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Data-Driven Innovation for NGO's:
How to define and mobilise the Data Revolution for Sustainable Development?

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Abstract

How can data be leveraged for sustainable development? This paper aims to help understanding the current state-of-art on data-driven innovation, and how Non-Governmental Organisations [NGOs] in the field of sustainable development can learn from it. Based on the preliminary analysis of 187 scientific articles on data-driven innovation, and scoping interviews we provide a view on (1) the definition of data-driven innovation, (2) challenges of NGOs in implementing data-driven innovation, and (3) across which sectors NGOs could find potentially valuable examples for further implementation.

Keywords— Data-Driven Innovation; Systematic Literature Review; Empirical Study; Innovation and Management Methods; Data Revolution; NGOs; Sustainable Development.

1   Introduction

Data is the lifeblood of decision making as it facilitates to inform policy and improve accountability. In 2014, the United Nations called to mobilise the data revolution for sustainable development. It is argued that in order to overcome current challenges in improving data for achieving and monitoring sustainable development, innovation within the sector is crucial (UN IAEG, 2014).

Innovation however appears to be a vague, blurry and universally applicable concept. Nonetheless, many organisations - whether the UN, public institutions or non-governmental organisation [NGO] - often feel compelled to indicate to be working on 'innovation' as it is expected to benefit the adopters of the innovation, the innovating firm and the society at large (Porter, 2011).

In this paper we report on our study encompassing a (1) systematic literature review, and a (2) set of semi-structured interviews in order to understand "data-driven innovation" and its application in NGOs.

This paper contributes to a better understanding of how "data-driven innovation" is defined in existing scientific literature. Moreover, it contributes an empirical view on which challenges NGOs face in implementing data-driven innovation methods for sustainable development, and which sectors might provide good examples for future implementations.

2   Background and Related Work

Within this section, we reflect upon the foreseen potential and challenges in using data for achieving sustainable development. It is argued that unleashing this potential requires further experimentation, innovation and adaptation by actors within the sector. After a first reflection on the so-called 'Data Revolution', we provide a basic definition of innovation in order to reflect more in-depth on the concept of 'data-driven innovation'. This provides a first basis to reflect on how data-driven innovation methods might help NGOs.

2.1   The Data Revolution

'New technologies are leading to an exponential increase in the volumes and types of data available, creating unprecedented opportunities for informing and transforming society' (UN IAEG, 2014). Innovative data-driven approaches already benefit various sectors through improving strategies and increasing efficiency. In particular, data provides new opportunities to inform decision making as it enables to inform policy and improve accountability.

The discussion on data for policy should be distinguished between two main types of data (Poel et al., 2015). The first refers to the use of *public datasets* (administrative (open) data and statistics) which are now used on a larger scale, used more intensively, and linked. The second refers to *new types of data sources* such as citizen reporting (e.g. crowd-sourcing of large-scale surveys), open web data (e.g. social media), digital breadcrumbs (e.g. mobile phone data) and remote sensing data (e.g. satellite imagery) (UN Global Pulse, 2012; Letouzé, Meier, & Vinck, 2013; Bellagio Big Data Workshop Participants, 2014). The development of novel methods and analytical tools provides increased opportunity to retrieve valuable insights from these data sources for informing policy. 'It is the processing of data in innovative ways that brings new economic and social benefits, and this value creates a virtuous circle to feed into more use of data-based decision making and analysis' (Hilbert, 2013).

In its report 'A World that Counts', the UN Independent Expert Advisory Group calls to promote and share innovation to mobilise the data revolution for sustainable development. It indicates that better data will lead to better insights, as well as that this requires strengthening of capacities within the sector (UN IAEG, 2014).

2.2 Data-Driven Innovation

Innovation can be defined as the introduction or adoption of an idea, practice or object that is perceived as new to a certain context. It sets itself apart from invention as invention refers to the creation, whereas innovation refers to the improvement or adaptation of a subject (based on the analysis of Edison, Bin Ali, and Torkar (2013)). The scope of innovation varies from products and processes to organizations, sectors and context. Two dimensions to innovation can be indicated: the degree of novelty (i.e. related to the context of innovation) or type of innovation (i.e. related to to the focus of innovation) (Edison et al., 2013).

Innovation research has distinguished between innovation types because they have different characteristics and their adoptions are not affected identically by environmental and organizational factors (Jansen, Van Den Bosch, & Volberda, 2006; Kimberly & Evanisko, 1981; Light, 1998). First of all, *product innovations* constitute the 'creation and subsequent introduction of a good or service that is either new, or an improved version of previous goods or services' (West, Ford, & Ibrahim, 2015). On the other hand, *process innovations* have an internal focus and aim to increase efficiency and effectiveness of the internal organizational processes to facilitate the production and delivery of goods and services

(Boer & During, 2001).

Retrieving insights from data requires the development and adoption of innovative data-driven approaches. The concept of "data-driven innovation" is however ill-defined as well as the methods through which these could be realised.

2.3 Data-Driven Innovation Methods and NGOs

Non-governmental organisations have long emerged as increasingly important actors in development cooperation alongside traditional development partners (IFAD et al., 2013; Rice, 1983; Eade et al., 2000). NGOs are non-profit organizations that operate by providing services and advocating change through organizing and mobilizing resources as well as disseminating information (Doh & Teegen, 2003; Spar & La Mure, 2003). Their numbers have risen sharply over time and they are controlling a larger share of humanitarian resources than ever before (Macrae et al., 2002).

Data are a potential valuable resource for NGOs for improving their decision making and informing their strategies. The UN IAEG (2014) indicates that in order to unleash this potential further innovation is needed to overcome current challenges. From the conception that NGOs are key drivers for sustainable development, it is key to understand what their role is in furthering the data revolution towards this same end as well as which methods they could adopt to support the implementation of data-driven innovation.

3 Research Objectives

The aim of this research is to identify the state-of-art in data-driven innovation methods presented in scientific literature, and to determine whether NGOs can benefit from these methods applied within other sectors. Following this we pose the following research questions: (1) *What is the state-of-the-art in scientific literature on data-driven innovation?*, and (2) *How can data-driven innovation methods support NGOs in their work?*

4 Methodology

Based on our twofold goal we divided our study into two approaches: (1) a systematic literature review (SLR) - to identify, evaluate and interpret the available scientific literature on data-driven innovation, and (2) semi-structured interviews - to identify the needs and challenges in practice for NGOs.

Systematic Literature Review (SLR) is a process for reviewing the literature using a comprehensive preplanned strategy to locate existing literature, evaluate the contribution, analyze and synthesize the findings and report the evidence to allow conclusions to be reached about what is known and, also, what is not known. By using this auditable methodology, we will be able to identify the gap in literature see the domains in which data-driven innovation is already applied and be in position to evaluate potential benefits and challenges for NGOs. Following the SLR guidelines as developed by Kitchenham (2004) we developed a protocol using the following stages: (1) Identification of research; (2) Selection of primary studies; (3) Study quality assessment; (4) Data extraction & monitoring; (5) Data synthesis. The SLR began with a search term that was used to search for relevant literature. Due to the manageable scale of existing scientific contributions, we used the search term: *"data-driven innovation"*. Our initial search in Google Scholar provided us with 304 articles, books references, etc. After removing duplicates and articles beyond the scope of this study, we ended up with 187 articles that met our criteria.

Semi-structured interviews. Based on the state-of-the-art scientific literature results, semi-structured interviews with various NGOs - mostly in the Netherlands - have been conducted in order to identify the needs and challenges in practice. Based on the results of the systematic literature review, we defined a qualitative questionnaire to investigate the extent to which NGOs are currently working towards implementing data-driven innovation as well as to identify foreseen benefits and challenges in doing so. We have conducted interviews with 8 core staff of NGOs working on development and implementation of innovative data-driven approaches within their organisations. The outcomes are valuable in order to investigate the challenges regarding data and also to identify ways that data-driven innovation methods could help NGOs.

Owing to the increased usage of the term data-driven innovation within the development sector, there is a distinct need for agreeing on a definition (Krause, 2013). Therefore, a definition of data-driven as concluded from the SLR and the interviews is presented.

5   Results

The results are divided into two parts. Firstly, we will introduce the outcomes from the Systematic Literature Review, and secondly, the results from the performed semi-structured interviews will be presented.

5.1   Systematic Literature Review

After our selection process, we assembled a repository of 187 relevant scientific articles on 'data-driven innovation'. A first analysis showed that government bodies (90) and business sector (89) implement the majority of initiatives with NGOs (8) remaining far behind. Results proved that these initiatives cover a wide spectrum of application areas.

Data-driven innovation initiatives implemented by NGOs focus primarily on proponents of open government, which analyse available data in order to check on their governments' policies and processes in countries such as Kenya, Nigeria, Liberia or Pakistan.

5.1.1   Industry Areas

We found that the inventory includes data-driven initiatives in a broad range of industry areas, using a categorisation of business sectors as defined by the Harvard Business School (n.d.). Figure 1 provides an overview of the categorisation of the 187 initiatives per primary industry area. Most initiatives focus on information and information technology as well as education and health. The large miscellaneous category comprises industry areas in which 5 or less data-driven initiatives have been found to take place.
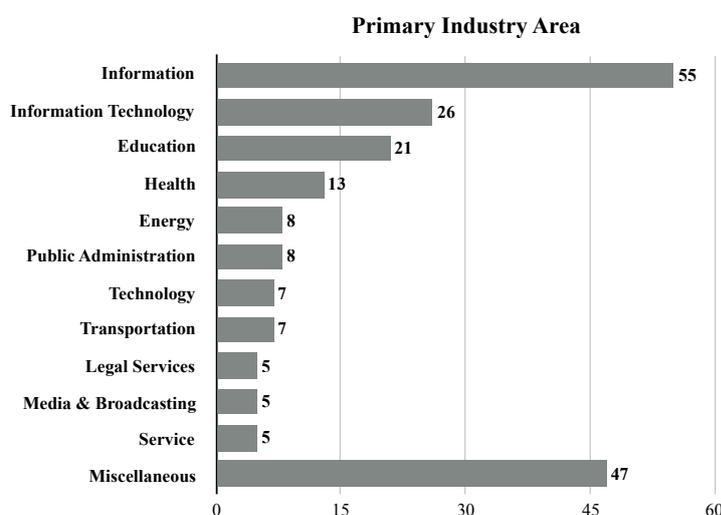

Figure 1: Primary Industry Area

A second observation is that the majority of the initiatives are relevant for two or more industry areas. This indicates that data-driven innovation initiatives cut across several industry areas, e.g. public administration, service, and information technology.

As regards the papers written by NGOs, we can clearly observe that the majority of them is focusing on the information area. Nearly all initiatives are relevant for two or more policy areas.

5.1.2 Classification of Papers and Contributions

In addition, we have conducted a paper classification using a categorization of the articles according to evaluation criteria defined by Wieringa, Maiden, Mead, and Rolland (2006). As depicted in Figure 2, the four largest groups of papers are: (1) Philosophical papers (24%), (2) Validation research (22%), (3) Proposal of a solution (19%), and (4) Evaluation research (16%). From this, we can extract that the data-driven innovation field is novel and most articles try to introduce data-driven innovation methods by experiments, new ways of looking at things or even by empirical studies. Below, we will provide a further reflection on each category with some related examples.
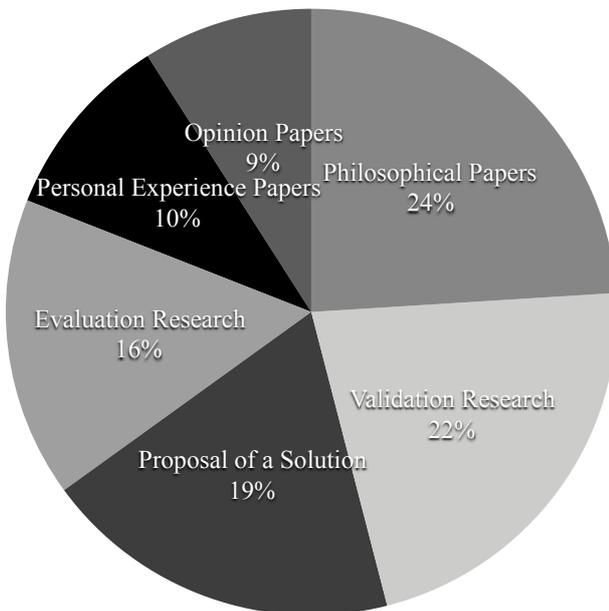

Figure 2: Classification of Papers

Philosophical papers. As we can observe the majority of the papers are philosophical. These papers describe a new conceptual framework, implying a new way of looking at things can fit in this category. This includes articles proposing a framework for policy discussions on data (Hemerly, 2013), reflecting on open government data (Jetzek, Avital, & Bjorn-Andersen, 2014), and defining innovation opportunities and future trends in different fields (Reiner & McKinley, 2012).

Validation research. The main characteristic of a validation research paper is that the proposed solution has not yet been implemented in practice. Possible research methods are experiments, mathematical analysis, simulation, etc. This includes, for example, an experiment on how data could change implementation strategies in providing human services (Kerman, Freundlich, Lee, & Brenner, 2012) and a re-

flection on how data-driven innovation could support statistical analysis in astro-geophysical research (Espy, Daae, & Shprits, 2010).

Proposal of a solution. This type of paper offers the proposal of a solution technique and its relevance, without a fullblown validation. A proof-of-concept may be offered by means of a small example or a sound argument. Mentioned initiatives within this category relate to how data-driven innovation could support the implementation of IoT (Internet of Things) systems in a smart city example (Hemerly, 2013), as well as a proposal on how data-driven approaches could improve the perfomance of wind farms (Kusiak, n.d.).

Evaluation research. In this category we see the investigation of a problem in practice or an implementation of a technique in practice. One article investigated the resistance that users feel to allowing companies to use their personal data in compensation of certain rewards (Nakagawa, Matsuda, & Ogi, 2015). Another article provided a reflection on how data-driven innovation was successfully applied in support of a staff development initiative (Sundet & Kellym, 2007).

The final two categories constitute *personal experience papers* and *opinion papers*. The papers in the former category constitute descriptive reflections on personal experiences of the author with the intention of communicating these to other practitioners in the field. The final class of papers is those that express an author's opinion without sharing new research results, designs, or conceptual frameworks.

5.2 Semi-Structured Interviews

A total of 8 interviews have been conducted, transcribed and analyzed. The eight interviewees included programme and policy officers, digital strategists, data and business development analysts, founders. All the interviewees are currently working for NGOs in the Netherlands. The participants that have been interviewed have experience ranging between six months and six years, with an average of 2.87 years. All the interviewees have done a comprehensive amount of projects within the field of data management. All interviews lasted between 20 and 50 minutes and were conducted by one interviewer and transcripts of the interviews were made.

Across the 8 interviews, NGO staff did indicate that their organisations focus primarily on work with (open) public datasets and survey data for informing their strategies. Further, most NGOs are starting to experiment with utilising alternative data sources such as SMS data, satellite imagery and internal project data. The most common data formats used constitute Excel, CSV and XML while there was only

limited mention of more complex formats such as SQL, GIS and JSON.

For analytical purposes, NGOs indicate the use of a wide variety of tools within and across their organisations. However, as indicated by one of the interviewees, data analysis is not considered the problem but focus should rather be on improving data availability and quality. Simultaneously, five interviewees mentioned that within their NGOs they have developed their own tool for data analysis and visualisation. During the interviews, NGO staff indicated that they encounter various challenges in implementing innovative data-driven approaches within their organisations. After coding all interviews, we encountered 174 instances in which a specific challenge was mentioned which we subsequently categorised across the following topics: (1) data quality (28%); (2) technical (21%); institutional (15%); social (15%); data responsibility (10%); and miscellaneous (11%). Figure 3 provides an overview of the main categories and figure 4 a subdivision of challenges mentioned as part of data quality.
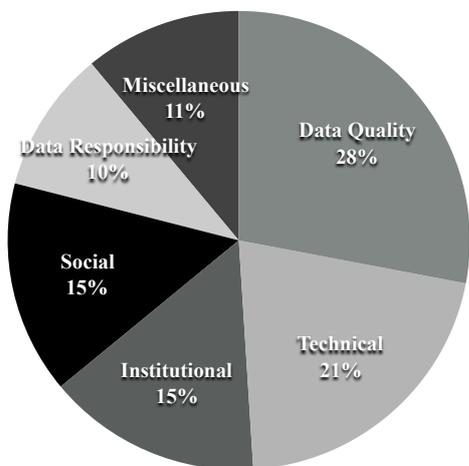

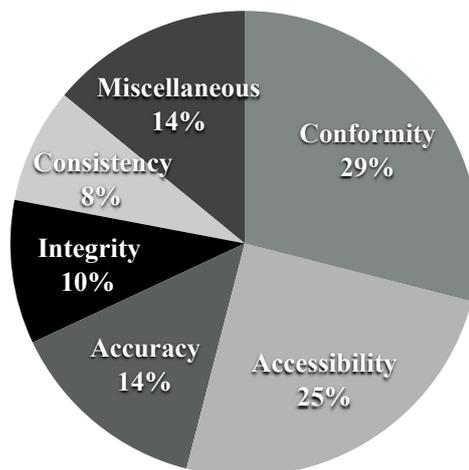Figure 3: Challenges for Data-Driven Innovation in NGOs

Figure 4: Sub-Division Data Quality Challenges

The most mentioned type of challenges relate to *data quality* which includes, amongst others, the following aspects: conformity, accessibility, accuracy, integrity, consistency etc. It is often indicated that poor data quality can seriously hinder or damage the efficiency and performance of organisations in implenting data-driven approaches (Scannapieco, Missier, & Batini, 2005).

Technical barriers are mostly related to the publishing of data in a format that is not machine-readable. Also, quite some interviewees mentioned problems with configuring data transformation and especially the lack of a linking or combining functionality.

Regarding *institutional challenges*, the majority of them were related to the lack of knowledge and capacity to innovate. Simultaneously, it was indicated that NGOs face restraints in setting long-term goals due to the nature of their work which would subsequently hamper investing in innovation trajectories.

Social challenges mostly reflected concerns regarding effective aid communication and fears of losing trust amongst donors. Moreover, many interviewees mentioned the lack of people working with data in NGOs arguably influenced by a lack of expertise and data literacy.

All interviewees raised concerns regarding *data responsibility*. Issues regarding data disclosure and the applicability of different legal frameworks per country were mentioned most. Further, respondents indicated that NGOs handle super sensitive data causing fears to do more harm than good.

The *miscellaneous* category includes a wide variety of challenges, amongst which, there was mentioning of the lack of available budgets for innovation trajectories as well as diverse operational challenges in implementing data-driven innovation.

At last, interviewees indicated that there is also a lot of misunderstanding of what innovation entails and that the term is often used as a buzzword by people who are not familiar with technology. In particular, two interviewees concluded that it is one thing to be innovative and another to do something with innovation.

6   Discussion

Within our discussion, we first provide a working definition of data-driven innovation as well as indicated additional aspects highlighted by NGO staff. Further, we reflect on key challenges as identified by NGOs in implementing data-driven innovation and set a roadmap for how NGOs could improve current processes through learning from other sectors.

6.1   Defining Data-Driven Innovation

As there is no commonly agreed-upon definition of 'data-driven innovation', we have collected the definitions provided in the various research papers (SLR) and from the interviewees' opinions. Following an approach similar to that of Laanti, Similä, and Abrahamsson (2013), we have analysed where the emphasis was put in each definition. This provides us with the opportunity to propose a new definition taking into regard key principles and elements.

As part of the of the SLR, we found 8 papers that provided a definition on "data-driven innovation". We found that across these definitions the following three key aspects were highlighted: (1) *information provision* (Iyer, Jayanti, Lou, Kalyanaraman, & Ramani, 2005; Kusiak & Tang, 2006; Kitchin, 2014; Hemerly, 2013; Al-Khouri, 2013) indicating how new types of data and analytics provide the opportunity to gain new insights and support knowledge generation; (2) *decision making* (Zuiderwijk, Helbig, Gil-García, & Janssen, 2014; Hemerly, 2013; Al-Khouri, 2013) relating to how data-driven approaches could transform and improve current decision making processes; (3) *problem solving* (Zuiderwijk et al., 2014; Hemerly, 2013; Eckartz, Hofman, & Van Veenstra, 2014; Al-Khouri, 2013) pertaining to how data could help to increase efficiency and effectiveness of current processes when confronting or solving problems. In recognition that a definition on data-driven innovation should thus encompass all these three key aspects, we propose the following definition:

"Data-Driven Innovation is about finding new ways to use data and analytics to inform decision making, improve organisational processes and create new methodologies for solving (global) challenges."

From the interviews, we concluded that NGOs highlight the following additional aspects in defining data-driven innovation: (1) *service provision* noting that data will provide new opportunities for informing decision making and therewith intervention strategies and aid delivery; (2) *organisational change* taking into consideration the vast effects that innovative data-driven approaches could have on the work and processes within the organisation and sector as a whole; (3) *data governance* indicating that key governance issues should be resolved in order to unleash the potential of data for development, particularly in relation to data standardisation and responsible data use.

6.2   Roadmap for Data-Driven Innovation for NGOs

Our findings indicate that most NGOs within the development sector are still at an entry level as regards data-driven innovation. Our respondents indicated that NGOs stay behind in data-driven innovation due to several challenges - most notably data quality, technical barriers and institutional challenges. Further, it was mentioned that NGOs often appear to lack the capacity and knowledge to implement data-driven innovation.

Where challenges are similar as in other sectors, cross-learning should be further encouraged. This also relates to the adoption of new tools and approaches as developed by others. Although several interviewees mentioned to benchmark other industries for cheaply available technological applications, many still focus on developing their own analytical and visualisation tools. NGOs should however not only focus on adaptation of already existing technologies, but of the processes through which data-driven innovations are being implemented as well.

It should however be noted that NGOs might face unique or highly context-specific challenges, as for example in relation to responsible data use. This would hence require larger investment in developing their own data-driven innovation trajectories. Nonetheless, it remains crucial to not become blind sighted in such circumstances and maintain open to the opportunities of cross-sectoral learning and exchange. A notable example constitutes the adaptation of de-identification standards from the health care sector in treating personal information in development and humanitarian context.

Moreover, cross-sectoral collaboration could further support data-driven innovation for sustainable development by

providing additional support to NGOs. Several respondents indicated that cooperation with organisations in other sectors helped by bringing in new experiences and perspectives into innovation processes. Besides providing additional knowledge, such collaborations could also help by increasing the currently limited capacity and resources. DataKind and Tableau Foundation constitute such examples in which employees from private organisations support NGOs in implementing data-driven innovation.

Overall, we account that focus within NGOs should be, to an increased extent, on learning from other sectors in implementing data-driven innovations. Moreover, cross-sectoral collaboration could support innovation practices through strengthening resources, capacities and knowledge within NGOs.

7 Conclusion

In this paper we contribute to the understanding of data-driven innovation methods and their application in NGOs. Based on a systematic literature review of 187 scientific articles, as well as 8 supportive interviews with management and policy officers, our analysis indicates that (1) data-driven innovation is conducted across various sectors of industry; (2) NGOs are still at an entry level and indicate that they face diverse and fundamental challenges in implementing data-driven innovation; and (3) cross-collaboration and learning from other sectors (i.e. information technology, education and service) could be beneficial to improve data for achieving and monitoring sustainable development.

While NGOs indicate to have limited capacity and resources as well as lack knowledge in implementing data-driven innovation, most organisations do implement their own trajectories in isolation. Therewith these organisations are missing out on opportunities to learn how actors in different contexts have worked on similar challenges. Instead of reinventing the wheel, NGOs should actually focus on innovation rather than (re)invention. This should be done through learning and adaptation of good examples from other sectors.

8 Future Research

Currently, we are working towards furthering the findings of this study by extending the systematic-literature review in order to include an analysis of (1) types of innovation implemented within different data-driven innovation initiatives; and (2) different challenges addressed and pertaining

data-driven innovation methods developed or introduced to confront these challenges. Furthermore, we aim to broaden the current results from the interviews by conducting a large-scale survey among NGOs.

Subsequently, the study could be expanded to identify barriers for data-driven innovation encountered by other stakeholders working within the development sector, as well as barriers within other contexts.

Acknowledgements

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