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Wheeling Big Data Articulations – Exploring Connections between Multiple Digital Ecosystems in Real Time

Short Paper

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Abstract

The world comprises of multiple ecological systems that vary in size and shape in spatial and temporal dimensions. In recent years, digital health has uncovered connectable coexisting ecosystems, including the most contagious healthcare conditions embedded within human and environmental ecosystems in different spatial dimensions. For example, the current pandemic and associated environments have created havoc worldwide on mental health and human wellbeing. The connectivity between human wellbeing, mental health and environmental ecologies can thus construe and leverage the change in human behaviors, including the movement of human habitat in its entirety in spatial dimensions. Real-time monitoring of human health and environmental events is necessary, for which we envisage the wheeling of big data articulations while mapping and modelling global ecosystems. Besides, the Big Data application collaborates with ecological events to underpin the persistence of human wellness in different biodiversity and make decisions on resource conservations in varying environmental changes. The connectivity between diverse ecologies can assess the interactions between elements and processes of systems, technological communities, and human habitats. The authors consider Big Data paradigm, design science research and domain application development to ascertain the connectivity between ecological systems. Attribute Journey Mapping and Modelling (AJMM) of ecological Big Data can add value to the knowledge of functional relationships and their interpretations, previously unknown and hidden in large volumes and varieties of data scattered in geographic dimensions.

Keywords: Big Data Wheeling, Digital Ecosystems, Design Science, Ontologies, IohT

Introduction and Purpose of Research

Our revolving planet Earth drives diverse coexisting ecosystems in geographic dimensions (Kim and Kotze, 2021). These ecosystems represent numerous volumes and varieties of digital data. In current contexts, a digital ecosystem is a community technology with groups of interconnected domains and systems guided by big data sources (Nimmagadda et al. 2016, 2020, 2021; Abbasi et al. 2016). The community can function as a composite ecological entity with interrelated multidimensional attributes deduced from Big Data sources. Integrating volumes and varieties of Big Data in multiple domains has become challenging in digital ecosystem management. The challenge is added with data heterogeneity, multidimensionality, and the complexity of digital ecosystems inherited, for example, by a phenomenon of embedded human, health (disease), and environmental systems. Embeddedness can be interpreted as the coexistence between multiple ecosystems and identifying the interactivity and "living together" phenomena is much-needed research. Though each ecosystem is explicit, the connectivity phenomenon between these systems is implicitly interpreted. Sustainability is another multifaceted phenomenon with composited relationships among geographically scattered Human, Health, and Environment (HHE) ecosystem communities, each ecosystem explicitly affecting the other. Strong interactions may coexist between the ecosystems through their elements and processes with sharp inherent boundaries. In addition, ecosystems can exhibit implicit discontinuities and overlaps between system boundaries in various scales and dimensions. These multi-scalable and multidimensional, multidirectional ecosystems (including spatial ecologies) can manifest an association based on a commonality of basic structural units and domains (Dakubo, 2010). Understanding the connectivity between multiple ecosystems can benefit from cognizing the ecosystems' sustainability. The research aims to explore the application of Big Data articulations and assess the digital divide between numerous human, healthcare, and environmental ecosystems. Interpreting connectivity phenomena between multiple coexisting ecosystems in new knowledge domains is an additional research purpose.

Research Significance and Motivation

Big Data modelling and analytics can facilitate major producing and service companies to explore new business opportunities, including efficient operations with happier healthcare clients. The research can add value to the customers and motivate them to acquire new customers with medium and large entrepreneurial skills. Big Data can adapt to competitive business environments, including decision support systems.

Research Methodology and Modelling Framework Development

A sustainable framework theory is needed with conceptual Information Systems (IS) construct designs to uncover the phenomena of connectivity between systems and implement them in multiple ecosystem contexts through a theorization process (Peffers, et al. 2007 and Hasan et al. 2019). Besides, specialized domain ontologies interpreted for every ecosystem can be vital in building relationships through various multidimensional attributes (Nimmagadda et al. 2022).

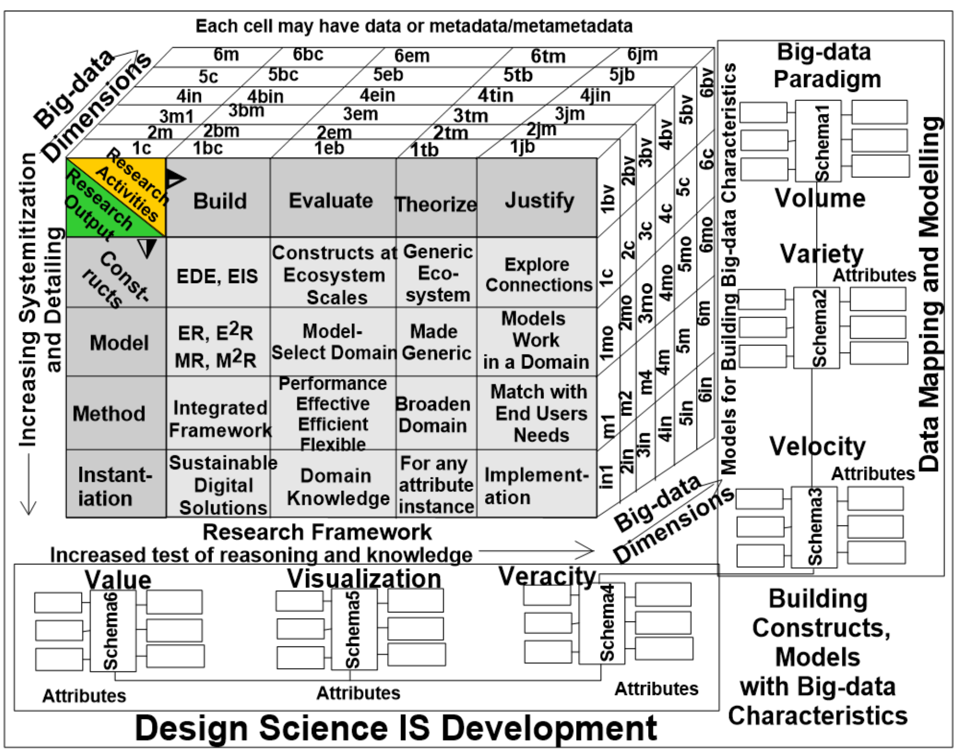

Figure 1: Big Data guided Design science information system framework development.

The authors develop Big Data-guided IS articulations for unifying and analyzing digital ecosystems within a sustainability framework. In the theorization process, the Design Science Guided Information System (DSIS) framework can bring multiple ecosystem contexts into a common platform and put them into practice with deliverable ecological products and services globally (Figure 1). The authors aim to generate new IS artefacts, interfaces, and agents in the integrated framework development, enabling easy access to ecological information by extracting and analyzing data views to create cognitive knowledge from fine-grained ecosystem metadata.

Data Collection Methods in Ecosystem Contexts

Several attribute dimensions are identified as relevant to human, disease, and environmental ecosystems and their enormous volumes and variety of data sources. For example, sensors placed in different geographic locations to observe earthquakes during disaster management or monitor patients' critical data during healthcare management are good examples of acquiring real-time data. Monitoring climate changes and global warming are different attributes, and their instances can be observed in real-time in spatial dimensions. Big Data always involves spatial attribute dimensions, implying that data represent several volumes of tera bytes with hundreds of varieties of data sources. Big Data systems drive the ecosystems, including the healthcare ecosystems envisaged and interpreted in spatial dimensions. Several software and hardware resources are involved in acquiring ecosystem data (Figure 2a). Kelly et al. 2019 and Dang et al. (2019) have discussed healthcare challenges through IohT and cloud computing platforms.

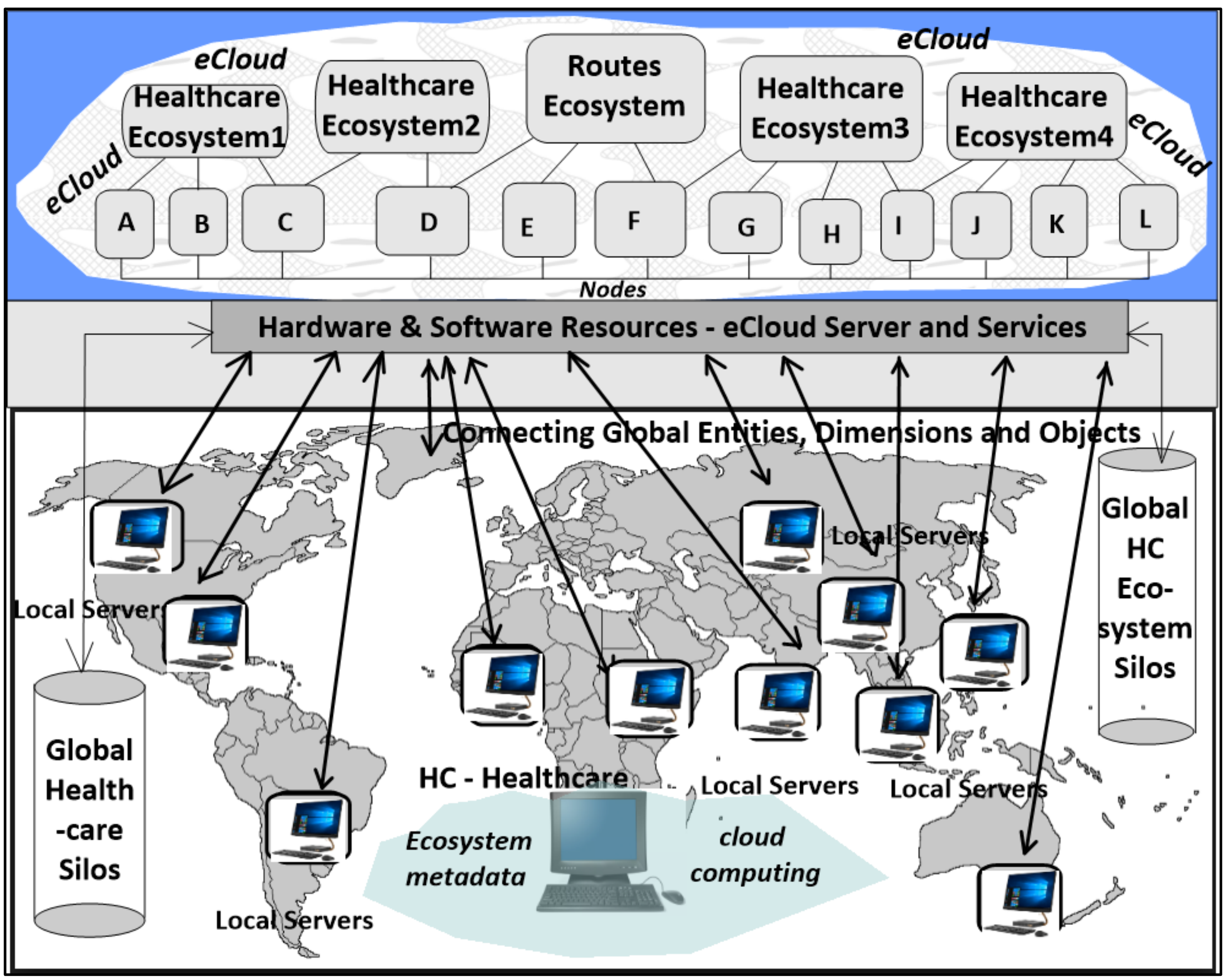

Figure 2a. Acquisition of healthcare ecosystem data sources – metadata cloud computing

As shown in Figure 2b, data acquisition is more straightforward; the authors can acquire the type of data based on the requirements and needs of Big Data paradigm that best fits the application domain. We have articulated several characteristics of Big Data and their linked attribute dimensions to map and model the ecosystem data and how they can be stored in multidimensional cuboid data structures or repositories. Wheeling of big data characteristics is demonstrated with connectable attribute dimensions, anomalies created due to scales, overlaps and boundaries between multiple ecosystems, as envisaged by human, healthcare, and environmental ecosystems.

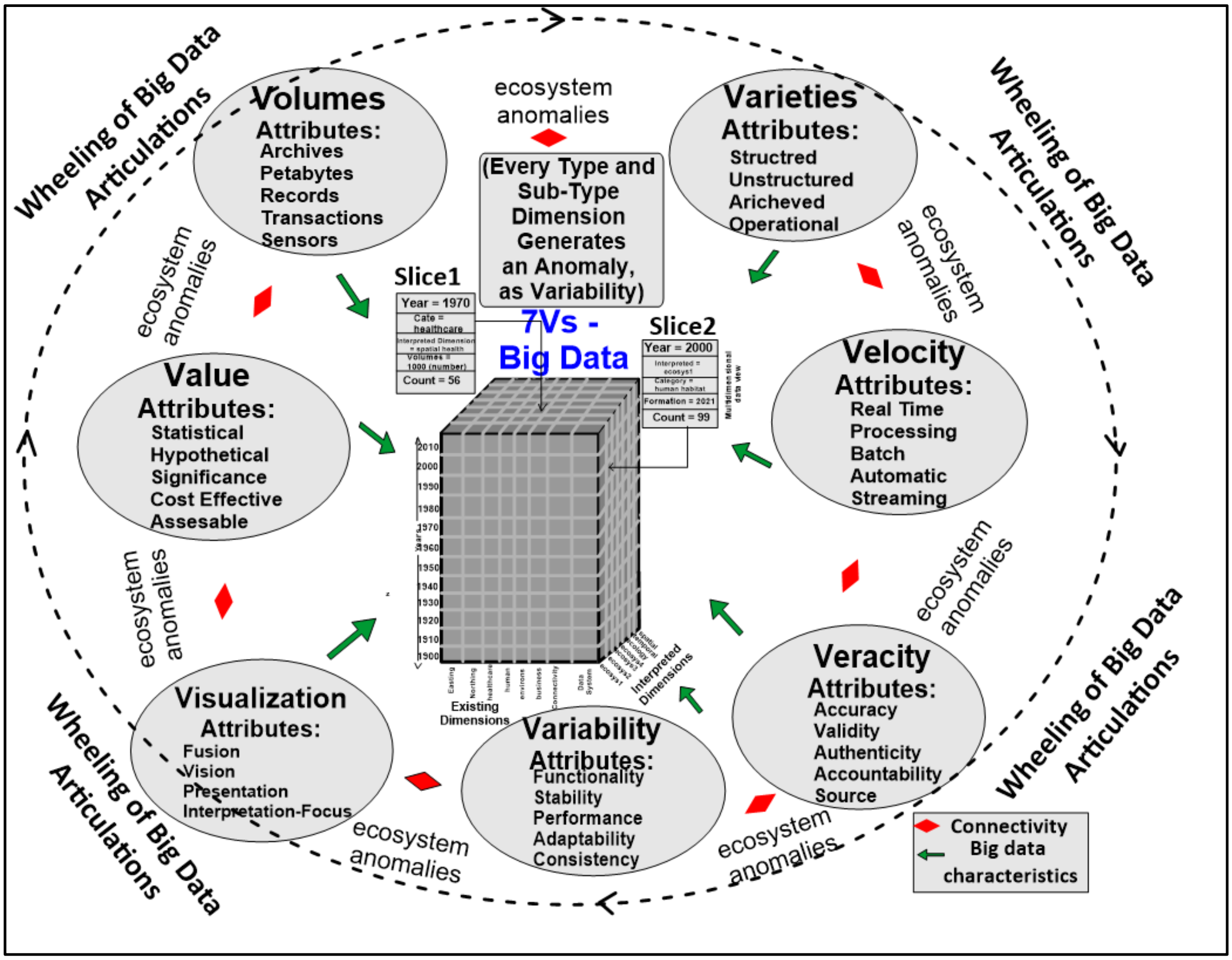

Figure 2b. Wheel of Big Data Architecture – Connecting various characteristics (big data computing from Figure 2a).

Research Findings

The analysis of multidimensional data and their connectivity in multiple domains demands an ontological cogency between various attributes to examine the uniqueness of ecosystem data for its data science. The new knowledge of ecosystem connectivity can contribute to attainable, sustainable new knowledge on system alliances and make them more ecologically functional. The integration across domains can significantly minimize the risk of ambiguity of knowledge construed by a single method of interpretation. Methodologies can facilitate generating new insights, ameliorating sustainable ecologies robustly and holistically. Assessing benchmarks and analyzing the impacts of Big Data procedures can further motivate us to know the multidimensional sustainability-informed management of ecosystems globally at micro, meso and macro levels. The authors resolve the ecosystem complexities of Human, Health, and Environment (HHE) ecosystem communities through DSIS applications, including qualitatively and quantitatively analyzing the IS-guided multidimensional digital ecosystem metadata through Attribute Journey Mapping and Modelling methodologies.

Research Implications

Digital ecosystems, in spatial dimensions, are constantly evolving and changing our perception, including knowledge of the shape and size of the landscape of the ecosphere. Implementing a research framework with the support of Big Data enables us to understand the implicit knowledge of scalable connections between multiple ecologies, besides demonstrating the usability and interoperability properties of IS artefacts with explicit design science knowledge. Understanding human behavior within contiguous environs and their effects on human wellness can benefit ecosystem service providers, scientists, and collaborators who wish to integrate with information science researchers. As an example, we have built data relationships between various attributes of multiple ecosystems through connectable schemas (Figure 3).

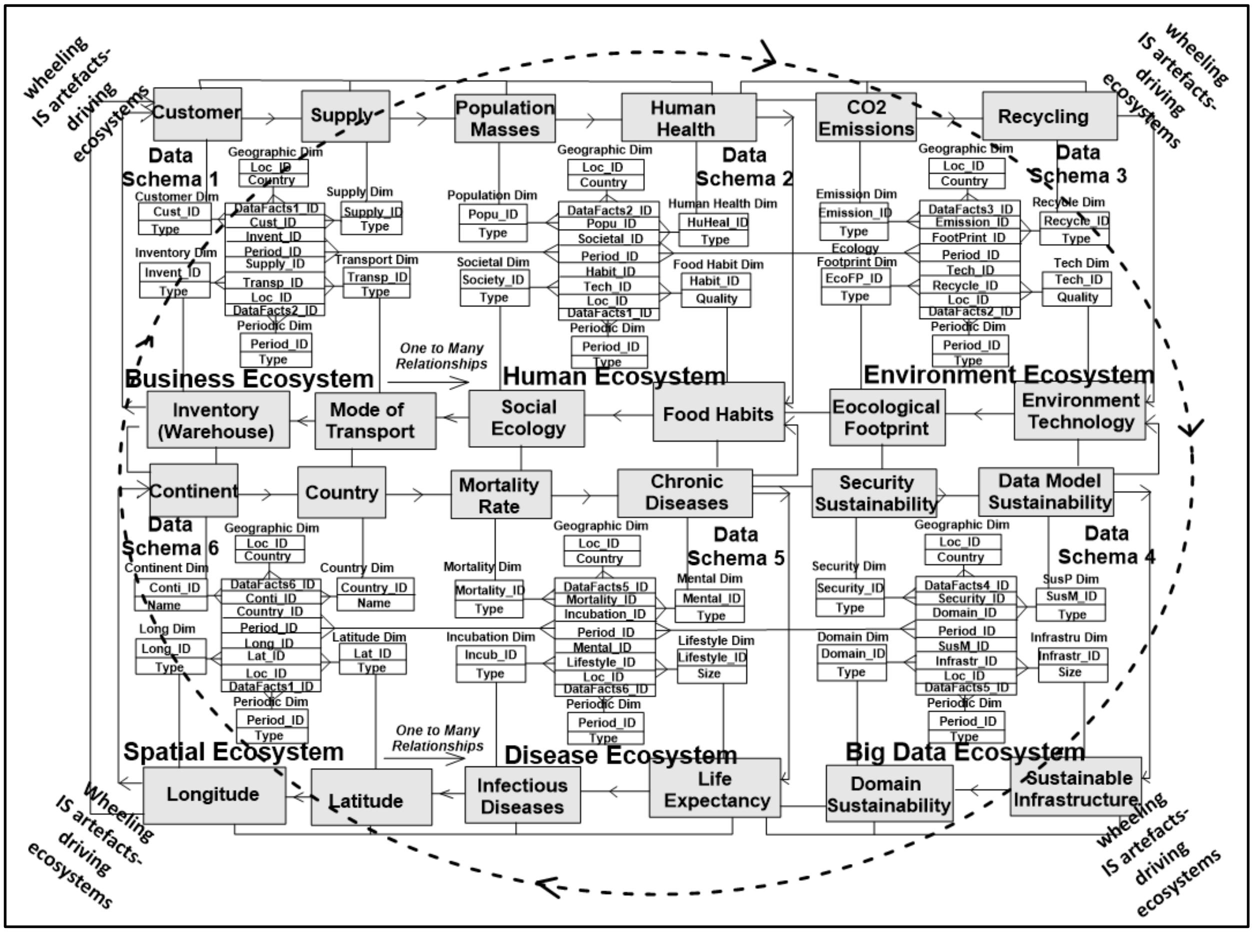

Figure 3. Information System (IS) artefact development – formulating multidimensional attributes through connectable data artefacts.

Several researchers have considered domain ontologies to interrelate or interconnect multiple attributes deduced from multiple domains and systems. For example, observing healthcare data instances in spatial dimensions and real-time conditions can attribute and support Big Data for decision-making in healthcare systems. These ontologies demonstrate the involvement of multiple digital ecosystems and their connectivity, cognitively facilitating Big Data analytics and ecosystem knowledge interpretation (Figure 4).

Building ontologies between attribute dimensions of multiple ecosystems can allow us to understand and add the relationships between the characteristics of the Big Data and their models (Kitchin and McArdle, 2016 and Antunes et al. 2022). In addition, ontologies can affect the data mining, visualization, and interpretation of ecosystem data, including the data science of spatial ecosystems and the adaptation of big data-driven decisions (Provost and Fawcett, 2013). Nimmagadda et al. (2022) have discussed the significance of developing sustainable digital ecosystems and their spatial-temporal knowledge. The authors have built the relationships between attributes of spatial and healthcare ecosystems to demonstrate the connectable events that are manageable by AJMM methodologies (Figure 4). Similar ontologies can be built for coexistent ecosystems usable by IohT tools and technologies.

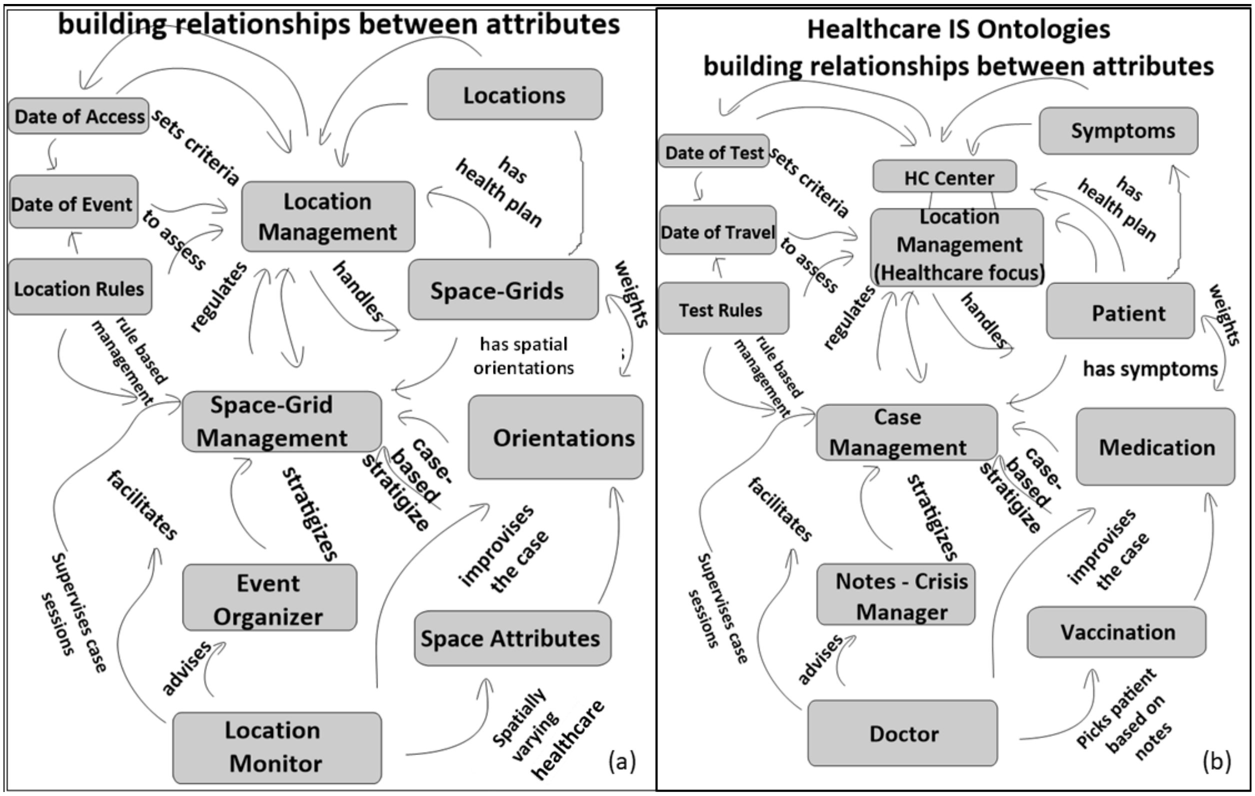

Figure 4. Building ontologies making attribute relationships and connecting healthcare events with spatial ecosystem.

Practical Implications of the Research

Easing the complexity of individual human, disease and environmental ecosystems and their integrated networks and visualizing unknown inherent knowledge of connectivity between the coexisting ecological influences are practical implications of the research. In addition, the usability of IS artefacts and ascertaining their evaluable interoperability utility property in ecological spaces are other research inferences.

Based on the IS articulations made in Figures 1-4, we have formulated a framework for implementing the Big Data architectural features (Figure 5). We have described the following stages of Big Data implementation:

(1) Data Acquisition: IoT tools and sensor technologies can make real-time big data acquisition through monitoring human activities, contagious and human wellness events, and the coexisting environmental events, including climate change measures supportive of mapping and modelling large-size global events.

(2) Identifying entities and dimensions and building relationships: Entities, dimensions and objects of various ecosystems are identified to build ER, dimensional and object-oriented models in support of mapping and modelling the attributes associated with multiple ecosystems considered in the study.

(3) Big Data Characteristics: Various features of big data are interpreted to collaborate with mapping and modelling tasks.

(4) *Ontology Structures:* These structures are responsible for building and formulating relationships between various attributes of human, healthcare, and environmental ecosystems. In addition, the relationship attributes are connectable in the mapping and modelling healthcare ecosystems and their concurrent ecological features.

(5) *Mapping and Modelling*: Various attribute features documented in the previous tasks are mapped and modelled using various graphic and mapping tools of Big Data paradigm (Figure 5).

(6) *Multidimensional Repository Design*: An integrated ecosystem metadata is created and stored in a repository system to organize further data mining tasks, interactive visualization of data views and their new knowledge interpretation.

(7) *Data Mining, Visualization, and Interpretation*: Data views are extracted from ecosystem metadata for visualizing and interpreting them for new knowledge of ecosystem products and services.

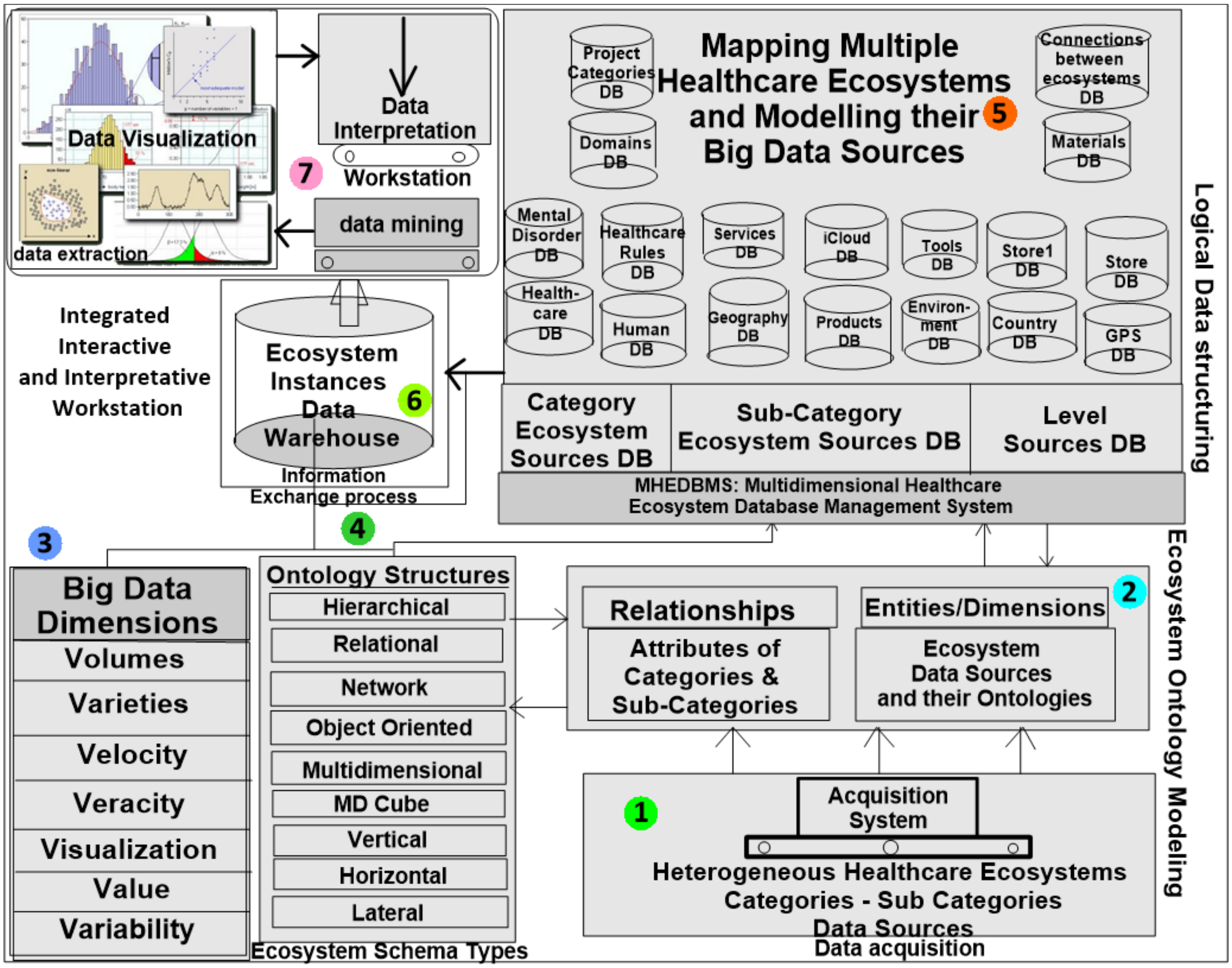

Figure 5. AJMM Framework for implementing the ecosystem architectures (as described in Figures 1-4).

Future Work and Research Audience

Research is ongoing, and we intend to implement the framework discussed in Figure 5 in different ecosystem contexts, ascertaining the role of wheeling of Big Data architectures in assimilating new knowledge of ecosystems with deliverable services and products. Healthcare professionals, Big Data enthusiasts, data scientists, and ecosystem service providers are the beneficiaries of the research.

References

Abbasi, A., Sarker, S., and Chiang, R. H. (2016). Big data research in information systems: Toward an inclusive research agenda. *Journal of the association for information systems*, *17*(2), 3.

Antunes, A. L., Cardoso, E., and Barateiro, J. (2022). Incorporation of Ontologies in Data Warehouse/Business Intelligence Systems - A Systematic Literature Review, International Journal of Information Management Data Insights, Volume 2, Issue 2, 2022,100131, https://doi.org/10.1016/j.jjimei.2022.100131.

Baskerville, R., Davison, R., Kaul, M., Wong, L. (2014). Designing Artefacts for Systems of Information. In: Doolin, B., Lamprou, E., Mitev, N., McLeod, L. (eds) Information Systems and Global Assemblages. (Re)Configuring Actors, Artefacts, Organizations. IS&O 2014. IFIP Advances in Information and Communication Technology, vol 446. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-45708-5_15.

Bharadwaj, A., Sawy, O. A., Pavlou, P. A. and Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights, MIS Quarterly, Special Issue: Digital Business Strategy.

Briscoe, G., Sadedin, S., & De Wilde, P. (2011). Digital Ecosystems: Ecosystem-Oriented Architectures. *Natural Computing, 10*, 1143-1194.

Ceccaroni, L. and Felipe, L. O. (2012). Ontologies for the design of ecosystems. Universal ontology of geographic space: semantic enrichment for spatial data. 207-228.

Creswell J. W. (2014). Research design: qualitative, quantitative, and mixed methods approaches / John W. Creswell. — 4th ed. 2014 by SAGE Publications, Inc.

Dang, L. M, Piran, M. J, Han, D, Min, K, Moon, H. A (2019). Survey on Internet of Things and Cloud Computing for Healthcare. *Electronics*. 2019; 8(7):768. https://doi.org/10.3390/electronics8070768

Dash, S., Shakyawar, S.K., Sharma, M. *et al*. (2019). Big data in healthcare: management, analysis and future prospects. *J Big Data* **6**, 54 (2019). https://doi.org/10.1186/s40537-019-0217-0.

Dakubo C. Y. (2010). Exploring the Linkages Between Ecosystems and Human Health. *Ecosystems and Human Health: A Critical Approach to Ecohealth Research and Practice*, 3–19. https://doi.org/10.1007/978-1-4419-0206-1_1.

Hassan, N. R., Mathiassen, L., and Lowry, P. B. (2019). The process of information systems theorizing as a discursive practice. *Journal of Information Technology*, *34*(3), 198–220. https://doi.org/10.1177/0268396219832004

Hevner, A. March, R., Salvatore T., Park, J. and Ram, S. (2004). "Design Science in Information Systems Research," *MIS Quarterly*, (28: 1).

Kitchin, R., and McArdle, G. (2016). What makes Big Data, Big Data? Exploring the ontological characteristics of 26 datasets. *Big Data & Society*, *3*(1). https://doi.org/10.1177/2053951716631130.

Kelly, J. T, Campbell, K. L, Gong E, Scuffham, P. (2019). The Internet of Things: Impact and Implications for Health Care Delivery J Med Internet Res 2020;22(11):e20135 doi: 10.2196/20135 PMID: 33170132PMCID: 7685921.

Kim, R.E. and Kotzé, L.J. (2021). Planetary boundaries at the intersection of Earth system law, science and governance: A state-of-the-art review. RECIEL, 30: 3-15. https://doi.org/10.1111/reel.12383.

Nimmagadda, S. L., G. Burke, and Reiners, T. (2016). "On big data guided embedded digital ecosystems (EDE) and their knowledge management," *2016 IEEE 14th International Conference on Industrial Informatics (INDIN)*, Poitiers, France, 2016, pp. 1312-1319, doi: 10.1109/INDIN.2016.7819370.

Nimmagadda, S. L. Namugenyi, C. Mani, N. and Reiners, T. (2020). "Managing Embedded Digital Ecosystems in Pandemic Big Data Contexts" (2020). *ACIS 2020 Proceedings*. 49. https://aisel.aisnet.org/acis2020/49.

Nimmagadda, S. and Dengya, Z. and Namugenyi, C. and Mani, N. and Zhu, D. (2021). Digital Web Ecosystem Development for Managing Social Network Data Science. In: Australasian Conference of Information Systems (ACIS), 6th Dec 2021, Sydney, Australia.

Nimmagadda, S., Reiners, T., Wood, L., & Mani, N. (2022). On Developing Sustainable Digital Ecosystems and their Spatial-temporal Knowledge Management. ACIS 2022 Proceedings. 20. https://aisel.aisnet.org/acis2022/20.

Peffers, K., Tuunanen, T., Rothenberger, M. A. and Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research, *Journal of Management Information Systems*, 24:3, 45-77, DOI: 10.2753/MIS0742-1222240302.

Provost, F., and Fawcett. T. (2013). Data Science and its Relationship to Big Data and Data-Driven Decision Making. Big Data. Mar 2013.51-59.http://doi.org/10.1089/big.2013.1508.

Venable, J., Pries-Heje, J. and Baskerville, R. (2016). FEDS: A Framework for Evaluation in Design Science Research. *Eur J Inf Syst* 25, 77–89 (2016). https://doi.org/10.1057/ejis.2014.36.