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Value derivation via Open Government Data (ODG) for attaining Sustainable Development Goals (SDGs) via trade & commerce: Case study of select trading partners

SDG's attainment via OGD value derivation across trade & commerce

Value derivation in trade & commerce via ODG for SDGs attainment

Charalampos Alexopoulos alexop@aegean.gr Greece University of the Aegean

Mohsan Ali Mohsan@aegean.gr Greece University of the Aegean

Yannis Charalabidis Yannisx@aegean.gr Greece University of the Aegean

Stuti Saxena stutisaxenaogd.vishnu@gmail.com India

Euripidis Loukis Eloukis@aegean.gr Greece University of the Aegean

Nina Rizun Nina.rizun@pg.edu.pl Poland Gdansk university of technology

Given the impetus upon the availability and quality of Open Government Data (OGD) as prime considerations for usability, the value derivation through OGD interoperability unleashes vistas for realizing the Sustainable Development Goals (SDGs) via economic activities. Therefore, economic growth and development in terms of the SDGs attainment is possible in the globalized contexts where trade & commerce assume significance. For the present study, SDG-specific OGD across the 4 OGD national portals (UK, US, The Netherlands, Greece) are assessed across the availability-interoperability axes to understand how trade & commerce amongst the 4 trading partners might facilitate the attainment of 17 SDGs with value derivation initiatives across commercial products/services of the stakeholders. Specifically, cosine similarity is assessed for drawing inferences for the availability-interoperability loci. Findings show that most value derivation activities via trade & commerce towards the attainment of SDGs in the 4 countries are facilitated across SDG4 (Quality Education) and SDG11 (Sustainable Cities and Communities) where the availability-interoperability focus is strongest whilst the reverse is true for SDG 5 (Gender Equality); SDG 10 (Reduced Inequality), and SDG 17 (Partnerships for the goals) where the availability-interoperability focus is weakest. The findings are suggestive of the need for the practitioners and policy-makers to

institutionalize OGD initiatives with qualitatively robust OGD to stimulate value creation via trade & commerce products/services in the domains linked with the SDGs.

CCS CONCEPTS • Computing in government • Open Government Data • Computing in other domains

Additional Keywords and Phrases: Open Government Data, OGD, Interoperability, Semantic interoperability, Economic growth, Trade, Commerce, UK, US, The Netherlands, Greece, Cosine similarity, Python 3.11.2

1 INTRODUCTION

As a watershed in the trajectory of administrative innovations, Open Government Data (OGD) initiatives-i.e. publishing datasets pertaining to the structural-functional aspects of administration by the government via dedicated web portals in machine-processable formats- have clinched their validity in terms of projecting a novel self-image of governments in terms of furthering economic growth, transparency, collaboration and realization of the 3 E's of administration, viz., economy, efficiency and effectiveness [1][2][3]. Specifically, there is a significant bearing on "economic growth and activity" via the "collaborative", "participatory" and "cooperative" stakeholder engagement through the analytical inferences drawn from the OGD. Such inferences are a factor of the extent of OGD interoperability (i.e. "the ability of two or more software components to cooperate despite differences in language, interface, and execution platform" [4: 285] across the diverse sectors like energy, education, transport, agriculture, demographics, economy, and the like [5]. Inter alia, such value derivation exercises are consequential for the national and global landscape in terms of the realization of the 17 United Nations' Sustainable Development Goals (SDGs), viz., SDG 1 (No poverty); SDG 2 (Zero Hunger); SDG 3 (Good health and well-being); SDG 4 (Quality Education); SDG 5 (Gender Equality); SDG 6 (Clean water and sanitation); SDG 7 (Affordable and Clean energy); SDG 8 (Decent work and Economic growth); SDG 9 (Industry, Innovation and Infrastructure); SDG 10 (Reduced Inequalities); SDG 11 (Sustainable cities and communities); SDG 12 (Responsible Consumption and Production); SDG 13 (Climate action); SDG 14 (Life below water); SDG 15 (Life on land); SDG 16 (Peace, justice and strong institutions); and, SDG 17 (Partnerships for the goals) [6]. Through value derivation exercises across the 17SDGs may be better attained via trade & commerce which calls for OGD interoperability from an international perspective (i.e. OGD interoperability "across" nations) in place of a narrower national perspective (i.e. OGD interoperability "within" a nation).

Trade & commerce have been considered as significant contributors towards economic growth and development given their value-additive role in the globalized landscape [7][8]. Also, value-derivation/innovative applications through trade & commerce via OGD interoperability procedures are possible only when two prime conditions are fulfilled: the availability of OGD across the range of sectors, and, the quality of OGD provisioned via the dedicated web portals [9][10]. The present study seeks to understand how the availability-interoperability nexus fares across the national OGD portals of four trading partners, viz., Greece, The Netherlands, United Kingdom (UK) and United States (US) who are also the members of the World Trade Organization (WTO) [11]. The selection of these countries was a factor of the trade indicators and relatively advanced performance across major internationally-acclaimed indices, viz., trade statistics, GDP, Doing Business Report, Transparency Index, Global Innovation Index, ODIN rankings, for that matter. Table 1 (bilateral trade & commerce among the countries, facilitating conditions for conducting business activities, economic growth and OGD initiatives' progression) provides the required edifice to conduct an integrated assessment of the four countries in terms of the availability-interoperability nexus across the 4 countries in terms of attaining SDG goals via trade & commerce activities. Thus, the overarching research question for the study is: "*How far does SDG-focused OGD availability-interoperability facilitate value derivation across trade & commerce for SDG attainment amongst the four trading partners, viz., US, UK, The Netherlands and Greece?*"

Table 1: Countries' performance across select indicators

Country ↓	Per capita GDP (Gross Domestic Product) 2020	Ranking across Corruption Perceptions Index 2020 (out of 180	Doing Business Ranking 2020 (out of 190	Global Innovation Index 2020 (out of 131	ODIN 2020 ranking (out of 187 countries)	ODIN score (out of 100)	Coverage score (out of 100)	Openness score (Out of 100)

	(USD)	countries)	countries)	countries)				
Interpretation →	Higher the figure, more is the supposedly material well-being of the residents	1st rank implies highest transparency and 180th rank implies the reverse	1st rank implies most conducive regulatory conditions for doing business and 190th rank the reverse	1st rank implies highest innovation performance and 131st rank implies the reverse	1st rank implies superb OGD initiative in terms of the platform's efficacy and 187th rank implies the worst performer in terms of the OGD delivery via the dedicated web platforms	Higher the score, more is the likelihood of being open, complete, statistically amenable and internationally-benchmarked for high quality	Higher the score, more is the availability of aggregated data and indicators	Higher the score, more is the likelihood of machine-processable OGD replete with license information and metadata availability
Netherlands (TN)	52162.6	8	42	5	6	82	70	91
US (US)	63530.6	25	6	3	22	70	61	78
Greece (GR)	17658.9	59	79	43	57	60	55	65
UK (UK)	40318.6	11	8	4	65	58	53	62
Annual trade statistics in $USD thousand (2020)								
TN-GR	4185669.27		TN-UK	71564919.03		TN-US	73713008.27	
US-GR	2797632.61		GR-UK	2430518.72		US-UK	113829913.34	

2 RELATED RESEARCH & HYPOTHESES

A close analysis of the three streams of literature, viz. **a)** Literature pertaining to the interoperability of datasets; and, **b)** OGD-focused literature contextualized across four selected countries. A close understanding of these two streams is important for deriving the research lacuna and situating the research question accordingly.

2.1 Literature referring to the interoperability of datasets

As such, interoperability is defined in terms of the datasets' and services' sharing among the stakeholders on the basis of the "agreements between requesters and providers on, for example, message passing protocols, procedure names, error codes, and argument types" [12: 271]. There are four types of data interoperability: technical (HTTP on the web facilitates technical interoperability such that the linkages are possible with other datasets available on the web; and, this holds immediate relevance for the OGD ecosystem), syntactic (the standardization of the communication involving a software client and server, however, it is not of much utility given the non-proprietary and machine-readable characteristics of OGD), organizational (involves high-level interexchange of datasets to realize specific goals; and, this is relevant for the OGD ecosystem given the collaboration and integrative stance of the government bodies) and semantic (providing a shared meaning to the datasets exchanged among the concerned providers/publishers; and, this is relevant for the OGD ecosystem because of the necessity to derive value out of the data re-use and potential applications across diverse fields) [13]. From another perspective, interoperability has been categorized as foundational (facilitating data exchange between two information technologies), structural (impetus on the data structure formats and other syntax-related issues) and semantic (the availability of common data models facilitates better understanding of the datasets across the different systems) [14].

Given its applicability and potential, interoperability finds apt usage across the digital contexts-case in point being the Internet of Things (IoT) technologies like cloud platforms, sensors, high-speed networks and the like [15], smart cities, Linked OGD pertaining to the Infrastructure for Spatial Information in the European Community (INSPIRE) [16] or the mySMARTLIfe platform wherein interoperability is facilitated with the Open Specifications Framework open APIs (Application Programming Interfaces), OGD and open SDKs (Software Development Kits) which ascertains interoperability of datasets across the smart cities of France, Germany and Finland [14]-given the involvement of the range of stakeholders in terms of the availability of multiple dashboards and visualizations across heterogeneous platforms which calls for their integration via interoperability techniques and aids [17]. Extending this argument further, it is understandable that OGD interoperability is facilitated on account of the availability of heterogeneous datasets sourced from different portals and/or sources/platforms notwithstanding the fact that there are conflictual structures and names on account of the URIs (Uniform Resource Identifiers) and the structuring of data cubes [18]. Thus, interoperability results in smoothening, harmonization or homogenization of the datasets sourced from diverse fonts. Furthermore, citizen interaction via the dataset interface is facilitated via the intelligent services layer.

2.2 OGD-focused literature contextualized in Greece, The Netherlands, UK, US

A snapshot of the key OGD-focused literature contextualized across the four countries has been provided in Table 2. It may be inferred that the demand-supply equilibrium in terms of the expectations and needs of the users vis-a-vis the OGD providers needs to be matched across the four countries apart from the trite issues, viz., lack of coordinative mechanisms among the government agencies, limited technical and functional functions for OGD re-use and interoperability by the users, low citizen engagement, and the like. However, there is no gainsaying the fact that the OGD are relatively at an advanced stage in line with their stage of economic development or OGD initiative's "readiness" and "openness" patterns (Table 2).

Table 2: OGD-focused research contextualized across the four countries

Author/s	Objective	Findings
	Greece	
[1]	Analyses technical, functional and semantic dimensions of OGD portals	But for geodata.gov.gr and Greek LOD Cloud, other OGD sources are yet to attain an advanced stage
[19]	Thematic, functional, semantic and technological characteristics of OGD sources is being presented	There is limited thematic coverage as also limited provision for data linking as also relatively low quality of OGD on account of missing metadata, non machine-readable formats or incompatibility vis-a-vis licensing requirements
[20]	Assesses the extent to which the EU standards are being adhered to in Greece	Technical, legal, economic and cultural regulatory norms should be fortified in Greece for ensuring the robustness of the Greek OGD initiatives
[21]	Assesses the extent to which OGD initiative is facilitative for Greek tourism sector	Lack of a participatory culture and trust create barriers for realizing the benefits from the "OpenGov" platform of Greece
	The Netherlands	
[22]	Assesses the probabilities of OGD value derivation	Challenges and opportunities are present in terms of the applications of the OGD via statistical inferences
[23]	Strategic execution of the OGD initiatives is measured across policy and strategy; legislative foundations, organizational arrangements, relevant skills, public support and awareness	Centralized OGD governance is preferred for ensuring the sustainability and long-term viability of OGD initiatives
[24]	Comparative assessment of seven Dutch OGD organizational OGD publishing policies and execution	Inter-organizational coordination is important for ensuring the success of the OGD initiatives and there is a need for ensuring the strategic execution of the OGD policies for furthering the usage of the same among the concerned stakeholders
	US	
[25]	Assessing the trajectory of the OGD Initiatives in US with regard to the drivers and barriers and the progression so far	Whilst the secrecy norms have been done away with to a great extent, the legislative norms need to be strengthened
[26]	Assessing the application of socio-technical approach for understanding how the OGD	An ecosystem approach may be adopted wherein the planning and execution of the OGD initiative involves the ecosystemic

		Greece
	Initiative may be furthered in the select cases of New York and St. Petersburg by the involvement of the stakeholders concerned	engagement of the concerned users across diverse domains such that the OGD policies are comprehensive to all and the actual benefits are being realized by all those concerned in a benefitting manner
[27]	Assessing the manner in which the US-supported Open Government Partnership (OGP) is in sync and being promoted by the US government as also being reflected in the OGD policies of the country	Whilst, on the one hand, the transparency and intergovernmental coordination notions are being upheld in the US Open Government Initiatives, the actual alignment of the same with the OGD is not being witnessed to a great extent
		UK
[28]	A comparative analysis of the UK and US OGD initiatives across two case studies was done, viz., health care (UK) and policing (US)	Civil society network was more of an advocacy-hinged in the US whilst it was more proactive in the UK; government-civil society interface in the US was more cooperative but formal in the UK; and, the overall control and monitoring was more direct and autonomous in the US than that in the UK
[29]	Assesses the significance of OGD initiative of UK from the perspective of broader implications on the policymaking	OGD initiative in the UK should be pitched in terms of furthering the country's image as being an "informational state" which encapsulates the need for sustaining the market economy
[30]	Presents a comparative assessment of the digital platforms maintained by the governments of France, Italy and UK	At the intra-national level, homogeneity in terms of the publishing of OGD by the governments is missing and there is fragmentation of efforts at the intra-national levels which leaves adverse impact on the participatory and collaborative pitches of the OGD initiative

2.3 Research gap

Amply attested from the aforesaid, it falls in place to draw an integrated assessment amongst the 4 countries within the loci of availability-interoperability fractal with specific alignment to the attainment of SDGs via trade & commerce. Besides substantiating the scant literature on OGD initiatives' contribution towards furthering economic progress of a country via value derivation, this study would also be a contribution towards the technical research taxon [31].

3 METHODOLOGY

The focus of the presented research is to examine the available SDG-focused OGD across 4 selected countries, viz., UK, US, Netherlands and Greece, in terms of the OGD availability and semantic interoperability among them. Semantic interoperability is defined in terms of the "definition of content, and deals with the human rather than machine interpretation of this content [...] interoperability at this level denotes that a common understanding exists between people regarding the definition of the content (information) being exchanged" [13: 6]. The datasets were retrieved by the national data portal of each country by manually visiting their data portals for the dataset's metadata and then were organized according to the 17 SDGs. Three researchers were involved in this manual procedure alongside the final concurrence of the two researchers. During this phase, special attention was paid to ensure the open data retrieved was in accordance with the SDG's thematic area. To proceed, each one of those datasets was analyzed from a semantic interoperability perspective by examining its "title", "description", "file type", "language", "version type", and "metadata". The reason these properties were included in the analysis is that they can be used to measure the semantic proximity of the datasets.

The downloaded datasets were integrated in one file, where all the necessary information was stored for all the 17 SDGs and the four countries in a structured format (Comma-Separated values (csv)). The data was prepared for the analysis by following the typical pre-processing steps and then it was analyzed using the related Python libraries [32] and cosine similarity comparison [33]. Cosine similarity returns a non-negative similarity index that indicates the extent of similarity, i.e. measurement of proximity between two sequences/datasets with each other. A value near 1 represents a high degree of similarity between the datasets, while a value close to 0 indicates a lower level of similarity. Thus, the cosine similarity looks for the common words in both sequences in the numerator and divides them by the sum of the unique words in both sequences in the denominator. The formula is presented in Figure 1.

Figure 1: Cosine similarity between two vectors, A and B

$$similarity(A,B) = \frac{A \cdot B}{\|A\| \times \|B\|} = \frac{\sum_{i=1}^{n} A_i \times B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \times \sqrt{\sum_{i=1}^{n} B_i^2}}$$

For instance:

Dataset 1: Number of Lawyers Number of lawyers, new entrants and departures

Dataset 2: Number of Accountants/Tax Professionals Number of active accountants, new entrants and departures

Cosine similarity index: 0.78 (Using the Cosine similarity formula, we determined that Dataset 1 and Dataset 2 share a 78% similarity in their titles and descriptions.)

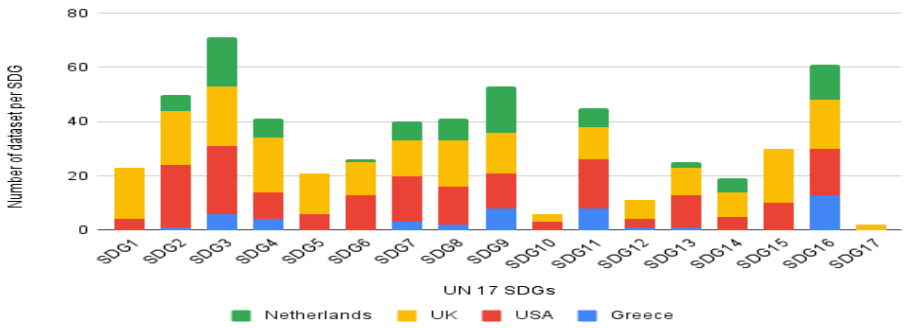
In our case, the aforementioned rationale was applied by comparing each dataset's attributes (as described earlier) against the other datasets of the same SDG of the other countries. The outcome of this comparison is intuitive with respect to the semantic interoperability of the examined datasets and its calculation can help determine the level to which this is achieved.

In total, 565 datasets were retrieved from the national OGD portal of each country and analyzed following the described methodology with concomitant 487,560 comparisons amongst them. Each SDG-related dataset vector was compared to every dataset vector of the other datasets of the same SDG of the other three countries. In order to pertain to meaningful results, only the datasets which scored higher than 50% in similarity were included for interpretation. The proposed methodology aims to target OGD semantic interoperability by quantifying the similarity of the examined data using the cosine similarity approach, while the OGD availability is based on their frequency per country per SDG experience.

4 RESULTS

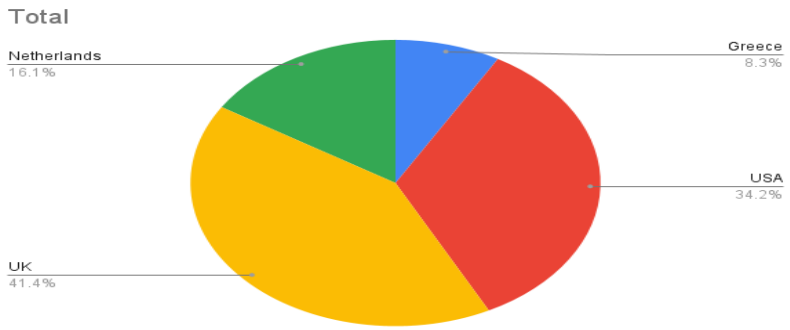
As the first parameter of examination in the presented study, the availability of OGD per SDG for the Netherlands, UK, USA and Greece are shown in Figure 2. The graph indicates that the SDGs with the highest number of datasets are SDG 3 and SDG 16, followed by SDG 9, SDG 2, and SDGs 11, 5, 6, 13, 14 and 15 are significantly lower in number. The SDGs 10, 12 and 17 are the ones represented by the lowest number of OGD. The colored parts of the graph represent each country's dataset contribution per SDG.

Figure 2: Availability of OGD per SDGs in the selected countries



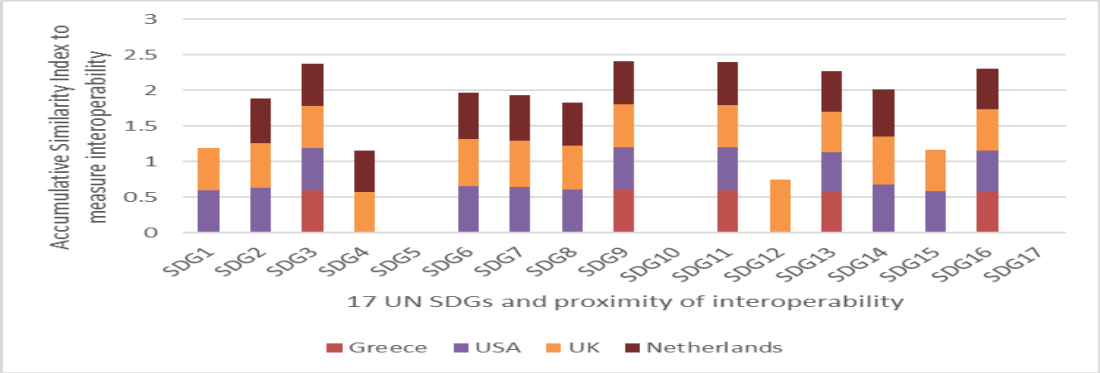
The pie chart of Figure 3 demonstrates an overview of the dataset contribution/availability) of each of the examined countries regarding their availability on SDG-related OGD. UK has the highest availability of OGD in our case, with a percentage of 41.4%, followed by the USA with 34.2%. The Netherlands and Greece contribute 16.1% and 8.3% respectively.

Figure 3: Availability of OGD for SDGs in the selected countries



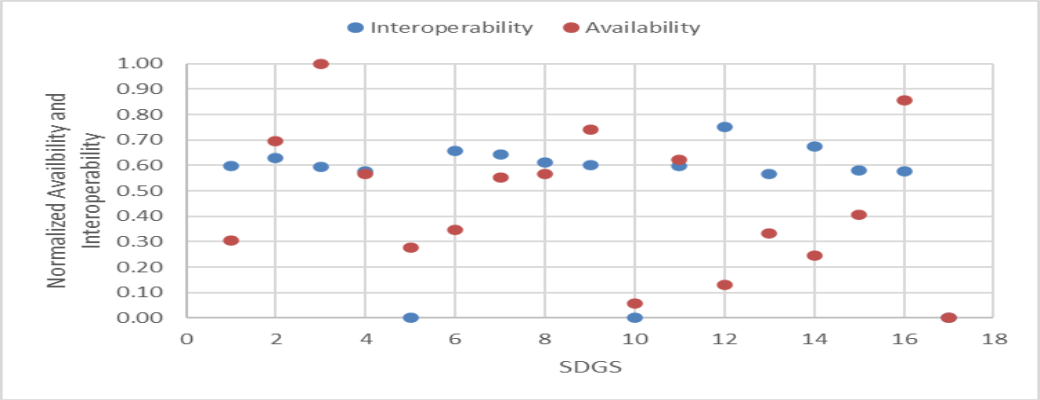
The integrated/accumulative similarity index represents a measure for the interoperability of the OGD distributed across the 17 SDGs for each of the four countries (Figure 4).

Figure 4: Similarity index for OGD for the 17 SDGs in the selected countries



The similarity index presented in Figure 4 is a measure of the semantic interoperability among the examined datasets, as in order to calculate it, various attributes of the datasets such as the name/title, description, language, metadata, version type and file type were compared during the proximity assessment procedure. The x-axis shows the SDGs per country (denoted in the different colors), while the y-axis shows the measure of accumulative similarity index for each SDG. The higher the value of the similarity index, the more interoperable the SDG-focused OGD. Figure 5 shows the normalized values for both interoperability (blue) and availability (red) of the datasets in a scatter plot. As Figure 5 indicates, the highest interoperable SDG is SDG 12 with a value of 0.75 (or 75% similarity), followed by SDG 14 with a similarity percentage of 67% (0.67). SDGs 6 and 7 follow closely after with values of 0.66 and 0.64 respectively. As far as the availability of datasets per SDG is concerned, SDG 3 has the highest percentage of 100%. High availability of OGD is also characterizing SDGs 16 and 9 with a percentage of 85.5% and around 73.9% respectively. SDGs offering low availability are SDGs 10 and 17 with almost no available OGD. The remaining SDGs are spread throughout the graph with intermediate values of semantic interoperability and availability.

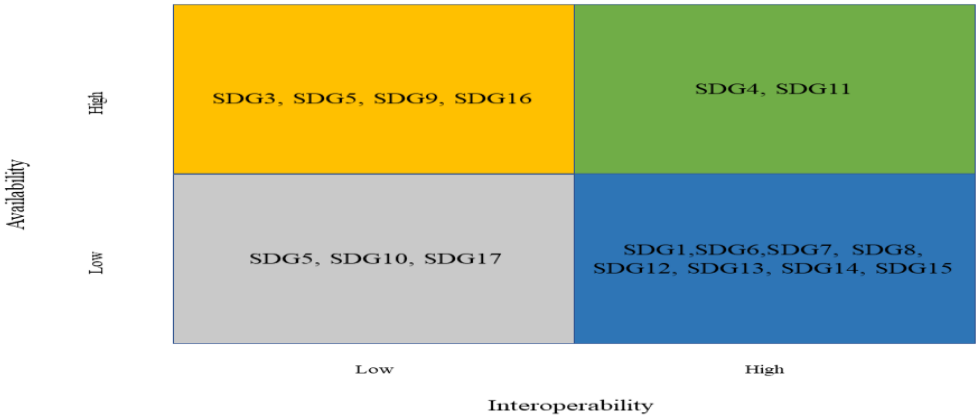
Figure 5: Scatter plot across the normalized values for availability and interoperability



As a different means of representation and to help visualize the aforementioned results in a more intuitive manner, Figure 6 shows the Availability – Interoperability Quadrant for the 17 SDGs, viz., SDG 1 (No poverty); SDG 2 (Zero Hunger); SDG 3 (Good health and well-being); SDG 4 (Quality Education); SDG 5 (Gender Equality); SDG 6 (Clean water and sanitation); SDG 7 (Affordable and Clean energy); SDG 8 (Decent work and Economic growth); SDG 9 (Industry, Innovation and Infrastructure); SDG 10 (Reduced Inequalities); SDG 11 (Sustainable cities and communities); SDG 12 (Responsible Consumption and Production); SDG 13 (Climate action); SDG 14 (Life below water); SDG 15 (Life on land); SDG 16 (Peace, justice and strong institutions); and, SDG 17 (Partnerships for the goals), across the 4 countries. The quadrant graph demonstrates the distribution and placement of each of the 17 SDGs across the availability-interoperability axes the summary of which is presented below:

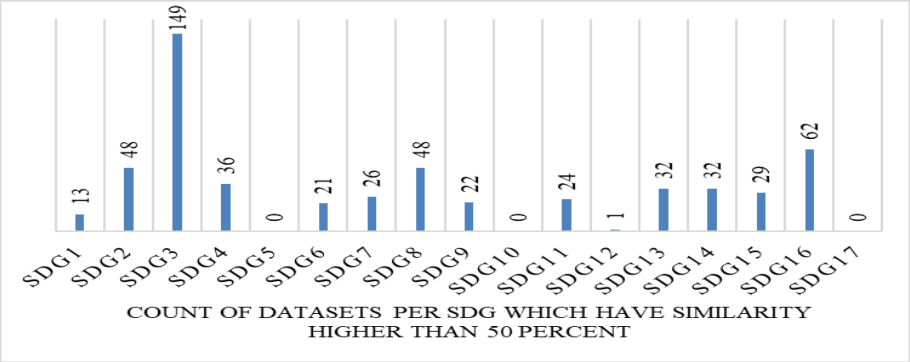
- Low Availability-Low Interoperability: SDG 5; SDG 10, SDG 17
- Low Availability-High Interoperability: SDG 1, SDG 6, SDG 7, SDG 8, SDG 12, SDG 13, SDG 14, SDG 15
- High Availability-Low Interoperability: SDG 3, SDG 5, SDG 9, SDG 16
- High Availability-High Interoperability: SDG 4, SDG 11

Figure 6: Availability - Interoperability Quadrant for the 17 SDGs



Furthermore, Figure 7 presents the number of SDG-focused OGD whose similarity score is more than 50%.

Figure 7: OGD per SDG with a similarity score > 50%



Thus, the reason for the low availability-low interoperability for SDG 5 is that no OGD scored a similarity over 50%. Similar are the case for SDGs 10, SDG 17 and SDG 12, with no or just 1 dataset satisfying this condition.

5 DISCUSSION

First off, a match between Table 2 and Figure 2 is attested given the similar assertions that the OGD initiatives across the 4 countries needs to be further strengthened in terms of quality as well as publishing. Most available SDG OGD is that of SDG 3 whilst the most highly interoperable SDG OGD pertains to SDG 12. Similarly least available SDG OGD is that of SDG 5 and 10 whilst the least interoperable SDG OGD is that of SDG 17. The best match for availability-interoperability SDG OGD pertains to SDG 4 and SDG 11 followed by those of SDG 8, 2 and 7. As far as the quadrant pertaining to the high availability-high interoperability is concerned, it is substantiated that increased availability of datasets shall be a precursor of increased interoperability whereas the other three quadrants' results are indicative of weak spatial interconnectedness [34]. For instance, in the event that there is a mismatch in terms of the quality-quantity, SDG-focused OGD, OGD-metadata, stakeholder demand versus government publishing [35][36], the "surprising" result for high availability-low interoperability may be better explained.

Furthermore, the results pertaining to SDG 4 and SDG 11 are in match with the overarching impetus of the 4 countries in terms of internationalization of education [37][38] as well as furthering sustainable development [39]. However, results pertaining to SDG-focused OGD pertaining to SDG5, 10, 12 and 17 are definitely surprising given the impetus upon promoting gender equality, societal equality, economic equality and responsible consumption and production [40][41][42][43]. However, it may be mentioned that such emphasis is probably surface-level and has not yet received the desired attention of the governments to further qualitatively robust OGD publishing across these SDGs. Finally, the congenial trade & commerce conditions might be bolstered to attain SDGs in the four countries by the increased value derivation activities of the stakeholders concerned given the impetus on globalization, economic progress, sustainable development, etc. [5][44][45].

6 CONCLUSIONS

Given the implications of OGD initiatives for furthering economic growth via value derivation initiatives of the stakeholders, the study sought to infer how the SDGs attainment in the 4 countries might be facilitated via trade & commerce across these trading partners. To drive home the point, the national OGD portals of the 4 countries were analyzed in terms of the tenets of semantic interoperability which assesses the availability-interoperability metric for the specific case of OGD here. Analyses across the SDG-focused OGD show that availability-interoperability focus is maximum across SDG 4 and SDG 11. Other quadrants' results are reflective of the need for proactiveness on the part of the government to publish qualitatively robust OGD for furthering the concerned stakeholders to engage in value derivation activities via trade & commerce in the domains of SDGs. The present study may be followed up by expanding the scope of the research question in terms of the countries' coverage and other metrics with specific implications for economic growth and development-case in point being the extent of government support for trade & commerce on the sidelines of SDGs among the trading partners. Finally, policy-makers and practitioners may derive insights from the present study in terms of streamlining the OGD initiatives with robust data quality to further the entrepreneurial spirit

among the concerned stakeholders for value derivation across significant trade & commerce products/services that would result in SDGs attainment too.

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