

RESEARCH PAPER

Open Data for Sustainable Development on a Knowledge-Based Economy: The Case of Botswana

Oarabile Sebubi, Irina Zlotnikova and Hlomani Hlomani

Department of Computer Science and Information Systems, Botswana International University of Science and Technology, Palapye, BW

Corresponding author: Oarabile Sebubi (mmaseb@hotmail.com)

A review of sustainable economic development perspectives reveals a lack of data-driven approaches that meet the needs of knowledge-based economies. This paper presents a conceptual design artefact, a theoretical framework that maps the open data pathway toward the achievement of a knowledge-based economy and sustainable economic development with a specific reference to Botswana. The proposed framework models the transition from open data to open knowledge. It further establishes the potential impact of that transition on the realisation of a knowledge-based economy, sustainable economic development, and the attainment of a knowledge society. The method adopted in the development of the framework involves three processes: 1) review of literature on key research concepts; 2) identification of relationships between research concepts; and 3) design and development of the proposed open data framework. The proposed framework will serve as a point of reference in open data-driven economic transitions and transformations in Botswana. This design artefact can be customised to meet the economic needs of other developing countries.

Keywords: open data; open knowledge; knowledge-based economy; knowledge society; sustainable economic development; botswana

1. Introduction

1.1. Background

The national strategic direction for Botswana, Agenda 2036, details Botswana's sustainable economic development aspirations of transforming to be a knowledge society founded on a knowledge-based economy (Vision 2036, 2016). Knowledge-based economies depend on the creation, dissemination and use of knowledge (OECD, 1996). Stehr (2012) defines knowledge as the capacity to act and an effectual vehicle for economic value creation (Filipović, et al., 2012). Knowledge-based economies are driven by inclusive knowledge, referred to as open knowledge. The Open Knowledge International (OKI) considers knowledge to be open if all have access to the information they need to comprehend and transform the world around them (OKI, n.d.). At the heart of open knowledge is open data (Aceel Medium, 2017). The Open Knowledge Foundation Network (OKFN) defines open data as any piece of content or data that is free to use, reuse, and redistribute for as long as appropriate credit is given to the originator (OKFN, n.d.).

Open data has potential in the achievement of Botswana's desire of being a knowledge-based economy and society, as well as attaining sustainable economic development as evidenced by the Botswana Open Data Readiness Assessment Survey (ODRA). The ODRA report unveiled that an open data program can contribute significantly to Botswana's innovation and economic aspirations. The report cites evidence of a nascent and innovative applications with ideas for ways in which open data could revolutionise key economic sectors, such as agriculture and tourism. The ODRA assessment has concluded that Botswana is open data mature as it has: 1) many of the key prerequisites for the successful implementation and benefit realisation from open data; 2) digitised many of the important datasets in preparation for open data move; and 3) the capability to easily extract data from other key systems through the e-Government program for publication of open data (World Bank Group, 2015). Despite this, both Agenda 2036 and the National Development Plan 11 (Agenda 2023) are not explicit on the open data position and contribution toward the achievement of sustainable economic development aspirations mentioned above.

From this introductory review, five concepts that are core to the design of the proposed framework were identified to serve as the focus of this research, being: open data, open knowledge, knowledge-based economy, knowledge society, and sustainable economic development.

1.2. The Need for an Open Data Driven Framework for Sustainable Economic Development on a Knowledge-based Economy

Open data can be leveraged to the attainment of a knowledge-based economy and sustainable economic development. Economic development is the process whereby the real per capita income of a country increases over a long period of time subject to a reduction in the absolute poverty line and fair income distribution (Edward, 1987). Sustainable economic development pertains to the maintenance of economic growth and dynamically efficient development patterns and the maintenance of a balance between optimal patterns of production, consumption, and trade change with standards of living (Ravago, et al., 2015). Currently, there is a lack of data-centric approaches to this effect. Some of the approaches that link sustainability to the environment advance the use of policies, regulations and incentives to induce environmentally rationale economic behaviour. Other approaches view sustainable economic development as the maximisation of goals across the biological and resource systems; the economic systems; and the social systems through an adaptive process of trade-offs (Edward, 1987). Therefore, on the basis of the potential of data in the attainment of sustainable economic development, there is a need for data-centric approaches to its realisation. Therefore, this research proposes a theoretical framework that maps the open data pathway toward the achievement of a knowledge-based economy and sustainable economic development.

2. Method

The framework was developed in 3 steps: 1) review of literature on key research concepts; 2) identification of relationships between these concepts; and 3) design and development of the open data framework.

2.1. Review of Literature on Research Concepts

A systematic literature review was conducted to determine the relationships between the key concepts of this research introduced in section 1.1. This approach is based on Kitchenham (2004) guidelines which entail the statement of research questions, search strategy, and research selection criteria. The generic research question was formulated as follows:

How can open data be leveraged for open knowledge toward the attainment of a knowledge-based economy and sustainable economic development?

This generic question was further divided into more specific sub-questions:

1. How does open data contribute to open knowledge?
2. How does open data contribute to a knowledge-based economy?
3. How does open data contribute to a knowledge society?
4. What is the relationship between a knowledge-based economy and a knowledge society?
5. How does a knowledge-based economy impact on the sustainability of economic development?

The key concepts in this research constituted search terms which were applied to a variety of resources: electronic databases; journals; grey literature (technical reports and work in progress reports); conference proceedings, and the Internet. The search strings were constructed using the 'AND' Boolean operator to extract articles that combine terms on the basis of the research questions:

- 'open data' and 'open knowledge';
- 'open data' and 'knowledge-based economy' and 'knowledge society';
- 'Knowledge-based economy' and 'knowledge society' and 'sustainable economic development'.

The inclusion and exclusion criteria were applied to scan the articles for relevance. Relevant articles satisfied any one of the following inclusion criteria: 1) an article that describes the relationship or linkage of the search terms; and 2) an article that describes one of the search terms in combination with any of the four concepts in this research. Irrelevant articles satisfied the exclusion criteria of containing the search terms in the search string but not necessarily focused on the description of the relationship, or linkage to each other.

2.2. Identification of Relationships between Key Concepts

This section presents a summary of research concepts' relationships. Open data is not by default open knowledge (Wang, 2017). In most cases, it is not in a format that developers can use to create applications (Asia Foundation, 2015). To qualify as open knowledge, open data has to be semantically structured and linked to support data integration, interoperability and reuse (Wang, 2017). It has to undergo transformation in which the datasets are cleansed and then converted to machine-readable formats which enable software developers to easily integrate into applications (Clarke & Harley, 2014).

Previous research works have discovered that open data is a shift towards knowledge-based economies (OECD, 2015); (Talaat, 2016). Juyeon et al., (2016) argues that in a knowledge-based economy, knowledge serves as the main driver of economic and innovation growth (Juyeon, et al., 2016). Knowledge-based economy is characterised by rapid and continuous changes in technology and innovation (Wessels, et al., 2017). They are also characterised by networks of national innovation systems; life-long learning, and effective infrastructures for global sharing of information (Juyeon, et al., 2016), (WSF, 2003). Knowledge-based economies depend on their ability to self-transform through successive waves of innovation and on developing regimes of consumption of products and services that service the infinitely variable identity construction demands of citizens (Hearn & Rooney, 2002). In the process of transforming the economy, the entire society is transformed as well into a 'knowledge society' (Civil Society, 2003).

Knowledge societies have an open approach to knowledge (UNESCO, 2013) and promotes the creation, access, utilisation, sharing and dissemination of information and knowledge by all so that they are empowered to improve the quality of their lives and to attain to their full potential (Civil Society, 2003). According to Stehr (2012), a knowledge society develops gradually and is transformed by the interaction and configuration of new technologies, data, needs, and imaginations, thus resulting in new innovations and possibilities. Therefore, the current open data mobilisation which is important in the establishment of knowledge societies is founded on a deep conviction of the potential value that can be derived from its inclusive use within a wider community (Wessels, et al., 2017). Knowledge societies are better positioned to achieve sustainable development due to their higher capability of achieving positive and lasting effects on economic prosperity (UNESCO, 2013). They are characterised by a combination of technological innovations, information and knowledge, and human creativity (UNESCO, 2013). At the heart of knowledge societies is a community of knowledge workers who exploit the knowledge to empower and enrich people, thus, cultivating sustainable societies (WSF, 2003). With the continuous free flow of information and knowledge, society is able to dynamically adapt to constant changes in the economic environment, finally achieving 'sustainable economic development' (Edward, 1987).

Sustainable economic development on a knowledge-based economy is characterised by open knowledge-driven development which is adaptive, and inclusive as well as continuous in growth (WSF, 2003).

In conclusion, open data is key to open knowledge which is crucial to the economic development of countries. It has potential to create conducive environment for the establishment of knowledge-based economies and the realisation of sustainable economic development. It has the potential to also facilitate the establishment of knowledge societies that have the ability to create, share and use knowledge to improve the well-being of the people and make them prosper. Knowledge-based economies and societies are characterised by an open knowledge cycle that revolutionises the way innovation, entrepreneurship and business is done. Specifically, they have created the notion of open knowledge, open innovation, open business and open entrepreneurship which serve as keys to inclusive and sustainable prosperity and wealth of nations. Therefore, as Botswana desires to be a knowledge-based economy, the key driver to the economic transformation that would yield Botswana that desired economic state is knowledge that is made available to all, thus creating a state of 'open knowledge'.

2.3. Design and Development of the Framework

The design and development of the framework was based on the relationships identified in section 2.2 above. The output of this step is the proposed framework in **Figure 1** which demonstrates a series of steps that constitute the open data pathway to the attainment of the knowledge-based economy and sustainable economic development.

3. Discussions

3.1. The Creation of Open Knowledge Resources

As illustrated in **Figure 1**, open data can be leveraged to create open knowledge resources, comprising of open knowledge bases and associated vocabularies. The open knowledge resources are created through the use of Semantic Web Technologies (SWTs) which offer the ability to import and transform the diversity of

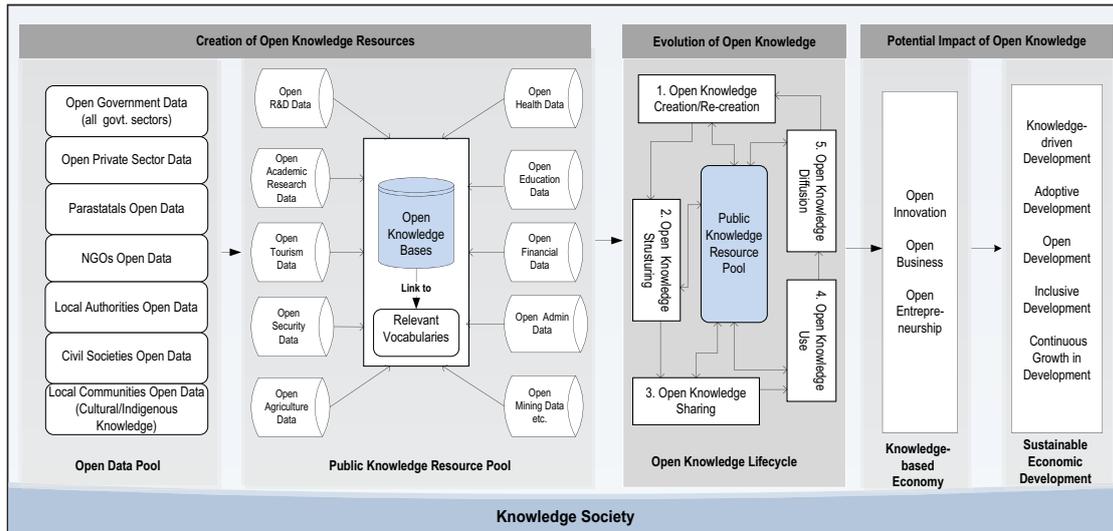


Figure 1: Open Data for Sustainable Economic Development (ODSED) Conceptual Framework (Evolution of Open Knowledge adapted from the generic knowledge lifecycle).

data from related but disconnected domains. These data which are in most cases published in static file formats (pdf, spreadsheets, and CSV) have to undergo transformation in which they are converted to a flexible format for publication, connection and interchange on the web, the Resource Description Framework (RDF). RDF data are then stored in RDF triple-stores which can be merged on the basis of relevant vocabularies, into a network of repositories that constitute the ‘Public Knowledge Resource Pool’.

3.2. The Evolution of Open Knowledge

The next step involves leveraging the open knowledge resources to create value. This is centred on the public knowledge resource pool and evolves through a lifecycle which comprises of the iterative processes of knowledge creation/re-creation, structuring, sharing, use, and diffusion. This iterative process flow enables a continuous reflection on the value and relevance of open knowledge. Leveraging on open knowledge resources involves the use of vocabularies to aid processing at each lifecycle stage.

Knowledge Creation/Re-creation: The public knowledge resource pool enables the creation and re-creation of knowledge. Knowledge creation is the production of knowledge in the form of new ideas, discoveries, products, applications, operations, discoveries, and services (Juyeon, et al., 2016). The public knowledge resource pool enables the integration of relevant datasets to create value, for example, a combination of datasets from the domains of finance, education, tax, security, water, electricity, human resources, health, investor, research, land, technology, transport, registration, and infrastructure gives insights on the Botswana market to potential investors. For knowledge to maintain value and relevance, it has to be updated to factor in current changes reflected in the latest pool of open data. Thus, knowledge re-creation represents the evolution of diffused knowledge (Evans, et al., 2014).

Open Knowledge Structuring: After the creation/re-creation of knowledge, it must be organised for easy retrieval and usage. The knowledge may be classified using a specific data structure (vocabulary) for ease of retrieval such as controlled vocabularies, taxonomies, thesauri, and ontologies. There are numerous ways of structuring knowledge, such as indexing, clustering, cataloguing, filtering, and codifying (Sagsan, 2006).

Open Knowledge Sharing: Knowledge structuring makes it easy to communicate and share knowledge. For instance ontologies create a common understanding of the data for ease of sharing and interoperability.

Open Knowledge Use: Once shared, knowledge can then be used and its value can be realised in efficiency improvement, problem solving, decision making, and innovative thinking activities (Evans, et al., 2014). The knowledge may be embodied into various models, systems and processes for production (Chungoora, n.d.). It may also be encapsulated in a prototype, or for a process made part of organisational procedures (Skyrme, 2011). Vocabularies increase the usability and value adding potential of the data by enabling common data definitions in a given domain and supporting data integration and interoperability.

Open Knowledge Diffusion: The diffusion of knowledge describes the spread of knowledge to the point that it becomes a public asset (Birkinshaw & Sheehan, 2002). That is, the openly shared knowledge is widely understood and spread to its consumers. In a competitive environment, once the market is saturated with a given set of knowledge, there is need to re-create it so as to earn some competitive advantage.

3.3. The Potential Impact of Open Knowledge

Open knowledge is the main driver of sustainable economic development in a knowledge-based economic environment. An economy dependent on the Knowledge creation/re-creation, sharing, use and diffusion is identified in this model as a 'knowledge-based economy'. A Knowledge-based economy, characterised by a free flow of information, fosters open innovation by enabling the creation of interlinkages to external sources of knowledge, thus enabling the expansion of the innovation output and its impact, and the opening up of new markets which are otherwise inaccessible (Ramos, et al., 2009). Open innovation results in an open market environment that enables openness in both entrepreneurship and businesses operations (Aceel Medium, 2017), all of which are critical to the realisation of sustainable economic development. Sustainable economic development is characterised by knowledge-driven development, adaptive development, open development, inclusive development and continuous growth in development. These knowledge-based transitions and transformations result in the attainment of a knowledge society whose livelihood is entirely depend on the continuous process of knowledge creation, sharing, use and diffusion. That is, the knowledge-based economy is the economic structure of a knowledge society.

4. Conclusions & Recommendations

The pool of data that is often publicly declared as *open data* has to undergo some transformations and restructuring in order to contribute to the open knowledge bases of a country. The open knowledge bases constitute the public knowledge resource pool thus fostering open knowledge. Open knowledge evolves around the open knowledge lifecycle which comprises of the iterative processes of knowledge creation, structuring, sharing, use and diffusion. Open knowledge serves as a basic component of a knowledge-based economy that enables open innovation, business and entrepreneurship. In turn, a knowledge-based economy founded on open knowledge achieves sustainable economic development which is characterised by knowledge-driven, adoptive, open, and inclusive development that is continuously growing at the same time. The kind of society that relies on open knowledge to achieve and sustain their economic development is identified in this framework as a knowledge society.

This paper concludes that the open data pathway modelled by the framework would assist Botswana and other developing countries in the endeavour to attain to a knowledge-based economy and to achieve sustainable economic development. This necessitates capacity building in numerous dimensions such as the development of relevant skills, infrastructure, systems and policies.

Competing Interests

The authors have no competing interests to declare.

References

- Aceel Medium.** 2017. *Open Data in the Knowledge Economy: Measuring the benenefits of open data in Lebanon.* s.l.: s.n.
- Asia Foundation.** 2015. [Online] Available at: <https://asiafoundation.org/2015/11/04/ogp-global-summit-open-government-open-knowledge/>.
- Birkinshaw, J and Sheehan, T.** 2002. Managing the Knowledge Life Cycle. *MITSloan Management Review*, October.
- Chungoora, T.** n.d. [Online] Available at: <https://www.udemy.com/practical-knowledge-modelling/>.
- Civil Society.** 2003. *Shaping Information Societies for Human Needs.* s.l.: s.n.
- Clarke, M and Harley, P.** 2014. How Smart Is Your Content? Using Semantic Enrichment to Improve Your User Experience and Your Bottom Line. *Science Editor*, 37(2): 40–44.
- Edward, BB.** 1987. The Concept of Sustainable Economic Development. *Environmental Conservation*, 14(2): 101–110. June. DOI: <https://doi.org/10.1017/S0376892900011449>

- Evans, M, Dalkir, K and Bidian, C.** 2014. A Holistic View of the Knowledge Life Cycle: The Knowledge Management. *The Electronic Journal of Knowledge Management*, 12(2): 85–97.
- Filipović, J, Devjak, S and Putnik, G.** 2012. Knowledge Based Economy: The Role of Expert Diaspora. *Panoeconomicus*, 3: 369–386. DOI: <https://doi.org/10.2298/PAN1203369F>
- Hearn, G and Rooney, D.** 2002. The future role of government in knowledge-based economies. *Foresight*, 4(6): 23–33. DOI: <https://doi.org/10.1108/14636680210453461>
- Juyeon, H, Jae-Nam, L and Byounggu, C.** 2016. Effect of Government Data Openness on a Knowledge-Based Economy. *Procedia Computer Science*, 91: 158–167. DOI: <https://doi.org/10.1016/j.procs.2016.07.053>
- Kitchenham, B.** 2004. *Procedures for performing systematic reviews*. s.l.: s.n.
- OECD.** 1996. *The Knowledge-based Economy*. Paris: s.n.
- OECD.** 2015. *Assessing Government Initiatives on Public Sector Information: A Review of The Oecd Council Recommendation*. Paris: s.n.
- OKFN.** n.d. [Online] Available at: <http://opendefinition.org/>.
- OKI.** n.d. [Online] Available at: <http://opendatahandbook.org/> [Accessed 19 January 2019].
- Ramos, I, Cardoso, M, Carvalho, JV and Graça, JI.** 2009. An Action Research on Open Knowledge and Technology Transfer. *IFIP AICT*, 301: 211–223. DOI: https://doi.org/10.1007/978-3-642-02388-0_15
- Ravago, M-LV, Balisacan, AM and Chakravorty, U.** 2015. The principles and practice of sustainable economic development: overview and synthesis. In: *Sustainable Economic Development*, 3–10. San Diego: Elsevier Inc. DOI: <https://doi.org/10.1016/B978-0-12-800347-3.00001-7>
- Sagsan, M.** 2006. *A new lifecycle model for procesing of knowledge management*. s.l.: s.n.
- Skyrme, DJ.** 2011. [Online] Available at: <https://www.skyrme.com/kmbasics/kcycles.htm>.
- Stehr, N.** 2012. Knowledge Societies. In: *The Wiley-Blackwell Encyclopedia of Globalization*. Cambridge: Wiley-Blackwell. DOI: <https://doi.org/10.1002/9780470670590.wbeog342>
- Talaat, MA.** 2016. Public Sector Information and Open Government Data. *Journal of Systems Integration*, 2: 25–32. DOI: <https://doi.org/10.20470/jsi.v7i2.252>
- UNESCO.** 2013. *Towards Knowledge Societies for Peace and Sustainable Development*. Paris: s.n.
- Vision 2036.** 2016. *Vision 2036: Achieving Prosperity for all*. Gaborone: Government of Botswana.
- Wang, Z.** 2017. *Open Knowledge Management Model in Open Innovation Environment*, 1–14. China: s.n.
- Wessels, B, Wadhwa, K, Finn, RL and Sveinsdottir, T.** 2017. *Open Data and the Knowledge Society*. Amsterdam: Amsterdam University Press. DOI: <https://doi.org/10.5117/9789462980181>
- World Bank Group.** 2015. *Botswana ODRA Report*. s.l.: s.n.
- WSF.** 2003. *Knowledge Based Society*. Budapest: s.n.

How to cite this article: Sebuli, O, Zlotnikova, I and Hlomani, H. 2020. Open Data for Sustainable Development on a Knowledge-Based Economy: The Case of Botswana. *Data Science Journal*, 19: 44, pp. 1–6. DOI: <https://doi.org/10.5334/dsj-2020-044>

Submitted: 31 January 2019 **Accepted:** 25 November 2019 **Published:** 06 November 2020

Copyright: © 2020 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/4.0/>.