a way that every citizen can afford the service. Otherwise the poor people will not be able to get the services and the e-Governance will not sustain.

Therefore, these six critical success factors (Infrastructure Development and Resource Sharing, Government Policy, Available Skilled Human Resource, Availability of service, Personal Information Security, Cost of service) should be addressed on urgent basis for strategic ICT management of sustainable e-Governance in Bangladesh.

i. Cyber security, Awareness of Citizen, Technology Transfer by Vendor, Quality of service, Environmental Hazard are also important factors and should be addressed accurately for strategic ITC management of sustainable e-Governance. Especially R and D should be strengthened for Technology Transfer by the vendors to attain Technological independency.

j. The decision makers, Planners and competent authority should also address the critical success factors such as Acceptability in Socio-Cultural aspects, Legal protection, Resource Consumption, Resource Conservation for strategic ICT management regarding sustainable e-Governance, yet these are least ranking CSFs.

k. The Environmental Factors has got less preference such as Environmental hazard has achieved only 1.6% preference. Concentration should give on Environmental Factors for sustainable development as environmental issue is very important for any development.

l. The model has the capability to assess the effectiveness of security devices such as intrusion detection systems, using an integrated Fuzzy AHP based analysis. The selection of features for this assessment was based on expert opinion and up-to-date research findings. AHP gives the highest priority the accuracy of attributes when working under Fuzzy Logic condition (Abushark, Yoosef B., et al., (2022).

## 5.7 Limitation

In this study, there were some limitations which must be account while interpreting and applying the results of this study.

Firstly, the number of Experts was only 10 for each method which is not a big number for this type of analytical research study.

Secondly, though this research work considered a number of influential critical success factors of strategic ICT management regarding sustainable e-Governance, but excluded many other factors (e.g. User friendliness, Lack of expertise of Government employees etc.).

Thirdly, the measuring scale used in this study measured on the expert opinion of the relevant field. However, the expert opinion may vary depending on expert's experience, knowledge and thinking level.

Fourthly, user as a stakeholder and their opinion was not included this research study as it is the out of scope of this study.

Despite this, this research is of great value for measuring the critical success factors and framing out a new model for strategic ICT management regarding sustainable e-

Governance in Bangladesh's perspective; it can be used as a guideline of making ICT strategic management for sustainable E-Governance in Bangladesh.

## 5.8 Further Research Direction

Strategic ICT management for sustainable e-governance is a wide, multi-disciplinary and relatively new area of research study. This research is an exploratory attempt to provide insight into the inner meaning of strategic ICT management. The discussions and analysis of this research were delineated on conceptual and theoretical aspects in the context of Bangladesh's transition to e-Governance. There is a wide scope of study in this field as it is a new area and complex in nature.

This study was based on the quantitative measure of the subjective perception of Critical success factors of strategic ICT management regarding sustainable e-Governance depending on the expert opinion. As this research was limited to 10 experts in each method, it is suggested that further research can be carried out including more experts for the validation of result and model which is developed in this research.

Another direction may be on specific critical success factors, only 15 crucial success factors (CSFs) are included in this study; future researchers may add more CSFs and evaluate the factors by extending the current research work.

By undertaking research from the same point of view, the researchers may also gauge and validate the findings of the current study. Other research methods, such as the real-time Delphi technique, the Strategic Migration Assessment and Readiness Tool (SMART) and the Fuzzy Analytical Network Process (Fuzzy ANP), may also be used by the researchers. Other method(s) results may be compared to and/or validated against the outcomes of this research endeavor.

The most important direction of further research may be the attempt to establish the empirical relationship between critical success factors for strategic ICT management and sustainable e-Governance. Because this study was only able to address and rank the critical success factors for strategic ICT management and sustainable e-Governance, based on preference level measurement and existing literature. The future researcher may also take the attempt to develop software for sensitivity test of findings.

## 5.9 Conclusion

Theoretically Strategic ICT management for sustainable e-Governance is comprehend in different ways by different scholars, researchers and implementers as the concept itself is quite broad, divergent and recent emerging one. For this reason, it is required to take a holistic approach for the purposes of theoretical understanding and on ground implementation.

The researcher has explored the CSFs of strategic ICT management for sustainable e-Governance by carrying out extensive literature review, piloting and from experience of Bangladesh's transition to e-Governance. Research findings, therefore supports the notion that some CSFs has to be addressed with top priority, some with middle priority and some are with low priority. Senior government officials, Policy formulator and decision-makers would need to understand the priority of Critical Success Factors, the preference level and act accordingly to attain the goal.

Review of literature reveals that different academicians, researcher and practitioners have identified the CSFs in their study like Infrastructure Development, Government policy, Human Resource, Cost, awareness, etc. Some Researcher named the CSF as different notation, but the function of CSF is same. For this research work 12 important CSFs identified from extensive literature review and piloting, 03 CSFs proposed/identified by the researcher as mentioned earlier of this study.

Based on the 15 CSFs and research findings, the researcher had framed out a new strategic ICT management model of sustainable e-Governance which could be applied either

independently for understanding and evaluating the Critical Success factors or as a part of general conceptual framework.

Yet there were some challenges and limitations, the author was able to make recommendations for strategic ICT management for sustainable e-Governance in Bangladesh and also for future studies. From the analysis and findings, it is clear that the sustainability of e-Governance largely depends on proper strategic ICT management of the planner, decision maker and above all the Government.

The researcher thus accomplishes that this study extends the knowledge in the area of strategic ICT management regarding sustainable e-Governance in the perspective of Bangladesh and this strategy must be able to squarely address the strategic challenges of ICT management for sustainable e-Governance ensuring the balanced growth. This model can be sued for other developing country.

# References


Abdelghaffar, H. A., (2010). *E-Strategies for Technological Diffusion and Adoption: National ICT Approaches for Socioeconomic Development,* Middlesex University,UK. DOI: 10.4018/978-1-60566-388-3.ch012

Abushark, Yoosef B., et al., (2022). Cyber Security analysis and evaluation for intrusion detection system. *Computers, Materials and Continua,*72:1665-1783. DOI: 10.32604/cmc.2022.025604

Abdelsalam, H. M., Reddick, C.G., Eikadi, H., (2012). *Managing E-Government Projects: Concepts, Issues, and Best Practices*, IGI Global. DOI:10.4018/978-1-4666-0086-7.ch010

Agbozo, E., and Asamoah, B.K., (2019). The role of e-government systems in ensuring government effectiveness and control of corruption. *R-Economy, Ural Federal University, Graduate School of Economics and Management,*5(2):53–60.
DOI: 10.15826/recon.2019.5.2.006.

Amidharmo,S. S., (2014). *Critical Success Factor for the implementation of knowledge management system in knowledge based Engineering Firm*, Queensland University of Technology, Queensland.

Apleni, A., and Smuts, H., (2020). *An e-Government Implementation Framework: A Developing Country Case Study*, Milpark Business School, Johannesburg, South Africa.

Ayag, Z., and Ozdemir, R.G., (2006). .A fuzzy AHP approach to evaluating machine tool alternatives. *Journal of Intelligent Manufacturing*, 17: 179–190.

Baharul, Golam., (2016). Technology Assessment by applying Fuzzy Hierarchical process for priority ranking of different power generation method in Bangladesh. *M.Sc. Thesis, of Bangladesh University of Engineering and Technology (BUET), Bangladesh*

Basyal, D. K., and Wan, j., (2016). What Should We Do for E-government in Nepal and How? An AHP Approach. *The Korean Journal of Policy Studies,* 31(3): 47-74.

Bhagat, C. Sharma, C. and Mishra, A. K.,(2021). Critical Success Factors for the implementation of e-governance - a case study of province 1 Nepal. *International Journal of Interdisciplinary Research in Arts and Humanities (IJIRAH),* 6 (1).

Bhushan, N., (2004). *Strategic Decision Making Applying the Analytic Hierarchy Process*, Springer:Verlag Publisher, London.

Borzdy, Y., (2009). Modern Approaches in Modeling of E-government. *Business Informatics*, 4: 60–67.

Buckley, J.J., (1985). Fuzzy hierarchical analysis. *Fuzzy Sets and Systems*,17:233-247.

Catrinu, M.D., (2006). Decision Aid for Planning Local Energy Systems: Application of Multi-Criteria Decision Analysis. *Doctoral Theses*: *Norwegian University of Science and Technology, Norway.*

Chan, H.K., Wang,X., (2013). *Fuzzy Hierarchical Model for Risk Assessment: Principles, Concepts, and Practical Applications*, Springer:Verlag, London .

Chang, D.Y., (1996). Applications of the extent analysis method on fuzzy AHP. *European Journal of Operational Research*, 95: 649–655.

Cheng, C.H., (1996). Evaluating naval tactical missile systems by fuzzy AHP based on the grade value of membership function, *European Journal of Operational Research*, 96:343–350.

Christopher, B., Eyitayo, T., and Katongo, A, M., (2018). Critical Success Factors for e-Government Projects: The case of Botswana. *Journal of e-Government Studies and Best Practices*. DOI: 10.5171/2018.335906.

Chua, D., H., K., Kog, Y., C., Loh, P., K., (1999). Critical success factors for different project objectives. *Journal of construction engineering and management*, 125(3):142-150.

Dalkey, N., and Helmer, O., (1963). An Experimental Application of the Delphi Method to the Use of Experts. *Management Science,* 9(3): 458.

CPTU: *e-Gp by Central Procurement Technical Unit*, [Online]. Available from <https://www.eprocure.gov.bd> [Accessed on 14.06.22].

Frey,B.B., (2018).*The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation*. **DOI:** https://dx.doi.org/10.4135/9781506326139.n367

Fuzzy Measure-Choquet Integral Calculation System, (2004): *Fuzzy measure and sensitivity analysis calculation software by CGI*, [Online]. Available from <http://www.isc.senshu-u.ac.jp/~thc0456/Efuzzyweb/fm11.html> [Accessed on 14.08.22].

Garcia, J. R., Pardo, T. A., (2005). E-government success factors: Mapping practical tools to theoretical foundations. *Government Information Quarterly*, 22( 2), 2005: 187-216.

Gordon, T. J., and Helmer, O., (1966). *Helmer's social Technology*, Basic Books: New York.

Gupta, A., Suri, P.K., Rajesh Kumar Singh, R.K.,( 2018). Analyzing the Interaction of Barriers in E-Governance Implementation for Effective Service Quality: Interpretive Structural Modeling Approach. *Business Perspectives and Research*, 7(1):59–75. DOI: 10.1177/2278533718800562

Guptaa, B., Dsgupta, S., Gupta, A., (2008). Adoption of ICT in a government organization in a developing country: An empirical study. *Journal of Strategic Information Systems*, 17: 140–154.

Hakim, M.L., Rahayu,A., Eeng Ahman, Wibowo,L.,A., (2022). The success factors of E-Government implementation in Indonesia. *Journal of Legal, Ethical and Regulatory Issues*, 25(1).

Haque, Latiful., Hossain, Gahangir., et al., (2006). e-Government Procurement of Developing Countries. In Proc. *International Conference on information and Communication Technology, Kuala Lampur, Malaysia.*

Hassan, MH., Lee, j., (2019). Policymakers' perspective about e-Government success using AHP approach: Policy implications towards entrenching Good Governance in Pakistan. *Transforming Government: People, Process and Policy*, 13(1): 93-118.

Helmer, O., and Rescher, N., (1960). *On the Epistemology of the inexact sciences*, Project Rand Report R-353.

Kanaan, A.G, Shahizan, B. H., Shahzad, A., (2016). A Conceptual Model for E-Government success factors developing countries. *International journal of science and research publications*, 6(12).

Khanh, N. T. V., (2014*). The critical factors affecting E-Government adoption: A Conceptual Framework in Vietnam*. School of IT Business, SOOGSIL University, South Korea.

Kong,F., Liu, H. (2005). Applying Fuzzy analytic hierarchy process to evaluate success factors of e-commerce. *International journal of information and systems sciences*,1(3): 406-412.

Laarhoven,P.J.M., Pedrycz, W., (1983). A fuzzy extension of saaty's priority theory. *Fuzzy Sets and Systems*, 11: 229–241.

Li, T. S., Huang, B. Y. , (2008). The Study of Applying Fuzzy Analytic Hierarchy Process in Supplier Selection. *Journal of Quantitative Management*, 5(2): 39 – 56.

Mahendran, P., Moorthy, M.B.K.,Saravanan,S., (2014). A Fuzzy AHP Approach for Selection of Measuring Instrument for Engineering College Selection. *Applied Mathematical Sciences*, 8(44): 2149 – 2161.

Manda, M. I. and Backhouse, J., (2016). Addressing trust, security and privacy concerns in e-government integration, interoperability and information sharing through policy: a case of South Africa. In: *CONF-IRM. Cape Town, South Africa,* May, 2016.

Medvedeva, M. A., Davletbaev, R. H., Berg, D. B., Nazarova, J. J., & Parusheva, S. S., (2016). Applications of mathematics in engineering and economics.AMEE, 1789. DOI: 10.1063/1.4968439.

Meysam, S., Mahsa, A., Sajad, E., (2012). Using Fuzzy multi criteria decision making approach for ranking the web browsers. *International Journal of Economics and Management Sciences*, Volume 1(8): 72-86.

Mittal, P., Kaur, A., (2013). E-Governance - A challenge for India. *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)* , 2(3).

Napitupulu, D., Indra, D., (2014). The Critical Success Factors Study for e-Government Implementation. *International Journal of Computer Applications*, 2014. DOI: 10.5120/15716-4588

Nesrine, B., Y., Narjès, B., and Henda, B., G., (2012). Integrating fuzzy case-based reasoning and particle swarm optimization to support decision making. *International Journal of Computer Science*, May.

Palladan, A. A., and Adamu, M.A., (2018). An Overview of Strategic Management Practices. *Austin Journal of Business Administration and Management*, June.

Network Readiness Index, 2021. *Purtulans Institute, Washington DC, USA*. Available from < https://networkreadinessindex.org/l> [Accessed on 14.09.22].

An Evaluation of 'eNothi' System in Government Office Management, 2019. *Project Report of a2i Project, Dhaka, Bangladesh.*

Rockart, J., F., (1979). Chief executives define their own data needs. *Harvard business review*, 57(2): 81-93.

Rosida, A.B., Razak, Zakaria, M.S., (2014), The Critical Success Factors for Effective ICT Governance in Malaysian Public Sector: A Delphi Study. *International Journal of Economics and Management Engineering*, 8(11).

Rowe, and Wright., (2001). *Expert Opinions in Forecasting: Role of the Delphi Technique, Principles of Forecasting*, A Handbook of Researchers and Practitioners: Kluwer Academic Publishers, Boston.

Rust, R. T., and Kannan, P. K., (2016). *Ee-service: New directions in theory and practice*, e Book, Newyork, USA. https://doi.org/10.4324/9781315291291

Sarfaraz,A., Mukerjee,P. Jenab,K., (2012). Using fuzzy analytical hierarchy process (AHP) to evaluate web development platform. *Department of Manufacturing Systems Engineering and Management, California State University, USA.*

Schuppan, P., (2009). E-Government in developing countries: Experiences from sub-Saharan Africa. *Government Information Quarterly*, 26(1):118-127.

Seo, J. W., Mehedi, H. G., (2016). E-government Efforts against Corruption in Bangladesh: What We Have Done and What We Have to Do. *Journal of Society & Change*, 10(1).

Shah, M. H., Siddiqui, F, A., (2006). Organizational critical success factors in adoption of e-banking at the Woolwich bank. *International journal of information managemen*t, 26 (6): 442-456.

Shaharani, A.A., (2016). Identifying Critical Success Factors for knowledge management implementation in higher education institutions: a study of the use of the Delphi method at King Fahd Security College (KFSC) in Saudi Arabia. *International Journal of Management and Applied Science*, 2(4).

Siddiquee, N., A., (2013). e-Government in Bangladesh: The Dawn of Citizen-Centric Public Administration. *Public Administration in South Asia*, eBook ISBN 9781315089294

Sultan, A., Khalid, a., et al, (2012). Analytic Hierarchy Process for the Success of e-Government. *Business Strategy series; Northampton*, 13(6):195-306. doi.org/10.1108/17515631211286146.

Saaty, T.L., Alexander, J.M., (1989). *Conflict Resolution- The Analytic Hierarchy Process*, Prager: New York, 1989.

Takahagi, E., (2000). On Identification methods of λ-fuzzy measures using weights and λ. *Japanese Journal of Fuzzy Sets and Systems*, 12(5): 665- 676.

Tanveer, A., (2021). E-Government in Bangladesh: Development and Present State. *International Journal of Social Science and Human Research*, 4(1): 557-567.

Jafarnejad, A., Ajalli, M., Sufi, M., et al, (2014). Recognition of Obstacles and providing different Guide-lines and promotion of electronic government in Iran. Arabian Journal of Business and Management Review (Nigerian Chapter) Vol. 2 (5).

Veličkovska, I., (2022). Implementation of a SWOT-AHP methodology for strategic development of a district heating plant in fuzzy environment. *Journal of Strategic Management*, 27(1): 043-056. DOI: 10.5937/StraMan2110001V.

Wan, J., and Hasan, G., (2015). Where Are E-governments in South Asian Countries? A Comparative Approach. *South Asian Studies, Lahore,*30(2): 7-24.

Yuan, T., Seng-cho, C.,Chou, T.,Tzeng, G., (2006). Evaluating IT/IS investments: A fuzzy multi-criteria decision model approach. *European Journal of Operational Research*, 173: 1026–1046.

Zadeh, L. A., (1965). *Fuzzy Set, Information and Control*, 8(1):338 – 353.

# Appendix A

**Research Topic:** Strategic ICT Management in Bangladesh's transition to e-Governance: Framing out a realistic sustainable approach

Researcher:

A.K.M. Golam Baharul
Doctor of Business Administration (DBA) Researcher
Department of MIS, Faculty of Business Study, University of Dhaka
E-mail:akmbaharul@gmail.com
Mobile: +8801550151309

## Description

This research work is being undertaken as part of Doctor of Business Administration (DBA) research project for A K M Golam Baharul. This research work is being conducted under the supervision of Md. Moqbul Hossain Bhuiyan, Professor, Department of MIS, Faculty of Business Study, University of Dhaka (DU). All the information and data obtained from the research will be treated with utmost confidentiality and anonymity. The purpose of this research study is to frame out a realistic sustainable approach for strategic ICT Management regarding sustainable E-Governance of Bangladesh as Bangladesh is now in transition position to E-governance and moving forward quickly to attain E-Governance in all sectors. In this research the critical success factors (CSFs) are identified which are necessary to frame out a realistic sustainable approach for strategic ICT and sustainable E-Governance in Bangladesh. The significance of each CSF is also assessed and ranked the CSFs to understand which Most Significant is and which is less significant to make the strategic ICT Management plan successful.

Many researches have been conducted research in various sectors of E-Governance, but scarcely any in the strategic ICT management for sustainable E-Governance in Bangladesh. Further, many previous studies tend to be theoretical and too general to be useful for an aspiring strategic ICT management for sustainable E-Governance. This research work is conducted by using powerful research tool Delphi Method approach

which is very useful in multi-disciplinary research topic. This research is aimed to address the knowledge gap by drawing on the experience and expertise of professionals in the ICT sector. It is hoped that the collective knowledge of these Professionals/Experts can produce a practical and achievable list of critical success factors for realistic sustainable approach of strategic ICT Management regarding sustainable E-Governance in Bangladesh.

## Expected Benefits

It is expected that this research work will benefit you. The final findings of the questionnaires will be reported back to you at the conclusion of the research work and you will get insight of CSFs for strategic ICT Management regarding sustainable E-Governance in Bangladesh.

## Participation

Your participation in this research study is completely voluntary. If you do agree to participate, you can withdraw from participation at any time during the research work without comment or penalty. Your decision to participate in this project will in no way to impact upon your current or future relationship with University of Dhaka (DU).

Your participation may involve two or more rounds of questionnaires. The questionnaires will be sent to you via e-mails through a Google Form Link. You can give answer in Google Forms which Link will be sent to you by mail. The researcher intends to employ the Delphi Method to explore expert opinion. Feedback of first round Delphi survey will be sent to you with the mean score of CSFs off all experts' opinion. You may change your answer after getting feedback, if you think to change or not, it is upon you. To complete the questionnaire it is expected to take 20-30 minutes of your time.

## Risk

There are no risks beyond normal day-to-day living associated with your participation in this work. Your all information will be ensured safe.

## Confidentiality

Your all comments and responses are anonymous and will be maintained with high confidentially. The names of individual persons are not required in any of the responses.

## Further information or query about the research work

Please contact the researcher if you have any questions or any query for further information about the research work.

# Invitation

Dear Mr. ----------

**Subject:** Request to participate in a Doctor of Business Administration Research Work under MIS department, Faculty of Business Studies, University of Dhaka (DU), Bangladesh.

Dear Sir,

My name is A K M Golam Baharul. I am a Bangladesh Civil Service official of Telecommunications cadre, now working as a General Manager/Director in Bangladesh Telecommunications Company Limited (BTCL), a state owned Telecommunication company. I am currently studying for Doctor of Business Administration (DBA) degree in MIS at MIS department of Faculty of Business Studies, University of Dhaka (DU). I am writing to request your participation in my research study. My research work supervisor Md. Moqbul Hossain Bhuiyan, Professor, MIS, DU, has suggested that your experience and expert opinion would be beneficial to this study.

The Objective of my research is to identify the critical success factors (CSFs) and asses the significance of CSFs to frame out a realistic sustainable ICT Management approach that will help the Decision Makers (DMs) to plan the strategic ICT management for sustainable E-Governance in Bangladesh as Bangladesh is in Transition state of transformation of E-Governance.

Your kind participation would involve completing two rounds or more of questionnaires, which will be conducted anonymously and confidentially. It is expected that this research will benefit you. By participating in this research, you will help to generate new knowledge about framing out a realistic sustainable approach for strategic ICT management, sustainable E-Governance in Bangladesh which helps the country as a whole. Further, the results of all the questionnaires will be reported back to you after each round. This way you will gain a unique insight into what other experts think about strategic ICT management for sustainable E-Governance in Bangladesh.

Please refer to the attached participant information in the Google Form and consent forms for more details of your contribution on this research work.

For giving your Expert Opinion, Please CLICK ON THE “FILL OUT IN GOOGLE FORM" tab.

I am looking forward to your kind participation in this research work. Please do not hesitate to contact me if you have any questions or query.

Thanks in advance for your participation.

Kind regards,

A K M Golam Baharul

DBA Researcher, MIS Department, University of Dhaka

Address: General Manger, Billing System, BTCL Bhaban, Sher-E-Bangla Nagar, Dhaka.

Phone: +8801550151309

Email: akmbaharul@gmail.com

# Consent of Participation

The return of the completed Google Form questionnaire is accepted as an indication of your consent to participate in this project. The submission of this Google Form will be considered as your signed consent you are indicating that you:

• You have read and understood the information document regarding this research work.

• You have understood that if you have any additional questions you can contact the researcher without any hesitation.

• You have understood that you are free to withdraw at any time from this research work, without comment or penalty.

• You have understood that you can contact the Researcher regarding Ethics of research to +8801550151309 or akmbaharul@gmail.com, if you have concerns about the ethical conduct of the research work.

If you are agreed to participate in this research work, please give the following information. Thanks in advance for your participation in research work.

Name:

Designation:

Organization:

Year of Experience:

Date:

# Questionnaire

# Questionnaires for Delphi Method

(**Please notice:** Make sure that the sums of the rank values of 15 CSFs would be in data range contained ranked data. Since there is 15 CSFs (1 to 15) the sum of rankings of 15 CSF should be $1 + 2 + \cdots + 15 = 15 \cdot 16 / 2 = 120$)

| Scale | Level of Significance |
|---|---|
| 1 | Absolutely Extremely Significant |
| 2 | In between 15 and 13 |
| 3 | Extremely Significant |
| 4 | In between 13 and 11 |
| 5 | Very Significant |
| 6 | In between 11 and 9 |
| 7 | Somewhat Significant |
| 8 | Significant |
| 9 | Less Significant |
| 10 | In Between 7 and 5 |
| 11 | More Less Significant |
| 12 | In between 5 and 3 |
| 13 | Very Less Significant |
| 14 | In Between 1 and 3 |
| 15 | Least Significant |

**Linguistic Likert scale for Delphi Study**

1. Please rank the CSF, Technology Transfer by vendors at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

2. Please rank the CSF, Infrastructure Development and Resource Sharing at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

3. Please rank the CSF, Available Skilled Human Resource at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

4. Please rank the CSF, Government Policy at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

5. Please rank the CSF, Awareness of Citizen at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

6. Please rank the CSF, Acceptability in socio-Cultural aspects at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

7. Please rank the CSF, Cost of service at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

8. Please rank the CSF, Availability of service at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

9. Please rank the CSF, Quality of service at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

10. Please rank the CSF, Cyber Security at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

11. Please rank the CSF, Personal Information Security at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

12. Please rank the CSF, Legal protection at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

13. Please rank the CSF, Environmental Hazard at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

14. Please rank the CSF, Resource Consumption aspects at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

15. Please rank the CSF, Resource Conservation aspects at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely Significant and Scale 15 being Least Significant, Likert Scale.

| Rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

# Appendix B

## Preamble

**Research Topic:** Strategic ICT Management in Bangladesh's transition to E-Governance: Framing out a realistic sustainable approach

**Researcher:**

A.K.M. Golam Baharul
Doctor of Business Administration (DBA) Researcher
Department of MIS, Faculty of Business Study, University of Dhaka
E-mail:akmbaharul@gmail.com
Mobile: +8801550151309

## Description

This research work is being undertaken as part of Doctor of Business Administration (DBA) research project for A K M Golam Baharul. This research work is being conducted under the supervision of Md. Moqbul Hossain Bhuiyan, Professor, Department of MIS, Faculty of Business Study, University of Dhaka (DU). All the information and data obtained from the research will be treated with utmost confidentiality and anonymity. The purpose of this research study is to frame out a realistic sustainable approach for strategic ICT Management regarding sustainable E-Governance of Bangladesh as Bangladesh is now in transition position to E-governance and moving forward quickly to attain E-Governance in all sectors. In this research the critical success factors (CSFs) are identified which are necessary to frame out a realistic sustainable approach for strategic ICT and sustainable E-Governance in Bangladesh. The significance of each CSF is also assessed and ranked the CSFs to understand which Most Significant is and which is less significant to make the strategic ICT Management plan successful.

Many researches have been conducted research in various sectors of E-Governance, but scarcely any in the strategic ICT management for sustainable E-Governance in Bangladesh. Further, many previous studies tend to be theoretical and too general to be

useful for an aspiring strategic ICT management for sustainable E-Governance. This research work is conducted by using powerful research tool Fuzzy AHP tool which is very useful in multi-disciplinary research topic. This research is aimed to address the knowledge gap by drawing on the experience and expertise of professionals in the ICT sector. It is hoped that the collective knowledge of these professionals/Experts can produce a practical and achievable list of critical success factors for realistic sustainable approach for strategic ICT Management and sustainable E-Governance in Bangladesh.

## Expected Benefits

It is expected that this research work will benefit you. The final findings of the questionnaires will be reported back to you at the conclusion of the research work and you will get insight of CSFs for strategic ICT Management and sustainable E-Governance in Bangladesh.

## Participation

Your participation in this research study is completely voluntary. If you do agree to participate, you can withdraw from participation at any time during the research work without comment or penalty. Your decision to participate will in no way impact upon your current or future relationship with University of Dhaka (DU).

Your participation may involve two or more rounds of questionnaires. The questionnaires will be sent to the you via e-mails. You can give answer in Google Forms which Link will be sent to you by mail. The researcher intends to employ the Fuzzy AHP method. In case of inconsistent of Matrix, feedback will give to you for changing the answer. To complete the questionnaire, it is expected to take 20-30 minutes of your time.

## Risk

There are no risks beyond normal day-to-day living associated with your participation in this work. Your all information will be ensured safe.

## Confidentiality

Your all comments and responses are anonymous and will be maintained with high confidentially. The names of individual persons are not required in any of the responses.

## Further information or query about the research work

Please contact the researcher if you have any questions or any query for further information about the research work.

# Invitation

Dear Mr. ----------

Subject: Request to participate in a Doctor of Business Administration Research Work under MIS department, Faculty of Business Studies, University of Dhaka (DU), Bangladesh.

Dear Sir,

My name is A K M Golam Baharul. I am a Bangladesh Civil Service official of Telecommunications cadre, now working as a General Manager/Director in Bangladesh Telecommunications Company Limited (BTCL), a state-owned Telecommunication company. I am currently studying for Doctor of Business Administration (DBA) degree in MIS at MIS department of Faculty of Business Studies, University of Dhaka (DU). I am writing to request your participation in my research study. My research work supervisor Md. Moqbul Hossain Bhuiyan, Professor, MIS, DU, has suggested that your experience and expert opinion would be beneficial to this study.

The Objective of my research is to identify the critical success factors (CSFs) and asses the significance of CSFs to frame out a realistic sustainable ICT Management approach that will help the Decision Makers (DMs) to plan the strategic ICT management for sustainable E-Governance in Bangladesh as Bangladesh is in Transition state of transformation of E-Governance.

Your kind participation would involve completing two rounds or more of questionnaires, which will be conducted anonymously and confidentially. It is expected that this research will benefit you. By participating in this research, you will help to generate new knowledge about framing out a realistic sustainable approach for strategic ICT management, sustainable E-Governance in Bangladesh which helps the country as a whole. Further, the results of all the questionnaires will be reported back to you after each round. This way you will gain a unique insight into what other experts think about strategic ICT management for sustainable E-Governance in Bangladesh.

Please refer to the attached participant information in the Google Form and consent forms for more details of your contribution on this research work.

For giving your Expert Opinion, Please CLICK ON THE “FILL OUT IN GOOGLE FORM" tab.

I am looking forward to your kind participation in this research work. Please do not hesitate to contact me if you have any questions or query.

Thanks in advance for your participation.

Kind regards,

A K M Golam Baharul
DBA Researcher, MIS Department, University of Dhaka
Address: General Manger, Billing System, BTCL Bhaban, Sher-E-Bangla Nagar, Dhaka.
Phone: +8801550151309
Email: akmbaharul@gmail.com

# Consent of Participation

The return of the completed Google Form questionnaire is accepted as an indication of your consent to participate in this project. The submission of this Google Form will be considered as your signed consent you are indicating that:

• You have read and understood the information document regarding this research work.

• You have understood that if you have any additional questions you can contact the researcher without any hesitation.

• You have understood that you are free to withdraw at any time from this research work, without comment or penalty.

• You have understood that you can contact the Researcher regarding Ethics of research to +8801550151309 or akmbaharul@gmail.com, if you have concerns about the ethical conduct of the research work.

If you are agreed to participate in this research work, Please give the following information. Thanks in advance for your participation in research work.

Name:

Designation:

Organization:

Year of Experience:

Date:

# Questionnaire

**Please Notice:**

AB: Absolutely more important/More than Extremely Important (preferred), Scale: 9

VS: Very strongly more important (preferred) Scale: 7

ST: Strongly more important (preferred), Scale: 5

WK: Weakly more important (preferred), Scale: 3

EQ: Equally more important (preferred), Scale: 1

Scale 8,6,4,2 is intermediate value between two scales

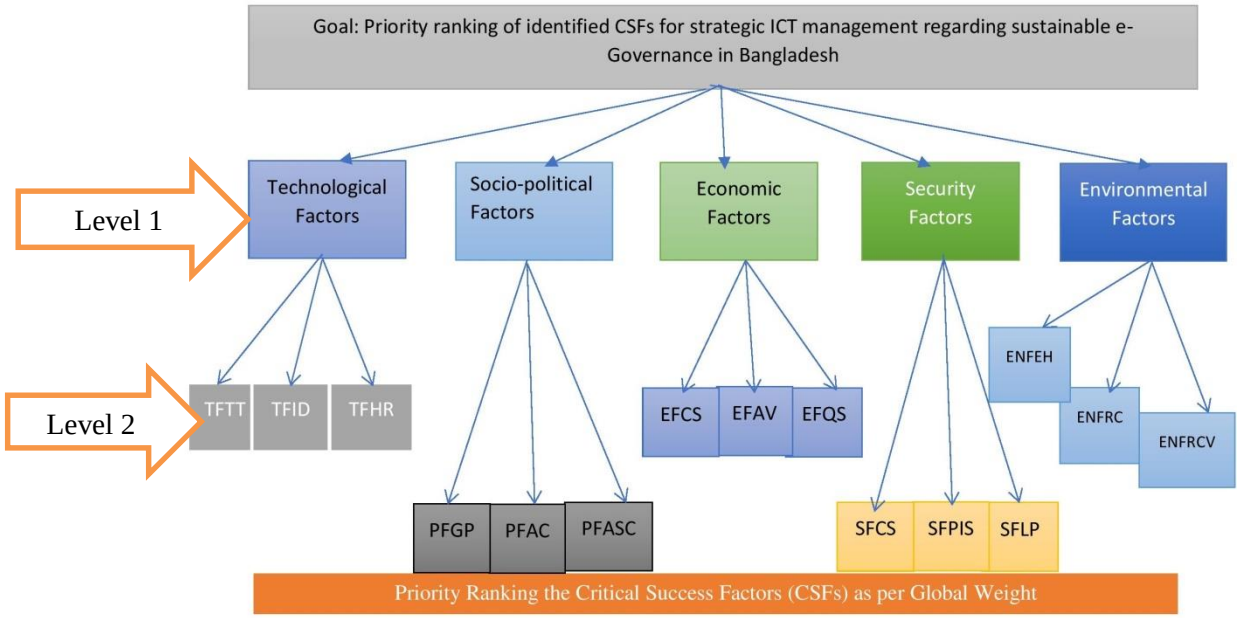



Figure : The structure of Fuzzy AHP hierarchical model (Source: Developed by the Researcher)

## Questionnaires for LEVEL 1 Critical Success Factors (CSFs)

1. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: the Technological Factor (TF) or Socio-political Factor (PF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is

important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Technological Factor (TF) More Important b) Socio-political Factor (PF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TF | | | | | | | | | | | | | | | | | | PF |

2. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Technological Factor (TF) or Economic Factor (EF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Technological Factor (TF) More Important b) Economic Factor (EF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TF | | | | | | | | | | | | | | | | | | EF |

3. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: the Technological Factor (TF) or Security Factor (SF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Technological Factor (TF) More Important b) Security Factor (SF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TF | | | | | | | | | | | | | | | | | | SF |

4. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Technological Factor (TF) or Environmental (ENF)? And please select the scale (1 to 9)

considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Technological Factor (TF) More Important b) Environmental Factor (ENF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TF | | | | | | | | | | | | | | | | | | ENF |

5. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Socio-political Factor (PF) or Economic Factor (EF)? And please select the scale (1 to 9) considering your choice(Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Socio-political Factor (PF) More Important b) Economic Factor (EF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| PF | | | | | | | | | | | | | | | | | | EF |

6. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Socio-political Factor (PF) or Security Factor (SF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Socio-political Factor (PF) More Important b) Security Factor (SF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| PF | | | | | | | | | | | | | | | | | | SF |

7. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Socio-political Factor (PF) or Environmental Factor (ENF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Socio-political Factor (PF) More Important b) Environmental Factor (ENF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| PF | | | | | | | | | | | | | | | | | | ENF |

8. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Economic Factor (EF) or Security Factor (SF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Economic Factor (EF) More Important b) Security Factor (SF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| EF | | | | | | | | | | | | | | | | | | SF |

9. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Economic Factor (EF) or Environmental Factor (ENF)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Economic Factor (EF) More Important b) Environmental Factor (ENF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| EF | | | | | | | | | | | | | | | | | | ENF |

10. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Security (SF) or Environmental Factor (ENF)? And please select the scale (1 to 9) considering your choice(Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Security Factor (SF) More Important b) Environmental Factor (ENF) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| SF | | | | | | | | | | | | | | | | | | ENF |

## Questionnaires for Level 2 Critical Success Factors (CSFs)

## A) Technological Factors

11. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Technological F a c t o r (TF), which is more important as per your opinion: Technology Transfer by vendors (TFTT) or Infrastructure development and Resource Sharing (TFID)? And please select the scale (1 to 9) considering your choice(Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Technology Transfer by vendors (TFTT) More Important b) Infra-structure Development and Resource Sharing (TFID) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TFTT | | | | | | | | | | | | | | | | | | TFID |

12. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Technological F a c t o r (TF), which is more important as per your opinion: Technology Transfer by Vendors

(TFTT) or Availability of Skilled Human Resource (TFHR)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for just Equally Important.

a) Technology Transfer by Vendors (TFTT) More Important b) Availability of Skilled Human Resource (TFHR) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TFTT | | | | | | | | | | | | | | | | | | TFHR |

13. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Technological Factor (TF), which is more important as per your opinion: Infrastructure Development and Resource Sharing (TFID) or Available Skilled Human Resource (TFHR)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Infrastructure Development and Resource Sharing (TFID) More Important b) Available Skilled Human Resource (TFHR) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| TFID | | | | | | | | | | | | | | | | | | TFHR |

## B) Socio-Political Factors

14. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Socio-Political Factors (PF), which is more important as per your opinion: Government Policy (PFGP) or Awareness of Citizen (PFAC)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Government Policy (PFGP) More Important b) Awareness of Citizen (PFAC) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| PFGP | | | | | | | | | | | | | | | | | | PFAC |

15. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Socio-Political Factors (PF), which is more important as per your opinion: Government Policy (PFGP) or Acceptability in Socio-Cultural aspects (PFASC)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Government Policy (PFGP) More Important b) Acceptability in Socio-Cultural aspects (PFAC) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| PFGP | | | | | | | | | | | | | | | | | | PFASC |

16. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Socio-Political Factors (PF), which is more important as per your opinion: Awareness of Citizen (PFAC) or Acceptability in Socio-Cultural aspects (PFAsC)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Awareness of Citizen More Important (PFAC) b) Acceptability in Socio-Cultural aspects More Important (PFASC)

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| PFAC | | | | | | | | | | | | | | | | | | PFASC |

# C) Economic Factors

17. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Economic Factors (EF), which is more important as per your opinion: Cost of Service (EFCS) or Availability of Service (EFAS)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Cost of Service (EFCS) More Important b) Availability of Service (EFAS) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| EFCS | | | | | | | | | | | | | | | | | | EFAS |

18. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Economic Factors (EF), which is more important as per your opinion: Cost of Service (EFCS) or Quality of Service (EFQS)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Cost of service (EFCS) More Important b) Quality of Service (EFQS) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| EFCS | | | | | | | | | | | | | | | | | | EFQS |

19. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Economic Factors (EF), which is more important as per your opinion: Availability of Service (EFAS) or Quality of Service (EFQS)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Availability of Service (EFAS) More Important b) Quality of Service (EFQS) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| EFAS | | | | | | | | | | | | | | | | | | EFQS |

## D) Security Factors

20. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Security Factors (SF), which is more important as per your opinion: Cyber Security (SFCYS) or Personal Information security (SFPIS)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Cyber Security (SFCYS) More Important b) Personal Information Security (CSPIS) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| SFCYS | | | | | | | | | | | | | | | | | | CFPIS |

21. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Security Factors (SF), which is more important as per your opinion: Cyber Security (SFCYS) or Legal protection (SFLP)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Cyber Security (SFCYS) More Important b) Legal protection (SFLP) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| SFCYS | | | | | | | | | | | | | | | | | | SFLP |

22. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Security Factors (SF), which is more important as per your opinion: Personal Information security (SFPIS) or Legal protection (SFLP)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Personal information Security (SFPIS) More Important b) Legal protection (SFLP) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| SFPIS | | | | | | | | | | | | | | | | | | SFLP |

## E) Environmental Factors

23. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Environmental Factors (ENF), which is more important as per your opinion: Environmental Hazard (ENFEH)) or Resource consumption (ENFRC)? And please select the scale (1 to 9) considering your choice (Left side Item or Right Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Environmental Hazard (ENFEH) More Important b) Resource Consumption (ENFRC) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| ENFEH | | | | | | | | | | | | | | | | | | ENFRC |

24. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Environmental Factors (EF), which is more important as per your opinion: Environmental Hazard (ENFEH) or Resource Conservation (ENFRC)? And please select the scale (1 to 9) considering

your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Environmental Hazard (ENFEH) More Important b) Resource Conservation (ENFRCV) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| ENFEH | | | | | | | | | | | | | | | | | | EFRCV |

25. Let consider Critical Success Factors (CSFs) for strategic ICT management regarding sustainable E-Governance in Bangladesh issues, with respect to Environmental Factors (EF), which is more important as per your opinion: Resource consumption (ENFRC) or Resource conservation (ENFRCOV)? And please select the scale (1 to 9) considering your choice (Left side Item or Right-Side Item) that how much it is important than other in one pair: 9 for More than Extremely Important and 1 for Just Equally Important.

a) Resource Consumption (ENFRC) More Important b) Resource Conservation (ENFRCV) More Important

| | Left Item is more Important | | | | | | | | EQ | Right Item is more Important | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Eva.Item | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Eva.Item |
| EFRC | | | | | | | | | | | | | | | | | | EFRCV |

# Appendix C

## Expert Participant of this Research Work for Fuzzy AHP Method

| Sl. No. | Expert | Category | Education | Organization |
|---|---|---|---|---|
| 1 | Expert -1 | Academician/Researcher | Ph.D. | University of Liberal Arts, ULAB |
| 2 | Expert -2 | ICT Professional | B.Sc. Eng. MBA | Bangladesh Telecommunications Company Limited (Former T&T) |
| 3 | Expert -3 | ICT Professional | B.Sc. Eng., MPA | Department of Telecommunications, Ministry of Post, Telecom and ICT |
| 4 | Expert -4 | Academician/Researcher | Ph.D. | BUET |
| 5 | Expert -5 | ICT Professional | B.Sc. Eng., MBA | Teletalk Bangladesh Limited |
| 6 | Expert -6 | ICT Professional | B.Sc. Eng., MBA | Bangladesh Sub-marine Cable Company Limited |
| 7 | Expert -7 | Bureaucrat | M.Sc. | ICT Division, Ministry of post, Telecom and ICT |
| 8 | Expert -8 | Management Expert | M.Sc. | Bangladesh Power Development Board (BPDB) |
| 9 | Expert -9 | ICT Processional | B.Sc. Eng., MBA | Grameen Phone Limited |
| 10 | Expert -10 | Business Professional | M.A. | Universal Trims (RMG) |

## Expert Participant of this Research Work for Delphi Method

| Sl. No. | Expert | Category | Education | Organization |
|---|---|---|---|---|
| 1 | Expert -1 | Academician/Researcher | Ph.D. | City University, Bangladesh |
| 2 | Expert -2 | ICT Professional | B.Sc. Eng. MBA | Bangladesh Telecommunications Company Limited (Former T&T) |
| 3 | Expert -3 | ICT Professional | B.Sc. Eng., MBA | Department of Telecommunications, Ministry of Post, Telecom and ICT |
| 4 | Expert -4 | Academician/Researcher | Ph.D. | BUET |
| 5 | Expert -5 | ICT Professional | B.Sc. Eng., MBA | Teletalk Bangladesh Limited |
| 6 | Expert -6 | ICT Professional | B.Sc. Eng., MBA | Bangladesh Sub-marine Cable Company Limited |
| 7 | Expert -7 | Bureaucrat | M.Sc. | ICT Division, Ministry of post, Telecom and ICT |
| 8 | Expert -8 | Management Expert | M.Sc. | Bangladesh Power Development Board (BPDB) |
| 9 | Expert -9 | ICT Processional | B.Sc. Eng., MBA | Grameen Phone Limited |
| 10 | Expert -10 | Business Professional | M.A. | Master Simex Paper Limited |

# Appendix D

1.Defuzified weight of 10 Expert participants of Level-1 CSFs

**Expert- 1**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4276 |
| **PF** | 0.2216 |
| **EF** | 0.2058 |
| **SF** | 0.1509 |
| **ENVF** | 0.0257 |

**Expert- 2**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4434 |
| **PF** | 0.1974 |
| **EF** | 0.1899 |
| **SF** | 0.1407 |
| **ENVF** | 0.0278 |

**Expert- 3**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4443 |
| **PF** | 0.1925 |
| **EF** | 0.1859 |
| **SF** | 0.1402 |
| **ENVF** | 0.0268 |

**Expert- 4**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4474 |
| **PF** | 0.1991 |
| **EF** | 0.1883 |
| **SF** | 0.1423 |
| **ENVF** | 0.0254 |

**Expert- 5**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4432 |
| **PF** | 0.1973 |
| **EF** | 0.1884 |
| **SF** | 0.1408 |
| **ENVF** | 0.0249 |

**Expert- 6**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4424 |
| **PF** | 0.1981 |
| **EF** | 0.1864 |
| **SF** | 0.1409 |
| **ENVF** | 0.0274 |

**Expert- 7**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4423 |
| **PF** | 0.1954 |
| **EF** | 0.1849 |
| **SF** | 0.1408 |
| **ENVF** | 0.0268 |

**Expert- 8**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4452 |
| **PF** | 0.1983 |
| **EF** | 0.2033 |
| **SF** | 0.1374 |
| **ENVF** | 0.0258 |

**Expert- 9**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4433 |
| **PF** | 0.1972 |
| **EF** | 0.1809 |
| **SF** | 0.1409 |
| **ENVF** | 0.0279 |

**Expert- 10**

| CSF Name | Defuzified Weight |
|---|---|
| **TF** | 0.4434 |
| **PF** | 0.1993 |
| **EF** | 0.1838 |
| **SF** | 0.1419 |
| **ENVF** | 0.0294 |

**Aggregation of 10 Expert's Opinion and ranking the level-1 CSFs:**

| CSF | Exp-1 | Exp-2 | Exp-3 | Exp-4 | Exp-5 | Exp-6 | Exp-7 | Exp-8 | Exp-9 | Exp-10 | Aggr. Defuzi-fied Weight | Final Normalized weight | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TF** | 0.4276 | 0.4434 | 0.4443 | 0.4474 | 0.4432 | 0.4424 | 0.4423 | 0.4452 | 0.4433 | 0.4434 | 0.4423 | 0.4422 | 1 |
| **PF** | 0.2216 | 0.1974 | 0.1925 | 0.1991 | 0.1973 | 0.1981 | 0.1954 | 0.1983 | 0.1972 | 0.1993 | 0.1996 | 0.1996 | 2 |
| **EF** | 0.2058 | 0.1899 | 0.1859 | 0.1883 | 0.1884 | 0.1864 | 0.1849 | 0.2033 | 0.1809 | 0.1838 | 0.1898 | 0.1897 | 3 |
| **SF** | 0.1509 | 0.1407 | 0.1402 | 0.1423 | 0.1408 | 0.1409 | 0.1408 | 0.1374 | 0.1409 | 0.1419 | 0.1417 | 0.1417 | 4 |
| **ENVF** | 0.0257 | 0.0278 | 0.0268 | 0.0254 | 0.0249 | 0.0274 | 0.0268 | 0.0258 | 0.0279 | 0.0294 | 0.0268 | 0.0268 | 5 |
| Weight Sum | | | | | | | | | | | 1.0001 | 1.0000 | |

## 2. Level-2 CSFs Calculation and factor weight

### Expert 1

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.07182 | 0.03177 | 0.03127 |
| TFID | 0.69914 | 0.30923 | 0.30437 |
| TFHR | 0.2647 | 0.11708 | 0.11524 |
| PFGP | 0.7305 | 0.14581 | 0.14352 |
| PFAC | 0.1885 | 0.03762 | 0.03703 |
| PFASC | 0.081 | 0.01617 | 0.01591 |
| EFCS | 0.2684 | 0.05094 | 0.05014 |
| EFAS | 0.6144 | 0.11661 | 0.11478 |
| EFQS | 0.1172 | 0.02224 | 0.02189 |
| SFCYS | 0.2785 | 0.03946 | 0.03884 |
| SFPIS | 0.663 | 0.09395 | 0.09247 |
| SFLP | 0.0585 | 0.00829 | 0.00816 |
| ENFEH | 0.6483 | 0.01737 | 0.01710 |
| ENFRC | 0.2296 | 0.00615 | 0.00606 |
| ENFRCV | 0.122 | 0.00327 | 0.00322 |
| Weight Sum of global normalized weight | | | 1.00000 |

### Expert 2

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0585 | 0.02587 | 0.02587 |
| TFID | 0.663 | 0.29324 | 0.29319 |
| TFHR | 0.2785 | 0.12318 | 0.12316 |
| PFGP | 0.7852 | 0.15673 | 0.15669 |
| PFAC | 0.1489 | 0.02972 | 0.02971 |
| PFASC | 0.0659 | 0.01315 | 0.01315 |
| EFCS | 0.2684 | 0.05094 | 0.05093 |
| EFAS | 0.6144 | 0.11661 | 0.11659 |
| EFQS | 0.1172 | 0.02224 | 0.02224 |
| SFCYS | 0.2785 | 0.03946 | 0.03946 |
| SFPIS | 0.663 | 0.09395 | 0.09393 |
| SFLP | 0.0585 | 0.00829 | 0.00829 |
| ENFEH | 0.5472 | 0.01466 | 0.01466 |
| ENFRC | 0.2631 | 0.00705 | 0.00705 |
| ENFRCV | 0.1897 | 0.00508 | 0.00508 |
| Weight Sum of global normalized weight | | | 1.00000 |

## Expert 3

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0585 | 0.02587 | 0.02587 |
| TFID | 0.663 | 0.29324 | 0.29319 |
| TFHR | 0.2785 | 0.12318 | 0.12316 |
| PFGP | 0.7852 | 0.15673 | 0.15670 |
| PFAC | 0.1489 | 0.02972 | 0.02971 |
| PFASC | 0.0659 | 0.01315 | 0.01315 |
| EFCS | 0.2684 | 0.05094 | 0.05093 |
| EFAS | 0.6144 | 0.11661 | 0.11659 |
| EFQS | 0.1172 | 0.02224 | 0.02224 |
| SFCYS | 0.2785 | 0.03946 | 0.03946 |
| SFPIS | 0.663 | 0.09395 | 0.09393 |
| SFLP | 0.0585 | 0.00829 | 0.00829 |
| ENFEH | 0.5472 | 0.01565 | 0.01565 |
| ENFRC | 0.2631 | 0.00621 | 0.00621 |
| ENFRCV | 0.1897 | 0.00493 | 0.00493 |
| Weight Sum of global normalized weight | | | 1.00000 |

## Expert 4

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0719 | 0.0322 | 0.03220 |
| TFID | 0.6491 | 0.2904 | 0.29043 |
| TFHR | 0.279 | 0.1248 | 0.12481 |
| PFGP | 0.7305 | 0.1454 | 0.14541 |
| PFAC | 0.1885 | 0.0375 | 0.03750 |
| PFASC | 0.081 | 0.0161 | 0.01610 |
| EFCS | 0.2684 | 0.05 | 0.05001 |
| EFAS | 0.6144 | 0.1144 | 0.11441 |
| EFQS | 0.1172 | 0.0218 | 0.02180 |
| SFCYS | 0.2785 | 0.0395 | 0.03950 |
| SFPIS | 0.663 | 0.0941 | 0.09411 |
| SFLP | 0.0585 | 0.0083 | 0.00830 |
| ENFEH | 0.6483 | 0.0165 | 0.01650 |
| ENFRC | 0.2296 | 0.0058 | 0.00580 |
| ENFRCV | 0.122 | 0.0031 | 0.00310 |
| Weight Sum of global normalized weight | | | 1.00000 |

## Expert 5

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0585 | 0.026 | 0.02600 |
| TFID | 0.663 | 0.2945 | 0.29450 |
| TFHR | 0.2785 | 0.1237 | 0.12370 |
| PFGP | 0.7852 | 0.1549 | 0.15490 |
| PFAC | 0.1489 | 0.0294 | 0.02940 |
| PFASC | 0.0659 | 0.013 | 0.01300 |
| EFCS | 0.2684 | 0.051 | 0.05100 |
| EFAS | 0.6144 | 0.1167 | 0.11670 |
| EFQS | 0.1172 | 0.0223 | 0.02230 |
| SFCYS | 0.2785 | 0.0392 | 0.03920 |
| SFPIS | 0.663 | 0.0933 | 0.09330 |
| SFLP | 0.0585 | 0.0082 | 0.00820 |
| ENFEH | 0.5472 | 0.0152 | 0.01520 |
| ENFRC | 0.2631 | 0.0073 | 0.00730 |
| ENFRCV | 0.1897 | 0.0053 | 0.00530 |
| Weight Sum of global normalized weight | | | 1.00000 |

## Expert 6

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0719 | 0.0322 | 0.03220 |
| TFID | 0.6491 | 0.2904 | 0.29043 |
| TFHR | 0.279 | 0.1248 | 0.12481 |
| PFGP | 0.7305 | 0.1454 | 0.14541 |
| PFAC | 0.1885 | 0.0375 | 0.03750 |
| PFASC | 0.081 | 0.0161 | 0.01610 |
| EFCS | 0.2684 | 0.05 | 0.05001 |
| EFAS | 0.6144 | 0.1144 | 0.11441 |
| EFQS | 0.1172 | 0.0218 | 0.02180 |
| SFCYS | 0.2785 | 0.0395 | 0.03950 |
| SFPIS | 0.663 | 0.0941 | 0.09411 |
| SFLP | 0.0585 | 0.0083 | 0.00830 |
| ENFEH | 0.6483 | 0.0165 | 0.01650 |
| ENFRC | 0.2296 | 0.0058 | 0.00580 |
| ENFRCV | 0.122 | 0.0031 | 0.00310 |
| Weight Sum of global moralized weight | | | 1.00000 |

## Expert 7

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0585 | 0.026 | 0.02600 |
| TFID | 0.663 | 0.2945 | 0.29447 |
| TFHR | 0.2785 | 0.1237 | 0.12369 |
| PFGP | 0.7852 | 0.1549 | 0.15488 |
| PFAC | 0.1489 | 0.0294 | 0.02940 |
| PFASC | 0.0659 | 0.013 | 0.01300 |
| EFCS | 0.2684 | 0.051 | 0.05099 |
| EFAS | 0.6144 | 0.1167 | 0.11669 |
| EFQS | 0.1172 | 0.0223 | 0.02230 |
| SFCYS | 0.2785 | 0.0392 | 0.03920 |
| SFPIS | 0.663 | 0.0933 | 0.09329 |
| SFLP | 0.0585 | 0.0082 | 0.00820 |
| ENFEH | 0.5841 | 0.0163 | 0.01630 |
| ENFRC | 0.2318 | 0.0065 | 0.00650 |
| ENFRCV | 0.184 | 0.0051 | 0.00510 |
| Weight Sum of global normalized weight | | | 1.00000 |

## Expert 8

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0585 | 0.026 | 0.02600 |
| TFID | 0.663 | 0.2945 | 0.29450 |
| TFHR | 0.2785 | 0.1237 | 0.12370 |
| PFGP | 0.7852 | 0.1549 | 0.15490 |
| PFAC | 0.1489 | 0.0294 | 0.02940 |
| PFASC | 0.0659 | 0.013 | 0.01300 |
| EFCS | 0.2684 | 0.051 | 0.05100 |
| EFAS | 0.6144 | 0.1167 | 0.11670 |
| EFQS | 0.1172 | 0.0223 | 0.02230 |
| SFCYS | 0.2785 | 0.0392 | 0.03920 |
| SFPIS | 0.663 | 0.0933 | 0.09330 |
| SFLP | 0.0585 | 0.0082 | 0.00820 |
| ENFEH | 0.5472 | 0.0152 | 0.01520 |
| ENFRC | 0.2631 | 0.0073 | 0.00730 |
| ENFRCV | 0.1897 | 0.0053 | 0.00530 |
| Weight Sum of global normalized weight | | | 1.00000 |

## Expert 9

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0719 | 0.0322 | 0.03220 |
| TFID | 0.6491 | 0.2904 | 0.29043 |
| TFHR | 0.279 | 0.1248 | 0.12481 |
| PFGP | 0.7305 | 0.1454 | 0.14541 |
| PFAC | 0.1885 | 0.0375 | 0.03750 |
| PFASC | 0.081 | 0.0161 | 0.01610 |
| EFCS | 0.2684 | 0.05 | 0.05001 |
| EFAS | 0.6144 | 0.1144 | 0.11441 |
| EFQS | 0.1172 | 0.0218 | 0.02180 |
| SFCYS | 0.2785 | 0.0395 | 0.03950 |
| SFPIS | 0.663 | 0.0941 | 0.09411 |
| SFLP | 0.0585 | 0.0083 | 0.00830 |
| ENFEH | 0.6483 | 0.0165 | 0.01650 |
| ENFRC | 0.2296 | 0.0058 | 0.00580 |
| ENFRCV | 0.122 | 0.0031 | 0.00310 |
| Weight Sum of global normalized weight | | | 1.00000 |

## Expert 10

| CSF | Defuzified local weight Level 2 CSF | Defuzified global weight of Level 2 CSF | Normalized global weight of Level 2 CSF |
|---|---|---|---|
| TFTT | 0.0719 | 0.0322 | 0.03220 |
| TFID | 0.6491 | 0.2904 | 0.29043 |
| TFHR | 0.279 | 0.1248 | 0.12481 |
| PFGP | 0.7305 | 0.1454 | 0.14541 |
| PFAC | 0.1885 | 0.0375 | 0.03750 |
| PFASC | 0.081 | 0.0161 | 0.01610 |
| EFCS | 0.2684 | 0.05 | 0.05001 |
| EFAS | 0.6144 | 0.1144 | 0.11441 |
| EFQS | 0.1172 | 0.0218 | 0.02180 |
| SFCYS | 0.2785 | 0.0395 | 0.03950 |
| SFPIS | 0.663 | 0.0941 | 0.09411 |
| SFLP | 0.0585 | 0.0083 | 0.00830 |
| ENFEH | 0.6483 | 0.0165 | 0.01650 |
| ENFRC | 0.2296 | 0.0058 | 0.00580 |
| ENFRCV | 0.122 | 0.0031 | 0.00310 |
| Weight Sum of global normalized weight | | | 1.00000 |

Aggregation 0f 10 Experts opinion of level 2 CSFs and calculation of final normalized weight was as follows:

| CSF | E1 | E2 | E3 | E4 | E5 | E6 | E7 | E8 | E9 | E10 | Final Normalized Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TFTT | 0.0313 | 0.0259 | 0.0259 | 0.0322 | 0.0260 | 0.0322 | 0.0260 | 0.0260 | 0.0322 | 0.0322 | 0.0290 |
| TFID | 0.3044 | 0.2932 | 0.2932 | 0.2904 | 0.2945 | 0.2904 | 0.2945 | 0.2945 | 0.2904 | 0.2904 | 0.2936 |
| TFHR | 0.1152 | 0.1232 | 0.1232 | 0.1248 | 0.1237 | 0.1248 | 0.1237 | 0.1237 | 0.1248 | 0.1248 | 0.1232 |
| PFGP | 0.1435 | 0.1567 | 0.1567 | 0.1454 | 0.1549 | 0.1454 | 0.1549 | 0.1549 | 0.1454 | 0.1454 | 0.1503 |
| PFAC | 0.0370 | 0.0297 | 0.0297 | 0.0375 | 0.0294 | 0.0375 | 0.0294 | 0.0294 | 0.0375 | 0.0375 | 0.0335 |
| PFASC | 0.0159 | 0.0132 | 0.0132 | 0.0161 | 0.0130 | 0.0161 | 0.0130 | 0.0130 | 0.0161 | 0.0161 | 0.0146 |
| EFCS | 0.0501 | 0.0509 | 0.0509 | 0.0500 | 0.0510 | 0.0500 | 0.0510 | 0.0510 | 0.0500 | 0.0500 | 0.0505 |
| EFAS | 0.1148 | 0.1166 | 0.1166 | 0.1144 | 0.1167 | 0.1144 | 0.1167 | 0.1167 | 0.1144 | 0.1144 | 0.1156 |
| EFQS | 0.0219 | 0.0222 | 0.0222 | 0.0218 | 0.0223 | 0.0218 | 0.0223 | 0.0223 | 0.0218 | 0.0218 | 0.0220 |
| SFCYS | 0.0388 | 0.0395 | 0.0395 | 0.0395 | 0.0392 | 0.0395 | 0.0392 | 0.0392 | 0.0395 | 0.0395 | 0.0393 |
| SFPIS | 0.0925 | 0.0939 | 0.0939 | 0.0941 | 0.0933 | 0.0941 | 0.0933 | 0.0933 | 0.0941 | 0.0941 | 0.0936 |
| SFLP | 0.0082 | 0.0083 | 0.0083 | 0.0083 | 0.0082 | 0.0083 | 0.0082 | 0.0082 | 0.0083 | 0.0083 | 0.0083 |
| ENFEH | 0.0171 | 0.0147 | 0.0157 | 0.0165 | 0.0152 | 0.0165 | 0.0163 | 0.0152 | 0.0165 | 0.0165 | 0.0160 |
| ENFRC | 0.0061 | 0.0071 | 0.0062 | 0.0058 | 0.0073 | 0.0058 | 0.0065 | 0.0073 | 0.0058 | 0.0058 | 0.0064 |
| ENFRCV | 0.0032 | 0.0051 | 0.0049 | 0.0031 | 0.0053 | 0.0031 | 0.0051 | 0.0053 | 0.0031 | 0.0031 | 0.0041 |
| Weight sum of global normalized weight | | | | | | | | | | | 1.0000 |

Final weight and Ranking of level of preference of Level 2 or specific CSF:

| CSF | Final Weight | Rank | Preference |
|---|---|---|---|
| TFID | 0.2936 | 1 | 29.36% |
| PFGP | 0.1503 | 2 | 15.03% |
| TFHR | 0.1232 | 3 | 12.32% |
| EFAS | 0.1156 | 4 | 11.56% |
| SFPIS | 0.0936 | 5 | 9.37% |
| EFCS | 0.0505 | 6 | 5.05% |
| SFCYS | 0.0393 | 7 | 3.93% |
| PFAC | 0.0335 | 8 | 3.35% |
| TFTT | 0.0290 | 9 | 2.90% |
| EFQS | 0.0220 | 10 | 2.20% |
| ENFEH | 0.0160 | 11 | 1.60% |
| PFASC | 0.0146 | 12 | 1.46% |
| SFLP | 0.0083 | 13 | 0.83% |
| ENFRC | 0.0064 | 14 | 0.64% |
| ENFRCV | 0.0041 | 15 | 0.41% |

# Appendix E

**Google Form developed by Researcher for exploring Expert Opinion**

## A. For Fuzzy AHP Method

1. Do you agree to participate in the research work? If Yes, please continue. *
   Mark only one oval.

   ☐ Yes

   ☐ No

| | |
|---|---|
| Research Topic | Strategic ICT Management in Bangladesh's transition to E-Governance: Framing out a realistic sustainable approach |

2. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Technological Factor (TF) or Socio-political Factor (PF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important.

   *Check all that apply.*

   ☐ IF more important
   ☐ PF more important
   ☐ 9: Absolutely more important
   ☐ 8: In between 9 and 7
   ☐ 7: Very strongly more important
   ☐ 6: In between 7 and 5
   ☐ 5: Strongly more important
   ☐ 4: In between 5 and 3
   ☐ 3: Weakly more important
   ☐ 2: In between 3 and 1
   ☐ 1: Equally more important

3. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Technological Factor (TF) or Economic Factor (EF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] TF more important
- [ ] EF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

4. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Technological Factor (TF) or security Factor (SF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] TF more important
- [ ] SF more important
- [ ] 9: more than Extremely important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

5. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Technological Factor (TF) or Environmental Factor (ENF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] TF more important
- [ ] ENF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

6. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Socio-political Factor (PF) or Economic Factor (EF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] PF more important
- [ ] EF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

7. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Socio-political Factor (PF) or Security Factor (SF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] PF more important
- [ ] SF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

8. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Socio-political Factor (PF) or Environmental Factor (ENF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] PF more important
- [ ] ENF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

9. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Economic Factor (EF) or Security Factor (SF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] EF more important
- [ ] SF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

10. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Economic Factor (EF) or Environmental Factor (ENF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] EF more important
- [ ] ENF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

11. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, which is more important to you: The Security Factor (SF) or Environmental Factor (ENF)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] SF more important
- [ ] ENF more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

12. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Technology Factor (TF), which is more important as per your opinion: Technology Transfer by vendors (TT) or Infrastructure development and Resource Sharing (ID)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair. 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] TT more important
- [ ] ID more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

13. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Technology Factor (TF), which is more important as per your opinion: Technology Transfer by vendors (TT) or Availability of Skilled Human Resource (HR)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] TT more important
- [ ] HR more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

14. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Technology Factor (TF), which is more important as per your opinion: Infrastructure development and Resource Sharing (ID) or Available Skilled Human Resource (HR)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] ID more important
- [ ] HR more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

15. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Socio-Political Factors (PF), which is more important as per your opinion: Government Policy (GP) or Awareness of Citizen (AWC)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] GP more important
- [ ] AWC more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

16. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Socio-Political Factors (PF), which is more important as per your opinion: Government Policy (GP) or Acceptability in Socio- Cultural aspects (ASC)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] GP more important
- [ ] ASC more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

17. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Socio-Political Factors (PF), which is more important as per your opinion: Awareness of citizen (AWC) or Acceptability in Socio- Cultural aspects (ASC)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] AWC more important
- [ ] ASC more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

18. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Economic Factors (EF), which is more important as per your opinion: Cost of Service (CS) or Availability of Service (AS)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: for 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] AWC more important
- [ ] ASC more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

19. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Economic Factors (EF), which is more important as per your opinion: Cost of Service (CS) or Quality of Service (QS)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] CS more important
- [ ] QS more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

20. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Economic Factors (EF), which is more important as per your opinion: Availability of Service (AS) or Quality of Service (QS)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

*Check all that apply.*

- [ ] AS more important
- [ ] QS more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

21. 20. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Security Factors (SF), which is more important as per your opinion: Cyber Security (CYS) or Personal information Security (PIS)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

Check all that apply.

- [ ] CYS more important
- [ ] PIS more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

22. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Security Factors (SF), which is more important as per your opinion: Cyber Security (CYS) or Legal protection (LP)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

Check all that apply.

- [ ] CYS more important
- [ ] LP more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

23. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Security Factors (SF), which is more important as per your opinion: Personal Information Security (PIS) or Legal protection (LP)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair9 for more than extremely important and 1 for just Equally more important

Check all that apply.

- [ ] PIS more important
- [ ] LP more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

24. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Environmental Factors (ENF), which is more important as per your opinion: Environmental Hazard (EH) or Resource consumption (RC)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

Check all that apply.

- [ ] EH more important
- [ ] RC more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

25. 24. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Environmental Factors (ENF), which is more important as per your opinion: Environmental Hazard (ENH) or Resource Conservation (RCV)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair: 9 for more than extremely important and 1 for just Equally more important

Check all that apply.

- [ ] EH more important
- [ ] RCV more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

26. Let consider Critical Success Factors (CSFs) for strategic ICT management * regarding sustainable E-Governance in Bangladesh issues, with respect to Environmental Factors (EF), which is more important as per your opinion: Resource Consumption (RC) or Resource Conservation (RCV)? And please select the scale (1 to 9) considering your choice that how much it is important than other in one pair9 for more than extremely important and 1 for just Equally more important

Check all that apply.

- [ ] RC more important
- [ ] RCV more important
- [ ] 9: Absolutely more important
- [ ] 8: In between 9 and 7
- [ ] 7: Very strongly more important
- [ ] 6: In between 7 and 5
- [ ] 5: Strongly more important
- [ ] 4: In between 5 and 3
- [ ] 3: Weakly more important
- [ ] 2: In between 3 and 1
- [ ] 1: Equally more important

## B. For Delphi Method

| | |
|---|---|
| Research Topic | Research Topic: Strategic ICT Management in Bangladesh's transition to E-Governance: Framing out a realistic sustainable approach |

1. Do you agree to participate in the research work? If Yes, please continue. *

*Mark only one oval.*

- ☐ Yes
- ☐ No

| | |
|---|---|
| Research Topic | Research Topic: Strategic ICT Management in Bangladesh's transition to E-Governance: Framing out a realistic sustainable approach<br><br>**Please note: Make sure that the sums of the rank values of 15 CSFs would be in data range contained ranked data. Since there is 15 CSFs the sum of rankings of 15 CSF (Q1 to Q15) should be (1+2+ …+15=15*16/2=120 |

2. Please rank the CSF, Technology Transfer by vendors at the level of significance * for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF)

Check all that apply.

- ☐ Technology Transfer by vendors
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ 13
- ☐ 14
- ☐ 15

3. Please rank the CSF, Infrastructure Development and Resource sharing at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF)

Check all that apply

Infrastructure Development and Resource Sharing

- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

4. Please rank the CSF, Available skilled Human Resource at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply.

- [ ] Available skilled Human Resource
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

5. Please rank the CSF, Government Policy at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Government Policy
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

6. Please rank the CSF, Awareness of Citizen at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply.

- [ ] Awareness of Citizen
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

7. Please rank the CSF, Acceptability in socio-Cultural aspects at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Acceptability in socio-Cultural aspects
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

8. Please rank the CSF, Cost of service at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Cost of service
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

9. Please rank the CSF, Availability of service at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Availability of service
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

10. Please rank the CSF, Quality of service at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Quality of service
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

11. Please rank the CSF, Cyber Security at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Cyber Security
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

12. Please rank the CSF, Personal Information Security at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Personal Information Security
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

13. Please rank the CSF, Legal protection at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- ☐ Legal protection
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ 13
- ☐ 14
- ☐ 15

14. Please rank the CSF, Environmental Hazard at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- ☐ Environmental Hazard
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ 13
- ☐ 14
- ☐ 15

15. Please rank the CSF, Resource Consumption at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Resource Consumption
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15

16. Please rank the CSF, Resource Conservation at the level of significance for strategic ICT Management regarding sustainable E-Governance in Bangladesh: Scale 1 being Extremely significant and scale 15 being least significant, Likert Scale, (Please Check the first box and then give rank on that CSF).

Check all that apply

- [ ] Resource Conservation
- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15