

Chapter 14

QFD Approach for Integrated Information and Data Management Ecosystem: Umbrella Modelling Through Internet of Things



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Abstract The journey of human civilization has been phenomenal and indeed multi-dimensional. It started with the struggle for existence, survival, growth, transformation and enrichment for gratifying physical as well as intellectual aspirations. Experiential knowledge system and scientific acumen had been the propeller of the engine of development which essentially began with the ignition of fire followed by the inventions of wheels and so on. With the growing complexities of life and multifaceted ambitions, the problems are becoming compounded which need to be solved by the interface of cognitive skills and technology. Triumph of human societies has crossed many milestones at different ages i.e., Stone Age, Bronze Age and Iron Age through evolutionary historical episodes like Paleolithic, Mesolithic and Neolithic era. The dynamics of contemporary human civilization solely depends on knowledge economy at the behest of the present information age. The impetus of information has been widely accepted and practiced across the horizontally and vertically integrated economic orientations worldwide. The degree of intensity and commitment might differ among various societies throughout the globe. The concept of Internet of Things (IoTs) has become popular among practitioners, academia and researchers as it acts as the idea of umbrella value proposition with the synergy of related multipliers. The growth trajectory for the advancement and welfare of human races primarily depends on the availability, accessibility and usability of data on multi-dimensional variables. In fact, efficient data management system has become the backbone of all the developmental models. The government agencies even the corporate sectors are also reciprocating to this call of the hour and collect data in accordance with their sectoral limitation. This is

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welcoming but not exhaustive since it suffers from inconsistencies manifolds. Now, the priority and thrust have been convoluted on the real time data rather being confined into mere collection and use of unintegrated raw data. This chapter would attempt to develop a model based on ‘Quality Function Deployment (QFD)’ approach using IoT platform to augment the real-life data management system which would interact and share between all the stakeholders conforming the spirit of selective data privacy and confidentiality. This would also strive to bring reforms in the existing process of planning, strategy formulation and project implementations.

Keywords QFD approach · Integrated information · Data Management Ecosystem · Umbrella Modelling · Internet of Things (IoTs) · Real-life data management system

14.1 Introduction

14.1.1 *Genesis and Practice of IoT*

The term Internet of Things dates back to the year 1999. Most of the sources believe that Kevin Ashton (Co-founder of MIT’s Auto-ID Centre) is the one who coined the phrase “Internet of Things”. However, the acronym IoT is deemed to be the later innovation. IoT is one of the burning topics in the IT world now. It is a network of physical things embedded with software, microchip, sensor etc. which enables immediate access to information about the physical world thereby leads to improvement in efficiency and productivity. In a span of two decades, it has got widespread acceptance across the world.

14.1.2 *Opportunities for IoT*

The opportunities of IoT are enormous and ever increasing. The Business Insider projects around 24 billion IoT devices shall be installed by the end of 2020 [1]. However, the forecast of other researchers exceeds far ahead. Gartner projected around 25 billion devices by the same timeframe [2].

The IoT led ecosystem has been widely practiced in today economy and it is emerging with higher volumes in various sectors like Aerospace and Aviation, Automotive, Telecommunications, Medical and Healthcare Pharmaceutical, Retail, Logistics and Supply Chain Management, Manufacturing, Process, Transportation, Agriculture and Breeding, Media, Entertainment, Insurance, Mining etc. The Return on Investment (ROI) in IoT segment is projected to touch 13 trillion USD by 2025 [3].

It is predicted that more than half of spending on IoT sector may primarily focus on dedicated and customized manufacturing, transportation, logistics and utility services by 2020 which essentially portray that the future industry would be dominated by high-end transformative technologies [4].

14.1.3 Application of IoT

Over a period of time, IoT has emerged as an indispensable component for the development of every nation worldwide. It is being applied in diverse areas such as Smart Home, Wearable, Connected Cars, Industrial Internet, Smart Cities, Agriculture, Smart Retail, Energy Engagement, Healthcare, Poultry and Farming etc. Many industries like Healthcare, Transportation, Agriculture and Breeding, Media and Entertainment, Insurance, Recycling, to name a few, are increasingly using IoT [5]. Therefore, IoT intervention is inevitable in today's era to foster the growth of economy.

14.1.4 Information and Data Management Ecosystems: Experiences from India

The development of economy essentially relates to its resources, knowledge system, rate of creation of new knowledge and optimal sharing of knowledge and resources for making its dynamic and meaningful application. So, the focal point of supremacy in economic model depends on the sharing of information and knowledge system across the stakeholders to a large extent. In India, the state sponsored institutions including academia and research organizations have been creating high quality knowledge and various forms of information and databases regularly. But it suffers from comprehensive integration of all the knowledge and databases in a harmonious manner. As a result of that the India loses its quality and meaningful application. According to Global Entrepreneurship Index (GEI), 2018, India ranked 68th position out of 137 countries across the globe where India scored least in Technology Absorption (5%) followed by Networking (14%) and Cultural Support (14%) in order to understand the propensity of entrepreneurship in India from global standards [6]. This signifies that in general, India lacks in sharing knowledge and information that essentially has created least performance in absorbing technology from lab to market followed by its culture of creating integrated network or platform for sharing information.

Of late, the State Agencies are concentrating to create nationwide database network for example Shodh Ganga in India for Higher Education, INFLIBNET, various reports of Sample survey or Rounds of NSSO Working Groups etc. However, these attempts are miniscule in comparison to its overall demand.

The availability of integrated knowledge set, the ease of access and its effective use are the pre-requisites for scientific and economic development of the state. The transparency and disclosure of Private Sectors in India are not encouraging in general barring a few large firms. There are instances of dubious information and over-estimations of information revealed by the organizations. The concept of creating integrates and shareable Corporate Database is almost absent in India except miniscule attempts by a few agencies purely for commercial purposes.

14.1.5 Exploring Problems in Information and Data Management Ecosystems

The economy of developing nations is quite different from the developed ones. The firms in India are, in fact, sandwiched by various compelling forces and inhibiting factors. The dynamics of rapid technological advancement, bottlenecks like resource crunch, global competitions and turbulence in policy directions are the indicative examples of such antecedents. All the firms in India do not function on excelling their core competency for fetching higher growth. Many of them suffer from threat perception for their existence, survival and perpetuity. Under these circumstances; it may be suicidal for the firms to share all its information in the name of transparency or disclosure. So, India has become the victim of its inherent inconsistencies and challenges for creating integrated and shareable database system as compared to western world.

14.1.6 Concept of 'Quality Function Deployment' (QFD)

QFD can be referred as a system that attempts to translate the quality parameters of Product, Process and Services as a part of TQM initiative for achieving desired customer satisfaction.

14.1.7 Development of QFD Approach

The works of Akao describes that the QFD approach originated in Japan during late 60s of 20th Century [7]. The QFD initiative was first observed when the Oil Tanker was designed at the Kobe Shipyards of Japan in 1972. Mizuno also used this model to design customer satisfaction framework into a service offering encounter. In the mid of 80s of 20th Century, Don Clausing of MIT introduced this QFD as a design tool to the United States [8]. In fact, QFD is a strategic intervention to unify all the key areas so that the outcome of the process could be excelled and optimized.

14.1.8 QFD's Areas of Application

QFD is applied in diversified fields of application like Production, Product Design, Manufacturing, Information Technology (IT), Engineering, Research and Development (R&D) etc. [9] and other facets of life. It is well sought instrument that may be deployed in the organizational functions that are necessary to assure customer satisfaction which may include business, data management enabler/ecosystem etc. It is also deployed to achieve quality improvement, its management and to foster 4IR (Fourth Industrial Revolution).

14.2 Review of Literature

14.2.1 QFD

Since 1966, QFD has been extensively practiced by the leading companies across the world [10]. In fact, it is expected that QFD will be considered as effective tool for quality assurance in the information age [10, 11]. In QFD process, it is important to know weights for the customer requirements so as to initiate actions accordingly [12]. For this, a fuzzy Analytic Hierarchy Process (AHP) using extent analysis was proposed to determine the same. Besides, Wasserman also introduced a Decision Model for the prioritization of design requirement during the QFD planning process [13].

14.2.2 Integrated Information and Data Management Ecosystem

Integrated Information System (IIS) can play a crucial role for effective management of agriculture and ecosystem [14]. It is a tool for trouble-shooting, decision making and knowledge management [15]. Also for issues like Climate Change and Environmental Monitoring and Management, IIS is highly essential [16]. Integrated approach can serve as a model for Resource and Environment Management in the coming days.

Lari proposed a model which he believes that the model can serve as a framework for Quality Information Management within organizations [17].

Hua and Herstein iterated that IIS is necessary for successful policy making for the development of education system as it ensures open communication, information sharing and information use [18].

Carlson et al. proposed a system called Integrated Business Environmental Information Management (IBEIM) which efficiently supports and integrates environmental information management for Environmental Management Systems

(EMS) tools, LCA and other environmental process modelling tools, and Design for Environment tools. Through this system, Information and reports can be handled efficiently by organizations regardless of size [19].

14.2.3 Internet of Things (IoT) and Its Application

IoT can be considered as a global network infrastructure composed of numerous connected devices that rely on sensory, communication, networking, and information processing technologies [20]. A foundational technology for IoT is the RFID technology, which allows microchips to transmit the identification information to a reader through wireless communication. By using RFID readers, people can identify, track, and monitor any objects attached with RFID tags automatically [21]. RFID has been widely used in logistics, pharmaceutical production, retailing, and supply chain management, since 1980s [22, 23]. Another foundational technology for IoT is the Wireless Sensor Networks (WSNs), which mainly use interconnected intelligent sensors to sense and monitoring. Its applications include environmental monitoring, healthcare monitoring, industrial monitoring, traffic monitoring, and so on [24, 25].

14.3 Objectives of the Study

- (i) To study the importance of Integrated Information and Data Management Ecosystems.
- (ii) To propose QFD enabled Umbrella Modelling for Integrated Information and Data Management process through IoT intervention.
- (iii) To explore opportunities and challenges for implementing the model in Indian context.

14.4 Research Methodology

This paper is exploratory. The study is based on secondary information. It has been developed reviewing various research papers, reports and using relevant information.

14.5 Analysis and Interpretation

14.5.1 Analysis—I

The importance of Integrated Information and Data Management Ecosystems is enormous. Glimpses of indicative importance are noted below:

- There is lack cross-sectional data on various indicators catering to diversified domains. Even the data are not reliable and regularly published. This leads to inconsistencies in generating panel data.
- In India, there is need of real-time observations in most of the dimensions of economy. Another dimension is the available data set are not generated or published on same reference period. Now-a-days, high precision of real-life data is available that helps to make strategies projections/forecasting of weather conditions which can be shared for agriculture, fishermen working in the river and seas, agriculture practices etc. This minimises both loss of resources and loss of human and domesticated animals through strategic displacement or precautionary measures.
- Academicians, researchers and policy makers can formulate appropriate strategies for the emerging issues in terms of priorities of economy.
- Both the cross-sectional and panel data are helpful for designing both short-term and long-term policy planning in the form of e-governance, investment or implementation strategies. Cross-sectional data is for evaluating certain policy implementation activities.

From various studies, it is found that in spite of having positive relationship between the rate of corporate disclosure and transparency with the firms' net worth and profitability [26, 27] miniscule of firms and mostly the large firms have evidenced their efforts and commitments for corporate disclosure and transparency. The MSMEs are least interested in this area that results lesser confidence among all the stakeholders. On the contrary, the firms practicing higher order of Corporate Disclosure are sometimes questioned in terms of credibility and reliability of such information. The instance of Satyam, Enron, Lehman Brothers etc. are the testimony of such arguments where the firms desperately elevated and over projected the firm's net worth by creating fictitious assets. So, the quality, reliability and credibility of information disclosed by the firms are of paramount importance if the society is committed to have ethical practice and good governance (Fig. 14.1).

It is also important how fast the information has been collected by the firm. If the firm has to devise policies or strategies based on past data, it would be merely the 'System Approach' to management which can solve the problem on 'Reactive Mode'. In contrast to that if the firm is enabled with real-time data management system, the business entities may be strengthened with the ability to have 'Contingency Approach' to management that can 'stop the bleeding' instantly by divulging prospective and proactive mechanism. If the experiences and knowledge system (excepting the critical business secrecy) are shared and exchanged, the society would traverse with greater accomplishment and exposure to progress in the journey of excellence collectively with differentiated individual success story.

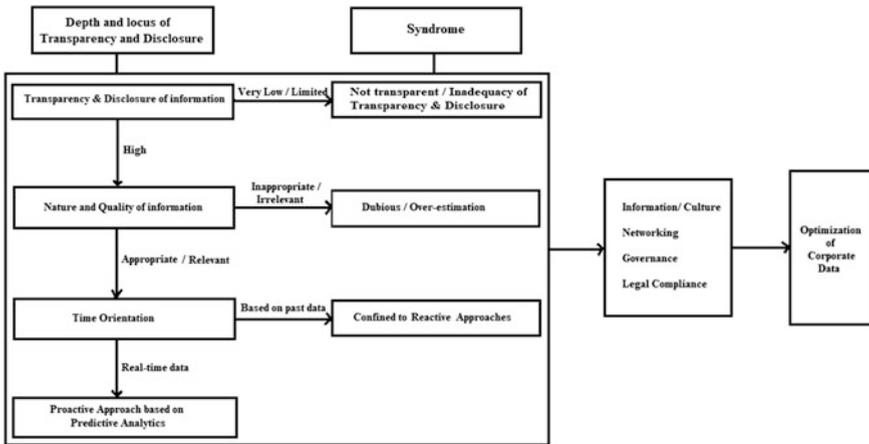
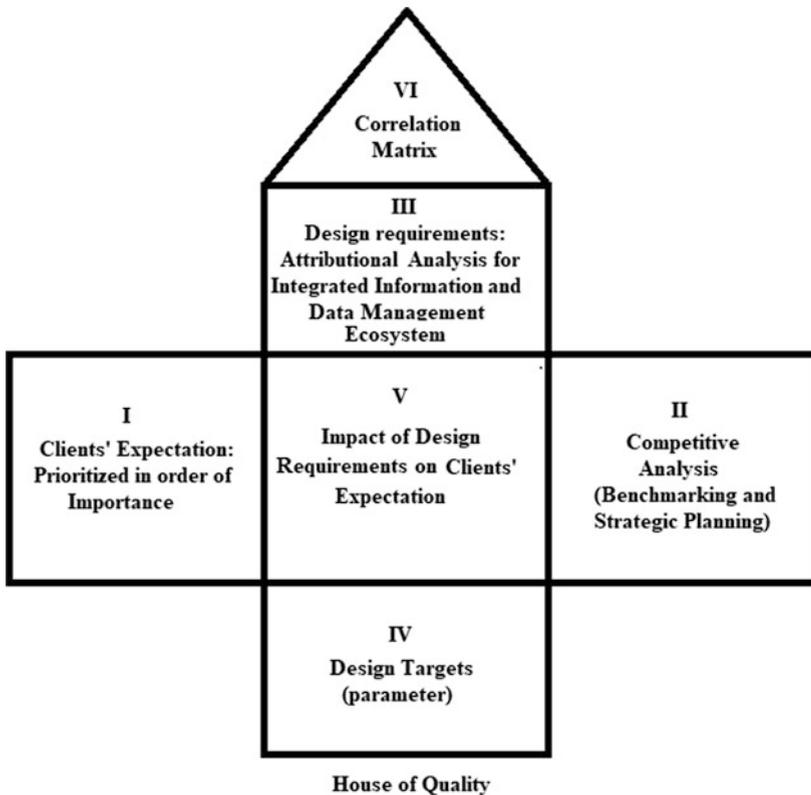


Fig. 14.1 Schematic diagram for rationalizing Integrated Information and Data Management Ecosystem. Developed by the Authors

The holistic development in the process of collectivism without diluting individual identity would have been the ultimate goal of effective and efficient Data Management Ecosystem. The degree of optimization of such process would determine the growth rate of Human Development Indicators. The ‘Schematic Decision Box’ has been depicted above to understand the depth and locus of Transparency and Disclosure that essentially prescribes for effective and efficient Integrated Information and Data Management Ecosystem.

14.5.2 Analysis—II

Abundance reserve of information and its on-time accessibility may be deemed as the most precious resource in the knowledge economy. The 4IR has empowered the society with the application of IoT that can be guided by developing Non-Human Intelligence through continuous Machine Learning (ML) protocol. The 4IR era enables the system that can interact with each other and analyse big quantum of data which may be collected on real-time basis. It is the high time to integrate and incorporate all the functional KRAs (Key Result Areas) that need to be blended to form a comprehensive ecosystem with the intervention of IoT infrastructure. The functional KRAs are to be embodied in the spirit of Quality Function Deployment (QFD).



The basic structure of QFD as explained in above figure essentially depicts how the QFD system operates in consonance with the voice of customer and the voice of organization divulging the spirit of Competitive Analysis. The relationship matrix helps to identify the designed targets.

The proposed model indicatively may comprise of the following functional KRAs (Fig. 14.2):

- **Real-time Information Recording System:** The devised framework would be able to collect record and retrieve all sort of valued information including research outcomes in the form of formula, copyright or patent etc., on real-time basis with the exposure of IoT led ecosystem.
- **Information Security Protocol and Client-Server Architecture:** The proposed model would instil appropriate Information Security Protocol so that the database would not corrupt or lose due to any malware attack. The system should have high precision 'Client-Server Architecture' so that it ensures free flow of data without any redundancy unless strategically entangled with limited access.
- **Interactive Protocol to develop Artificial Intelligence (AI) and Machine Learning (ML):** The designed framework would conceptually be reinforced in

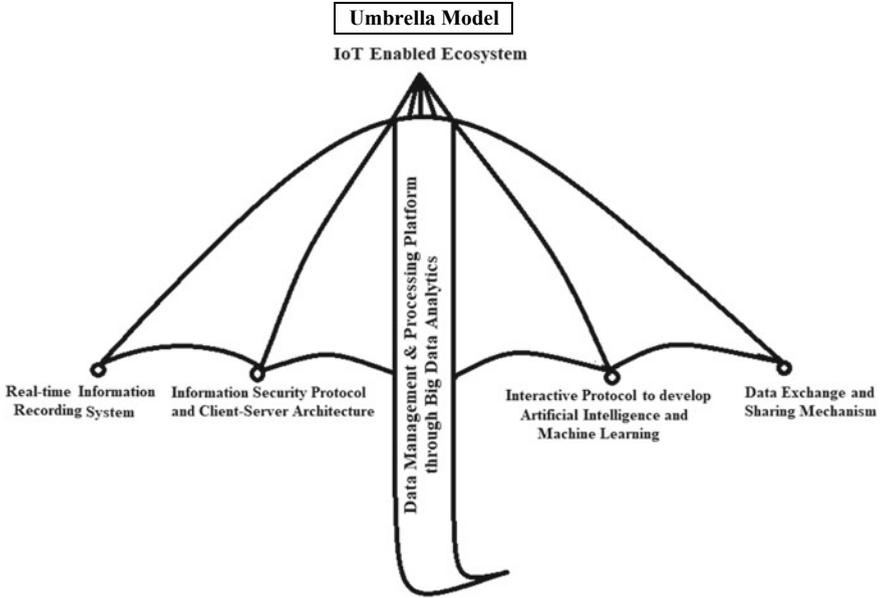


Fig. 14.2 QFD approach for Integrated Information and Data Management Ecosystem: Umbrella Model. Developed by the Authors

such a fashion that the various entities interact with each other at the fullest synergy of permutations and combinations to retrieve meaningful indications/predictions. The system may be allowed to expose with AI augmented with continuous ML exercises.

- **Data Exchange and Sharing Mechanism:** The purpose of this model is to ensure that all the clients should be able to access, share and exchange the information at the fullest of capacity. This functional KRA would enable to optimise the essence of coordination, consolidation and collaboration among all the stakeholders with the optimum utilization of effective and efficient Data Management System.
- **Data Management and Processing Platform through Big-Data Analytics:** All these KRAs would converge to experience real-time and meaningful interpretation so that the broader dimension of Big-Data Analytics i.e., Descriptive, Predictive and Prescriptive could be achieved holistically for the dynamic problems emerged into the real-life situation. All these competing priorities could be manifested as a fusion of Umbrella Modelling as presented below.

In fact, the QFD approach is of paramount importance in designing an Integrated Information and Data Management Ecosystem. The Quality Functions or the KRAs are to be identified, strengthened and the dynamic form of interactions among the KRAs would create Non-human Intelligence.

14.5.3 Analysis—III

14.5.3.1 Opportunities

The Integrated Information and Data Management Ecosystem has enormous demand for transforming India in terms of economic development, R& D and all other Value Chain functions. The state has concentrated to excel its data infrastructure particularly at the pretext of 4IR. The Union Ministry of Company Affairs, India recently announced to incorporate AI into MCA21 e-Governance service which will make compliance and registration procedures easier. Moreover, it can play a vital role in resolving conflicts as well [28]. The indicative Opportunity Matrix for this Data Revolution System may be identified as follows:

- i. Mobile penetration and internet access have been increasing in an incremental rate in India and Mobile Internet has become the pioneer in the access of internet service across the nation. The popularity of Direct Benefit Transfer (DBT) through Aadhar-based Biometric Smart Card has proved successful in Andhra Pradesh [29]. The Integrated Information and Data Management Ecosystem may lead to a massive transformation in the lives and economy of the regions which are remote and away from the central developmental trajectory.
- ii. There is a growing trend for emphasizing on Corporate Disclosure in the country which may create gigantic opportunities for comprehensive Data Management System.
- iii. In government system, RTI Act 2005 has opened and introduced the process of compulsory information flow on demand of every citizen of the nation. Thus, the Act enforces the government departments to collect, preserve and disseminates the information. However, there is no such Act for Corporate Bodies. The Integrated Information and Data Management Ecosystem would enable to synthesize all sorts of data that necessarily include the basic information of the corporate without intervening the key issues like Patent, Copyright, Business/Trade Secrets etc.
- iv. The growing popularity, adaptability and application of IoT have mesmerized the academician researchers and even the users of young generations which essentially creates a platform for sharing multiple and high magnitude of dataset in the public domain or open access forum. If the valuable information is integrated, this could lead the society with fascinating experience and illuminating features.
- v. Cutting-edge research depends on the voracity, quality and reliability of dataset and its continuum of data flow. This Pull Strategy would promote the culture and capacity for creating such high-end data infrastructure in the India and across the globe.

14.5.3.2 Challenges

In any study or research, the Opportunity Matrix determines the ease and expectancy mode of any model. But the future expectancy constructs must be complemented and supported by continuous form of tangible and intangible resources. One of the most vibrant factors may be the role of users and the commoners to make it successful. In Indian context, there are few indicative challenges or rather constraints that need to overcome. A subset of challenges are highlighted below:

- i. The country suffers from the lack of infrastructure facilities. As 68% of Indians rest in villages [30], it is difficult to bring them in the ambit of the sophisticated and high-end Data Management Ecosystem unless equitable infrastructural development takes place. However, it requires huge investment of financial resources. It is up to the nation to decide on the competitive priorities, that is, what extent the government is committed to value the essence and aspirations of developing Integrated Information and Data Management Ecosystem. Even if all the state and non-actors are unanimous to achieve such landmark, it is practically impossible to develop equitable infrastructure across Pan India within a smaller time frame. The government has been taking initiative consistently. The hallmark of ‘Bharat Nirman (2005–09)’ initiatives were witnessed to develop the rural infrastructure primarily in irrigation, roads, housing, water supply, electrification and rural telephony [29]. The trend has been fuelled and continued by subsequent governments through their various policy interventions.
- ii. India still suffers from adequate competency on a single language platform as it is difficult for the multi-lingual society to learn and practice on English language. The proposed Data Management System may be useful if majority of Indians can read and understand in English language.
- iii. The initial investment of such prototype or framework is associated with high cost implementation and that needs to be absorbed by the state and non-state multi-stakeholders.

14.6 Recommendations

The paper has demonstrated how the historical data as well as real-life information and knowledge system can be recorded, preserved, accessed and optimized so that every stakeholder of economy may excel in a mutually benefitting and collaborative manner. The development of 4IR has created enormous opportunity and genuine demand for creating dynamic database infrastructure which would be expected to interact arbitrarily as a form of AI. The implication of this paper may be conceived with the notion how the various forms and facets of data platform can be conjugated, integrated and inter-linked to create an Umbrella-shaped morphology.

14.7 Limitation of the Study

The study intends to formulate a dedicated model for integrating Information and Data Management Infrastructure based on available research inputs and existing frameworks. The model needs to be implemented in a test region i.e., a small district or sub-division where the robustness of the model may be verified. The emerging attributes or concerns during this experimentation process may be explored, identified and incorporated with the existing model framework. Thus, the information ecosystem can be strengthened through continuous development process. However, the model has not been trialed as its present form.

14.8 Conclusion

The world has been progressing through information age where big data analytics has become prolific leader of the millennium. The synergy and synthesis of Artificial Intelligence (AI) based on both panel data and real-life information is the future of our society. The transition and transformation of new generation technology and scientific application essentially depends on the momentum, magnitude and the quality of data storing, preservation, analysis and interaction process through experiential learning and QFD of all the attributes and entities. The fusion of such heterogeneous modalities in a most coherent framework for achieving Integrated Information and Data Management Ecosystem has become the call of the day which needs to be augmented both for developing and developed nations.

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