

Towards Open Data Impact Evaluation Framework – An Empirical Analysis of the Demand-side Response

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Abstract

Open data is widely presumed to have a social, environmental, political, and economic impact; however, the evidence to that impact has remained scarce. The impacts must be explored and quantified to give a reasonable insight into the supply-side activities and demand-side responses. Based on the data collected from open data users in Ireland, we address the questions what the impacts of open data are and what indicators can be used to quantify the impacts of future open data initiatives. Findings from this study revealed impact categories, areas, and specific indicators to each impact areas. Output of this research directly contributes to the development and implementation of the National Open Data Strategy. This research recommends that open data leaders revisit indicators in respond to the change of social context and call for new forms of joint action between public and private stakeholders to deliver data-driven public goods.

Keywords: Open data; open data impact; Impact measurement; Indicators; Open data in Ireland.

1. Introduction

The impact of open data on our societies can be compared to the ripples caused by a stone thrown in water: spreading outwards and affecting a larger and larger part of our lives (Jetzek et al., 2014). Governments striving to effectively collect, manage, and publish open data for use and re-use for commercial or other purposes (Kuhlman et al., 2017). Hence, for many governments, open data is now seen as a critical competitive advantage (Ahmadi Zeleti et al., 2016). These trends are reflected in the explosion of open data initiatives that have not yet lived up to their true potential (Jetzek et al., 2014).

In the case of open data initiatives, the work on developing evaluation strategies is under-developed relative to other, more established evaluation frameworks (e.g. in finance, or health expenditure). This is largely because of the difficulties in identifying

qualitative and quantitative measures. Often, the methodology described aims to measure the use (e.g., number of downloads) instead of the actual benefits to society that are created through open data use. The impact created by open data use generally refers to value for citizens, governments, businesses, and society as a whole (Corvo & Pastore, 2021).

This case study research presents the results of the Open Data Impact project of the Irish Government and builds on the data collected from 47 open data users *to qualitatively explore the impacts of open data use in Ireland and to identify indicators that can be used to quantify the impact of open data initiatives in the future.*

Findings suggest that open data use in Ireland has five main types of societal impact: improving governance of public administration, addressing public problems, creating new economic opportunities, empowering citizens, and sharing society, and improving democratic process. This study also revealed quantifiable indicators to evaluate the impact of open data initiatives regarding the five main types.

We contributed to 1) the existing state of the art in open data by developing the open data impact evaluation framework, and 2) to the implementation of the Ireland Open Data Strategy 2017-2022 and development of the next Open Data Strategy 2023-2025. Action 6.1 of the existing Strategy sets out a clear goal to “encourage the development of metrics that allow benefits capture, for example, what contribution Open Data makes to improve efficiency and effectiveness of public service delivery”.

In this research, we are specifically looking at direct impact which refers to evidence on whether outcomes are changing beneficiary longer-term conditions of interest or behavior (for example, improved a healthier population or a green energy). The key is to distinguish between the provision of open data (which involves supply-side activities) and actual demand for and/or utilization of open data-driven goods and services (demand-side response).

2. Background

2.1. Qualitative studies

Public access and use of open data has a direct impact on various sector of the economy (Ahmadi Zeleti et al., 2016). Attard (Attard, 2017) highlights that through providing access to relevant information, an open data initiative can be more transparent, and such transparency can lead to significant increase in social capital through enabling citizens to effectively interact with public bodies. Improved transparency will also impact public administrations in that there will be enhanced accountability within public sectors. Ultimately, open data promotes not just transparency and accountability, but also democracy. While each impact does not strictly require the previous one, each impact supports the next one to achieving a higher level of impact on the relevant stakeholders (Attard, 2017). At the government level, Jae-Nam Lee et al. (Lee et al., 2016) reveal that open government data can positively affect the global competitiveness of a country through development of the knowledge base enabled by knowledge absorption and knowledge creation from the use and re-use of such data. At the city and community level, Luís Carlos de Bernardes Rebelo (Carlos & Rebelo, 2021) assesses the impact of open data in urban resilience and highlights three main impacts from opening government data: transparency, releasing social and commercial value, and participatory governance.

An empirical open data study in UK (Worthy, 2015) concludes that open data impact measurement requires understanding patterns of use, through requests made or web views, alongside more intangible changes to the society including culture or behavior within contexts. The study reveals three main impacts of open data in the UK: *increased accountability* through professionalization of government systems, improved information flows, and a greater understanding internally of previously complex budget processes; *improved participation* through integrating the data into new participatory initiatives such as budget setting; and *improved information transmission* through creating narratives, informing citizens, and allowing local groups to use the new data as part of a growing set of online 'community building' tools.

With regard to the democratic impact, (Birchall, 2015) highlights that open government data can positively affect civic duty and advocates, each with their own field of interest. Moreover, Ruijter & Martinius (E. H. J. M. Ruijter & Martinius, 2017) investigates the democratic impact of open data using the simplified conception of democratic processes: monitorial, deliberative, and participatory. Findings suggest that open data impacts the monitorial process

which is concerned with the incorporation of data in daily work processes of government in terms of producing, unlocking, sharing, and using data; deliberative process which is concerned with the perspective of citizens in relation to diversity, the option of feedback and of storytelling, deliberation and engagement, and evidence-based policy decision making. Finally, the impact of data on the participatory process concerned e-government maturity and collaboration which empowers interactions between government and citizens, and information polity.

Verhulst and Young (Verhulst & Young, 2017) conduct an open data impact case studies at International level. The study reveals four open data impact areas: improving government, empowering citizens, creating opportunity, and solving problems. The EU Open Data Maturity study (Capgemini Invent, 2020) also focuses on four dimensions to rank European countries' open data maturity: Portal, Quality, Policy, and Impact. The Impact dimension aims to assess the impact of open data in EU countries. This report demonstrates numbers of high- and low-level indicators that can help measure the impact of open data initiatives: strategic awareness of the open data users/re-users, political impact, social impact, environmental impact, economic impact (Macro and Micro economic level impact).

Other reports by IDRC, the World Wide Web Foundation, and the Berkman Klein Center for Internet and Society (Centre et al., 2012) cites at least thirteen "theories of change," including open data's ability to reduce transaction costs, generate new forms of economic growth and prosperity, generate new revenue models, and disrupt traditional business models. Individual organizations and programs develop theories of change to understand whether invested actions and resources lead to desired outcomes (OECD, 2020).

In summary, qualitative studies to evaluate the impact of open data are context oriented and can have different objects of study, including: 1) the types of impact generated; 2) pathways and enabling conditions of impact; 3) application of data; and 4) the types of open datasets use. Some studies provide narrative accounts of impact, while others develop analytical models and tools for practitioners. These analytical models are practice oriented, attempting to map out the enabling factors which support open data impact and relate these factors to one another. Some demonstrate use cases based on existing open data projects and suggest data sources for monitoring purposes. Other studies identify typologies of impact or attempt to model how open data use translates into behavioral changes within and across organizations by applying methods such as outcome mapping.

2.2. Existing measurement approaches

2.2.1. Internationally applied approaches.

Organizations have, over time, created a plethora of measurement tools to assess open data. There are currently five prominent open data measurement methodologies that are used at the international level to assess a range of elements related to open government data. These measurement tools apply different criteria and measure different aspects of open data, using more than 130 different indicators in total.

With regards to measuring the publication and release of open government data, the Global Open Data Index (Open Knowledge Foundation, 2017) and Open Data Inventory (Crowell, 2016) provides assessment methodology and process, and each develops categories and indicators to measure data publication. The Global Open Data Index looks at 14 data categories that reflect key data that is relevant for civil society at large, and it does not look at the common open data assessment framework such as context, use or impact. The Open Data Inventory analyzes datasets across 20 data categories that are the most pertinent to managing and monitoring progress on the SDGs, as well as the social, economic, and environmental development of a country more generally.

With regards to the measuring the readiness, the Open Data Barometer (The World Wide Web Foundation, 2017) and the European Open Data Maturity Assessment (Capgemini Invent, 2020) provide cross-country metrics for readiness and impact. The Open Data Barometer (The World Wide Web Foundation, 2017) builds upon tripartite structure with three sub-indexes (readiness, implementation, and impacts), each containing three components (readiness: government policies & actions, entrepreneurs & business, and citizens & civil society; implementation: accountability datasets, innovation datasets, and social policy dataset; impacts: political, economic, and social). The European Open Data Maturity Assessment (Capgemini Invent, 2020)(van Hesteren et al., 2021) benchmarks the development of European countries against four open data dimensions (policy, quality, portal, and impact).

With regards to benchmarking the design and implementation of open data policies at the central level, the OECD's Open Useful Reusable Government Data index (OECD, 2020) stresses the sustained political and policy relevance of this area of work for OECD member and partner countries and beyond. The index looks at three major pillars (data availability, data accessibility, and government support for data reuse) and three sub-pillars each (availability: open by default policy, stakeholder engagement for data release, and implementation; accessibility: unrestricted access to

data policy, stakeholder engagement for data quality & completeness, and implementation; government support: data promotion initiatives and partnerships, data literacy programs, and monitoring impact). The results show that OECD countries are increasingly moving towards the development of government-wide data strategies.

To support research on data use and impact, organizations also built repositories of data use cases useful for follow-up analyses, e.g., Open Data for Development's Open Data Impact Map (Open Data for Development Network, n.d.).

2.2.2. Specific topic and subnational approaches.

Measurement tools also exist for specific topics or regions. The National Democratic Institute's Legislative Openness Data Explorer collects comparative, global information on legislative openness practices to provide a snapshot of performance in several areas of parliamentary transparency. Thirty-one chambers of parliament are currently covered on the site, though the administrators anticipate that many additional countries will be added in the coming months (The National Democratic Institute, n.d.). There are also subnational assessments, such as Open Cities Index hosted by Public Sector Digest and Canada's Open Data Exchange. The measurement activity aims to assess the openness of North American cities each year in three key theme areas: Readiness, Implementation, and Impact. According to this study, the City of Mississauga has been recognized as one of the most open cities in North America. The Open Knowledge International and Sunlight Foundation's U.S. City Open Data Census is a benchmarking tool that gives city staff and residents an understanding of what datasets are available in their city, and how their city compares to others across the country when it comes to open government data (Sunlight Foundation, 2018).

3. Open data in the Irish context

Ireland's Open Data Initiative began in 2014. The Department of Public Expenditure and Reform has policy responsibility for Ireland's national Open Data Initiative. The initiative is aligned with key Government priorities such as the Public Service Reform Program, Open Government Partnership Action Plan, eGovernment Strategy, Civil Service Renewal Program, and the National Data Infrastructure. With regards to the governance of open data, a top-down approach is used. The open data policy is set, coordinated, and implemented at the national level by the Department Public Expenditure and Reform and is a key element of the government's reform agenda.

Data.gov.ie is the central portal which provides easy access to datasets that are free to use, reuse, and redistribute. At this very moment, the catalogue includes over 14,000 open datasets (~13,000 are three stars according to the classical Tim Berners-Lee 5-star model) from over 95 publishers. A Publisher in data.gov.ie is any Irish Public Sector Body who publishes open data on this portal.

The Open Data Strategy 2017-2022 (Government Reform Unit, 2017) sets out seven strategic themes to guide the Open Data Initiative over the lifetime of the Strategy. These include: broaden the range of public bodies actively engaged in the Open Data Initiative; improve the quality, quantity and range of datasets available and improve the range of services available on the national portal; continued engagement with stakeholders to encourage the use of open data; support and encourage various groups of open data users including public service bodies; *evaluate the impacts, and benefits of open data initiatives* and ensure that effective governance structures are in place to implement the Strategy. Implementation of this strategy will be overseen by the Department of Public Expenditure & Reform.

Beyond the work being undertaken directly by the Department, there have been several other developments in this area that support the wider Initiative. Several organizations and local authorities have led the way in terms of releasing data. These include Central Statistics Office (CSO), Ordnance Survey Ireland (OSI), Met Eireann, and the Department of Housing Planning and Local Government. A wider Irish Open Data community, consisting of civil-society groups, citizens, SMEs, developers, universities, and public-bodies, has also been very active since 2010, regularly organizing meetups, talks, workshops, competitions, and hackathons, as well as publicizing the Open Data agenda nationally.

Significant progress has been made in progressing Ireland's open data initiative to date and in 2021, Ireland is ranked 2nd in the EU Open Data Maturity assessment (van Hesteren et al., 2021).

4. Research questions and methodology

This case study forms part of a larger research program of the Irish Government investigating the benefits and impacts of open data in Ireland. The study allows the researchers to closely examine the data within a specific context by selecting several individuals/organizations as the subjects of study (Darke et al., 1998).

The research strategy of this work is mostly qualitative in nature as data is collected and interpreted in relation to a specific case (Brink, 2018). Following

the inductive reasoning, this work aims to find answer to *RQ1: what are the impacts of open data use in Ireland?* and *RQ2: what are the indicators to measure the future open data initiative in Ireland?* The impact resulting from open data use cases in Ireland is considered in terms of *how open data impacts on people, communities, organizations, and government*. Researchers want to know *what changes take place due to the use of open data products and services in Ireland*.

The team selected online survey including both open and close ended questions making available semi-structured to unstructured data. The survey protocol was devised based on analysis of the literature and discovery of the key areas related to the 1) motivation to use open data products (e.g., open datasets, Apps) and services (e.g., street fixing, sport activities), 2) open data use application, 3) used open datasets, 4) observed and expected impact of open data, and 5) potential indicators to measure the impact. These five areas forms the five main sections of the survey.

Our case study approach aimed at collecting primary responses within one specific group of actors only (open data-demand side) but, from cases that vary from context to context (organizations and individuals using open data products and services).

The survey was designed using the EU Survey and went online on the 5th of May 2021. We adopt purposive and snowball strategies. For the first, the aim is to collect data from as many as experienced individuals/organizations as possible therefore, we targeted networks such as Open Data Advisory Group, Open Data Governance Board, Open Data Liaison Officers, and Irish Government specialized mailing lists. For the latter which is the most widely employed method in qualitative research, we accessed informants through contact information that is provided by other informants. During the months of May to December 2021, we have received 97 participants of which 47 are users of open data products and services in Ireland (the rest are publishers and represent the actors active in the supply-side of open data).

To analyze the data, researchers adopted the Constant Comparison Analysis technique (also referred to as "coding") (Leech & Onwuegbuzie, 2007) and includes open coding, creating categories, and abstraction (Brink, 2018). For coding inductively (e.g., codes that emerge from the data), we followed the guidelines presented in Hsieh and Shannon (Hsieh & Shannon, 2005). We begin coding with close reading of the prepared dataset and writing notes in text during the process of reading. The prepared dataset was perused several times and analyzed each time. As this process continues, labels for codes emerge in which they come directly from the data and are then become the initial coding scheme. Codes are then sorted into categories

based on how different or similar codes are. These emergent categories are used to organize and group codes into meaningful clusters. We reviewed this process over many times to allow the team to explore for new emerging categories as well as gather additional details related to each common category. Next, we define each category, subcategory, and codes.

From the perspective of trustworthiness and credibility of the data, the team pre-tested the developed survey, discussing and dissecting it with five domain experts. In addition, self-awareness of the researchers is equally essential therefore, the team also tested the survey many times as this helped to determine errors and whether the questions are suitable for obtaining rich data that answer the proposed research question. Feedbacks collected and errors identified were used to enhance the survey design and questions. To confirm the credibility and conformability of the analysis, analyzed data are cross-checked by more than one person to provide sound interpretation of the data. One researcher is responsible for the analysis and others carefully follow-up on the whole analysis process and categorization.

4. Results

Explicit distinction was made between qualitative and quantitative evaluation. In section 4.1, we present the qualitative analysis of the observed impacts of open data use in Ireland and in section 4.2, we used the categories and areas emerged from the qualitative analysis to exhibit relevant metrics that can be used to quantitatively evaluate the open data impacts in the future. In Table 1 (<https://bit.ly/3v4uGoO>), we present our impact evaluation framework that has emerged from the data. The framework consists of the impact categories, impact areas, and quantifiable indicators to measure open data initiatives against the impact areas. Additionally, we includes few use cases the varieties of open data and heterogeneity of the contexts of open data use and impact.

4.1. RQ1 – Direct impacts of open data

This research reveals that open data in Ireland has five main types of observed impact: improving governance of public administration; addressing public problems; creating new economic opportunities; empowering citizens and the sharing society; and improving democratic process. Participants demonstrate the immediate outcome that they observed out of using open data products and services. Observed outcomes are linked to each impact areas and categories and are briefly explained below.

Improving governance - First, open data is improving governance of public administration in

Ireland through improving public service delivery innovation; cost reduction; improving and implementing compliance and policy; and improving transparency and citizens information support.

Open data improves public service and its delivery through complementing and supporting the data that is already available to the government; supporting public sector decision making; development of public data-driven products and services; and public sector organizational process optimization and promoting innovation.

As open data is now readily available at lower cost and in machine-readable forms, it helps public bodies lowering transaction and issue-resolution costs, costs of operations, procedures, and cost of producing data. These outcomes can be achieved through organizational data optimization as open data is supporting and adding value to the existing organizational data, and organizational data process re-engineering by utilizing open data as a tool for organizational and operational data process enhancement.

Compliance is a top priority for public bodies in Ireland. Data suggests that open data in Ireland improves data compliance and policy implementation. Open data facilitates public bodies to evaluate and develop internal policy to facilitate efforts to comply with the national and international requirements and enable them to contribute in a meaningful way to the greater data ecosystem. In addition, open data supports organizations to develop their own data management policy to drive compliance efforts. These benefits can be achieved through development of new data products and services for example data journalism tools and services; organizational processes and data optimization to perform analysis of market and environmental status and regulatory compliance; supporting decision making at the public sector level by using data for policy analysis and data augmentation.

Lastly, open data use in Ireland improves transparency and citizen information support through improving public knowledge. Information sheds light on institutional behavior and how actually organizations behave in practice, in terms of how they make decisions, or the results of their actions. By being fully committed to data transparency and openness, Irish government provides citizens with information about what their government is doing so that government can be held accountable. Creating certain forms of data-driven transparency shapes the interaction between different internal and external actors and may therefore, be a deliberate strategy of the Irish government to generate strategic gains.

Addressing public problems - second, open data is addressing public problems in Ireland by improving social cohesion and self-organize capacity, and

improving service assessment for sustainable service use.

Open data improves social cohesion and self-organizing capacity through data-driven research activities and open scientific collaboration. Open data enrich research and help reveal societal issues. Research informed by open data helps identify, prioritize public problems, and develop solutions mostly related to social inclusion and capital. A wide range of open data is used to form and advise on potential multidisciplinary research topics and citizen science projects. In addition, open data also enables engagement between stakeholders, producing more targeted interventions and enhanced collaboration.

Citizens strive for sustainable value and sustainable services. Open data facilitates public service assessment activities that can lead to a more sustainable public value citizens experience surrounding public services. Public services are impacted when authorities are utilizing open data to make more informed decision. In service area, relevant open data are accessed and combined to provide important insights and evidence of public services conditions on the ground. In addition, open data is used to understand how different public services are impacting different communities. As a result of this assessment, existing services are revisited, and new services are designed. Additionally, citizens and policymakers use open data to analyze and reveal societal problems in new ways and engage in new forms of service assessment and social engagement. Data-driven sustainable value generation from the public services are the result of collaborative efforts.

Creating new economic opportunity - third, open data is creating new economic opportunity in Ireland through the provision of knowledge-based innovation and fostering green economic growth and sustainable development.

Data suggests that open data and re-use of open data become economically feasible when marginal costs incurred by re-production and distribution are drastically reduced. However, the real value and impact lie in the fact that people and organizations explore opportunities and develop innovative ideas, projects, collaboration, and a whole new data-driven ecosystem. Knowledge-based innovation of the country is positively impacted through development of new data products and services covering a wide range of open data applications such as products and services that facilitate research and development, analysis, data visualization, insights generation, and consultation. To facilitate impact, data are optimized through value-adding process to improve the quality of the data that can be used by other users.

Open data in Ireland contributes to the Sustainable Development Goals. Open data is impacting green

economic growth and sustainable development by improving the quality of policy-oriented research and providing evidence to support research and development of new data-driven green solutions. Technical solutions emerged that considerably enhance access to relevant data (i.e., ecological data).

Ireland is a small country with a fast-growing economy. Entrepreneurs are known for their creativity and ability to turn ideas into successful business therefore, they are critical stakeholders to this growing economy. Entrepreneurs and start-up businesses are adequately supported and very well positioned to harness the full potential of open data, by creating new business models. New applications and business models support environmental sustainability (i.e., reduce pollution, conserve natural resources and build resilience to climate change) through availability of quality and transparent data.

Empowering citizens and sharing society - fourth, open data helps empower residents of Ireland and the sharing society through improving citizens awareness and community-based development (resource and social mobilization), enabling more informed decision making and participation, facilitating behavioral change, and improving wellbeing, safety, and health support.

Open data is supporting the community-based development (resource and social mobilization) through facilitating relevant research that improves public knowledge and help inform new citizens advocacy initiatives aiming at identifying and addressing societal problems. In relation to improving public knowledge and dissemination of knowledge to wider public/advocacy groups, open data in Ireland is used to provide facts and information to citizens and citizens representatives who can advocate for quality information and services. Moreover, development of new data products and services (e.g., data visualization and open discussion platforms) by government organizations and companies help citizens develop substantial skills, knowledge capacity, and data literacy to experience community-driven development which in turn can support mobilize community resources and capabilities, and improve participation.

Open data use supports citizens decision making and participation through new data products and services (e.g., city dashboards/visualization, climate prediction apps) to help citizens make more informed decision on different aspects of their society. Additionally, open data is used to develop new web applications for public and governmental use - as decision-making support tools. On the one hand, public knowledge dissemination helps citizens use the publicly available information to make important decisions, and on the other hand, provide feedback and request information/data from their government. Ultimately, new business models can

emerge from the availability of more data that enable businesses to develop new solutions or enrich their existing value proposition.

Open data supports behavioral change through product innovation to get people into a new habit. Data suggests that some products become more habit forming to users than others and hence influence positive societal change. Therefore, data product design should focus on making the product habit forming and the priority is services that have the potential to address daily needs of the public. Yet, supporting citizens and advocacy programs are highly essential to promote provision of the open data offerings by a wide range of users. Open data modules or training courses and hackathons are essential to engage users to learn about their biggest challenges and help inform innovative behavioral change design. Data further suggests that behaviorally based interventions can affect the actions that individuals take regarding their health.

Open data improves citizen's wellbeing and health benefits through development of new data products and services. These offerings provide information on available health services, statistics on hospital cases and national waiting lists, and performance of new digital initiatives. Availability of health-related data provides researchers, journalists, patient advocates, and healthcare with an opportunity to improve efficiency of health service delivery and help citizens and patients make more informed choices about their health and care. In Ireland, there are some key open data initiatives undertaken by public authorities to provide health and wellbeing services to achieve health outcomes i.e., the Hale & Hearty Knowledge Base project.

Improving democratic process – finally, open data contributes to the monitorial, deliberative, and participatory democracy.

Open data contributes to improving monitorial democracy through availability of a wide range of real-time information and information products/services to facilitate citizens to make an informed decision. In addition, open data is used to inform self or group advocacy movements that can bring certain data/information on spotlight for citizens to create better knowledge about their government. This can positively improve communication and social and resource mobilization in the public sphere.

Open data contributes to improving deliberative democracy through development of products and services to allow citizens to connect to citizens, authorities, and other stakeholders in the ecosystem to debate on a particular social and political matters. This engagement contributes to improving citizens decision making and participation in the political system. Moreover, activities such as research and advocacy efforts to change political agenda are significantly

contributing to improving community-based development and behavioral change. Advocacy efforts at the citizens level mostly focus on social and skills mobilization through debates and discussion that is made available via the open data platforms and tools. Social mobilization recognizes that sustainable social and behavioral change requires many levels of involvement—from individual to community to policy and legislative action. Open data platforms and discussion apps are useful tools for these collective efforts.

Open data contributes to improving participatory democracy through development of innovative products and services to empower interactions between government and citizens and information polity. Data-driven offerings (e.g., open data platforms) can add to the citizens understanding of their community and social environment and enable them to engage and collaborate directly in the solution of societal problems. Such platforms enable citizens to understand (and engage with) the content of the debates and stages of the decision-making process in a fully transparent way. Development and availability of these services improve public's decision making, social and resource mobilization, and economic growth as participation is key to a thriving data innovation. Additionally, depending on the societal challenges that are being addressed (some services tend to address more local challenges), participation can help achieve social and behavioral change through co-development and use of these services. Real democratic participation at the community level enabled by data-driven services significantly improve mobility and wellbeing as citizens will become more responsive to changes that can lead to health gain. Availability of data services is particularly critical as Ireland strives to implement the Sustainable Development Goals and well-being at a local and regional level.

4.2. RQ2 – Quantifiable indicators

Below, we present our overall findings that we can see from the full list of indicators identified for each impact area. For a full list of proposed quantifiable indicators, please refer to the Table 1 (<https://bit.ly/3v4uGoO>).

As regards indicators to measure the impact of open data initiatives on *governance of public administration*, data suggests that government organizations are the main body to develop an optimum mix of flexible data-driven programs, activities and mechanisms that can be strategically utilized to achieve government's objectives (e.g., public service innovation, cost reduction, etc.). These objectives are achieved either directly by the government or in cooperation with other sectors such as

the private sector or the voluntary sector. *Therefore, most of the proposed indicators are appropriate for governmental use to evaluate the impact of open data on different dimensions of the government.*

As regards indicators to measure the impact of open data initiatives on *solving public problems*, indicators suggests that open data movement in Ireland is evolving towards more interaction, participation, and collaboration between different social actors and government entities. Indicators identified in this category emphasize on the role of open data on enabling social inclusion and citizen's collective efforts about important public affairs. *Indicators further suggests that the first step would be the presence of more interaction, participation, and collaboration mechanisms in the data.gov.ie portal.*

As regards indicators to measure the impact of open data initiatives on *creating new economic opportunities*, data suggests that open data encourages innovators and intermediaries and trigger acceptance in private sector and research communities. *Indicators identified in this category show that open data in Ireland has a great potential to transform hierarchal markets into an open and networked economy where new business models and data-driven goods can emerge.*

As regards indicators to measure the impact of open data initiatives on *empowering citizens and the sharing society*, data suggests that open data in Ireland provides citizens with the motivation, opportunity, and ability to generate sustainable value. Indicators show that citizens engagement help sustain open data initiatives in Ireland. Open data activism groups and journalism are important activities in this area. However, before we even start assessing the impact at this level, *we need to put in place potential resources to facilitate citizens develop a deeper understanding of to what ends (what it is we want to accomplish with open data) and by what means (how this can possibly happen).* Thus, measuring awareness is very vital before measuring the means (data and technology) and the outcome as social and technological progress co-evolves to generate sustainable value.

As regards indicators to measure the impact of open data initiatives on the *democratic process*, indicators suggests that the main idea is establishing networks connecting hundreds or even millions of people, combined with an abundance of freely flowing data and information, exhibit the features of a giant neural network, that exhibit emergent intelligence, and that computes data and community driven democratic solutions to the social and political problems. Open data platforms can provide these open citizens network with shared values and meaningful communication and interaction that citizens need to be included in the democratic process. There's no question that building a

healthy, thriving, and resilient democracy requires governments to open data to the public. However, focusing on increased access to greater amounts of open data without consideration for usability can limit the potential for sustainable open data re-use for democratic purposes. As can be seen from the list of indicators in this category, *assessing public problems and demands are the core objectives. Open data-based democracy can be truly maximized when data publication and usage are prioritized based on public demand.*

5. Discussions and practical implications

Below, we discuss some of the results of this study.

First, the use and impact of open data is more political than democratic (E. Ruijter et al., 2020). It is very important to ignore politics (publish data regardless of what the data reveals, or how they are used, and for whose interests) when publishing and using data for public benefit (E. Ruijter et al., 2020). We observed that open data movement is more political and seeks to present a good image of both the organization and the country in terms of openness and democratic government. Open data initiatives fail to make impact and the society more democratic if they simply serve the interests of capital by opening data for commercial use and further empowers those who are already empowered (Gurstein, 2011).

Second, we have presented the importance of open data products and services, more specifically open data platforms. However, we have observed that, open data platform users consider seeing a novel innovation to be most central to an engaging and encouraging design, while open data platform owners consider revenue models the most essential. The key point for discussion is therefore, how the different open data platform design requirements interrelate and how the new business models can be designed according to the market's state.

Third, with all the efforts and activities initiated by the national open data team, we observed that the public sector is becoming less involved in the field of open data. There is a significant gap between the data enthusiasts and the public sector. On the one hand, data enthusiasts use their technical and data skills to extract insights from open data and visualize them in a meaningful story. They are more likely to make impact out of open data use (Daphne van Hesteren et al., 2022). On the other hand, public bodies themselves have difficulty with re-using open data for organizational optimization and improving the government. The recent national open data effort tries to fill this gap by connecting public bodies with the data enthusiasts through offering variety of training courses, workshops for different user groups, or reaching out to universities

and schools to provide open data courses. Sustaining similar initiatives are necessary to bridge this gap.

Fourth, members of the public are the key stakeholders to the success of open data programs. Public wants to engage, participate, and influence a debate. However, they have differential access to the tools required to process the data, as well as varying levels of data and technical skills to analyze, contextualize, and interpret the data (Gurstein, 2011). Those groups who can make compelling sense of the data, they do not necessarily have the contacts needed to gain a public voice and influence a debate, or the political skill to take on a well-resourced and savvy opponent. Thus, to make a greater impact, open data leaders and initiatives must reconsider the way public are connected via and involved in open data activities (Sandoval-Almazan & Gil-Garcia, 2012).

Fifth, open data can provide a window of opportunity to introduce public service reforms by being broader embedded into the framework of public service quality and delivery (MacCarthaigh & Hardiman, 2019). We found interesting use cases where open data have been used to improve public services in Ireland. We observed that this was in large part made possible by those publicly available open data initiatives that seek to involve individuals (e.g., public and students) and spin-offs who have the required skills set to make sense of the data and use it to improve public services. This observation argues that 1) organizational fragmentation issue exists, and it is necessary for open data leaders to introduce a range of measures that are consistent with the post-New Public Management principles and priorities of government reform to strengthen public bodies co-ordination across government and engagement in open data initiatives in terms of introducing service planning, monitoring of performance, service review, and the use of indicators to measure the impact of their own services; 2) practices adopted by these individuals or spin-offs may not meet the core characteristics of the service reforms in public sphere. This alone may lead to equality and inclusion issues. Therefore, we suggest that developed open data solutions be closely monitored and evaluated against inequality and exclusion.

Sixth, lack of public awareness and knowledge on various social and contemporary issues is a major obstacle to community and sustainable development (Jetzek et al., 2014). On the one hand, data suggests that the use of open data by citizens is essential for knowledge creation, use, and share of competencies to persistent practical problems (citizen science). Open data platforms that facilitate data visualizations and enable open and free discussions among citizens are critical tools for citizens to transfer/gain knowledge and competencies to/from other members of the public.

Knowledge creation and diffusion enabled through these services contribute to improving social/demographic inclusion, community development, and inform social advocacy efforts on different critical social issues. This and similar democratic and participatory efforts impact social and resource mobilization, decision makings at the community level, and behavioral change. On the other hand, new open data-driven business models can emerge to support citizens participation, instill trust-building, and benefit SMEs and community organizations commercially. While open data innovations (e.g., participatory open data platforms) may not work in the same way for everyone, SMEs are better technically equipped to develop innovative products and services that can address societal challenges of the majority. Data suggests that, to improve participatory democracy, technology and/or services that require technical skills and data literacy to operate with should not be considered the only way of engaging citizens. As a result, businesses and civil society organizations must combine perspectives to understand, prioritize, and build joint sustainable solutions that can tackle bigger societal problems.

The main practical implication of this research is to provide public bodies with information for the development of the groundwork, supporting infrastructure, and policies that promote the publication and use of open data not only in public organizations but also by the members of the public, especially in terms of participation and collaboration. Understanding the impact of open data could help leaders to make informed decisions regarding public policies and reduce the gap among public sector organizations in terms of data publication, data sharing, and implement joint open data initiatives. It could also be useful as a roadmap for assessing existing initiatives and developing the next national Open Data Strategy.

6. Conclusions

Our aim with this paper is to explain what the impacts of open data use in Ireland are and identify potential indicators that can be used to measure the impacts of open data initiatives in the future. Our observation urge that open data leaders call for new forms of joint action between public and private stakeholders. This is largely possible if 1) organizations actively share, open, and re-use data across boundaries for public good and 2) new forms of citizens engagement is developed with the consideration that people are driven not only by the wish to improve their own material situation, but also by the need for subjective well-being and the wish to be a contributing member of society (Jetzek et al., 2014).

We note several limitations to this study. First, indicators for impact analyses may struggle to adequately observe and capture long-term changes because the social and economic context may change, which requires indicators to be adjusted to these changes. Second, measurements can be applied across various types of institutions ranging from single organizations (public or private) to entire countries. Therefore, adopting organizations are required to identify what indicators interact within their own unique ecosystem. Third, findings from this study are solely based on the open data use cases in Ireland. Further investigation may be needed to adopt it in other jurisdictions.

The team will continue their journey on finding high value datasets in the Irish context and further investigate possibilities that the results from this research project could support the European Data Strategy and Data Spaces.

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