Open Government Data in Educational Programs Curriculum: Current State and Prospects

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Abstract. Extant research on Open Government Data (OGD) has remained confined to the grappling of issues linked with its conceptual, theoretical and empirical dimensions, however focusing on the supply of OGD physical capital (ODG portals, datasets, etc.), and to a lesser degree on the demand for it (e.g., needs of potential users), but not dealing with relevant OGD human capital (human knowledge and skills concerning OGD). Furthermore, research on meta-analysis or literature reviews has not expanded its scope to unravel the formation of OGD human capital, and especially how the OGD theme is being showcased across universities' curriculum. The present research aims to contribute to filling this research gap, through an analysis of the OGD-related programs and courses offered at the graduate and post-graduate levels across the top-notch universities identified as per the indicators of the QS World University rankings, 2023. Our theoretical foundation is the widely recognized 'Human Capital Theory' from the economic science, which gives prominence to the importance of the human capital (human knowledge and skills) as an important complement of the classical physical capital (e.g., production equipment, ICT capital, etc.). Our findings indicate that there are only small number of courses concerning OGD in these top-notch universities; furthermore, a very small share of them have OGD an main topic, while most of them include only a part concerning OGD. Most of them focus on the exploitation of OGD of a specific thematic domain (mainly urban studies and health), and only a few deal with OGD in general. Furthermore, there is a prevalence of postgraduate courses, offered as part of MSC programs, followed by undergraduate courses, offered as part of BSC study programs, and to a much lesser degree short courses. Also, with respect to the objective of these OGD-related programs and courses, most of them aim at the generation of scientific value from OGD, while a smaller number aim at the generation of social-political value, and only a much smaller number at the development of economic value. Therefore, it can be concluded that the formation of OGD human capital by the examined universities is limited.

Keywords: Open Government Data (OGD) · Human Capital · Universities · Curriculum · MOOCs

1 Introduction

Open Government Data (OGD) pertains to the availability of datasets concerning government operations and functioning via license-free [1, 7], which are linked with different themes contingent upon the area of administration, such as health, education, climate, tourism, environment, infrastructure, etc. [44]. The OGD can be used by scientific, social-political as well as economic actors and enable the generation of considerable scientific, social-political and economic value respectively, and in general can become a significant contribution of government to the development of the digital economy and society [7]. Due to the great potential of OGD, governments of most countries have designed and implemented OGD initiatives, and at the same time international assessments/comparisons of them are regularly conducted, leading to the calculation for each country of various standard indices like the ODIN [31], OKFN [32], Open Data Barometer [30], etc. [25, 26]. Considerable research has been conducted about the quality of OGD portals and datasets from the supply perspective (i.e. the governments' efforts at maintaining the quality of datasets) as well as the demand perspective (i.e. the perceptions of users regarding the quality of datasets) side [10, 13, 19, 22, 24, 27, 33, 38, 39, 42, 46, 49–51, 56].

However, economic science research has revealed that though the physical capital (i.e. production equipment, ICT capital (including hardware and software), etc.) and the labour are traditionally regarded as the main factors for the production of goods and services (and value in general), it is of critical importance for the efficient and effective exploitation of the former to develop appropriate 'human capital' as well; it is meant as relevant knowledge and skills of humans, and its importance increases with the complexity and sophistication of the physical capital, and this has given rise to the development of 'Human Capital Theory' [12, 28, 41] in the economic science: it gives prominence to the importance of the human capital (knowledge and skills of humans) as an important complement of the classical physical capital for the efficient exploitation of the latter. So, as mentioned above there has been considerable research concerning the OGD physical capital that has been developed by many countries (mainly the OGD portals they have developed as well as the datasets they provide), but there is a lack of research concerning the formation of relevant OGD human capital, which is quite important for the generation of value (scientific, political-social, economic) from the existing OGD physical capital. As OGD can become a significant contribution of government to the development of the digital economy and society, and governments make large investments in OGD physical capital (OGD servers, portals, datasets), it is important to develop the required 'soft complement' of it: the required OGD human capital: humans' knowledge and skills about OGD as well as its exploitation and the generation of value (scientific, social-political, economic) from them. Therefore, further research is required in the OGD domain concerning the OGD human capital formation. Given the magnitude of academic research interest in OGD - especially in the last 10 years

- it remains to be assessed as to how far has the domain progressed in the academic environments with respect to teaching; surprisingly, no research has been conducted to elucidate the infusion in academic education of this very significant domain - that is relatable to the extent to which the governments are forwarding their claims regarding the furtherance of transparent and corruption-free administration apart from bolstering citizen participation, collaboration and trust [15, 18] besides serving as a means for value creation and innovation by a range of stakeholders [20, 21]. Research pertaining to meta-analysis and reviews of the OGD-focused studies already published in academic publication outlets is well-acknowledged [3, 23, 35, 47, 48], and in order to carry forward the baton of OGD research, the present study seeks to extend its directions towards OGD human capital, by examining how OGD theme fairs across university curricula across the globe. So, it focuses on the most important mechanisms of human capital formation in general for the economy, and the universities, aiming to investigate its educational activity towards the formation of ODG human capital.

Specifically, the research questions for the present study shall pertain to the specific tributary of thought: *How has the OGD theme traversed across universities' curricula across the globe?* Specifically, the nature and scope of OGD-focused curriculum in the selected top 40 universities (based on the QS World University Rankings, 2023) were investigated using both qualitative and quantitative approaches. Thus, the present study seeks to address the need to further "communication and interaction among researchers (through the "common language" it introduces)" [6] by unravelling the maze through which such dialogue and discussion have progressed over the years in the mainstream university classroom settings. As mentioned above, the theoretical foundation of our study is the widely recognised 'Human Capital Theory' from the economic science.

The structure of the research paper is as follows: following a review of the related literature on OGD, the research design has been spelt out in detail; thereafter, the results of our research are presented and discussed, followed by some concluding remarks towards the close of the study, and also limitations, future research pointers and practitioner implications.

2   Related Research

Given the fact that OGD is an emerging domain, academic interest is also at an emerging stage [47, 48, 55]. OGD has been conceptualised as "a very heterogenous field of research" [48] involving researchers from economics, public administration, political science, etc. and initially most of the empirical investigation on OGD between 2008 and 2013 has remained confined towards aspects like transparency, participation, collaboration, technology, regulation/law, acceptance/trust in government, G2C/G2B relationship, public/citizens value and accountability. In their follow-up study focusing on a longer timespan between 2002 and 2019, Wirtz et al. (2022) [47] underlined that considerable qualitative and quantitative research has been conducted to appreciate the OGD policies/regulation/law, drivers/barriers, success/performance/value, acceptance/satisfaction, use/adoption/implementation and actors/relationships. Three areas of OGD-focused studies have been found in the meta-analysis of the research publications across 2011 and 2015: transparency, participation and collaboration [9]. Saxena

[36] identified three strands in OGD-focused research as far as the period between 2009 and 2017 is concerned: OGD-focused research with theoretical and conceptual underpinnings, applied (contextual) research and user-focused research. Finally, Saxena and Alexopoulos (2022) [37] have identified the four strands in OGD-focused research wherein the timespan extended from 2011 until 2022: research on conceptualisation and review of OGD studies; research on the benefits and challenges of OGD implementation; research on the quality of OGD portals and research on the adoption and usage of OGD.

From the foregoing, the reviews on academic publications on OGD indicate that the extant research on OGD has focused on OGD physical capital, both from a supply perspective (e.g., ODG portals, datasets, etc.), and to a lesser degree from the demand perspective (e.g., needs/satisfaction of potential users). However, it has not dealt with the formation of relevant OGD human capital (human skills concerning OGD), despite its high importance for the efficient and effective exploitation of the physical OGD capital, and the generation of scientific, political-social and economic value from it; this is imperative due to the large investments that governments have made for the development of the existing OGD capital, and the high operating costs of it (especially for selecting, processing, anonymizing and publishing new datasets). So, there is a need to widen the ambit of OGD research to appreciate how OGD themes are being discussed and deliberated in other formats - university curriculum, for instance, and this constitutes the raison d'etre for the present research.

3 Methodology

The methodology of this research includes two steps. First, we examined and assessed the most prominent rankings for evaluating academic institutions, and thereafter, we selected the most appropriate one to proceed with our research. In the second step, we used this list to identify the top universities in order to collect data on the OGD-related courses and programs they conduct, which we then analysed across their academic levels, course type, content delivery method, teaching language, thematic domains, value generation, OGD content.

3.1 Universities Ranking List Selection

At this first stage we had to evaluate the Global University rankings and decide which was more suitable for our research objectives, in order to identifying the top 40 universities. Although there is a plethora of University ranking indices that cover different qualitative aspects of higher education, the main three [17] and more influential rankings are: a) Times Higher Education World University Rankings [52], b) Quacquarelli Symonds [34], and c) Academic Ranking of World Universities [40], which are always present in several academic comparisons of global university rankings [2, 45, 53]; therefore, we concluded that we could proceed with a detailed evaluation of these three major ones.

World University Rankings Times Higher Education (THE): The THE ranking was initially part of the QS rating system, but it became independent in 2009, and thereafter, the two systems had diverged their methodologies. This system uses thirteen performance indicators grouped into five categories: teaching, citations, research, international outlook and industry income.

Quacquarelli Symonds (QS): The QS rating system was first published in 2004, and its methodology is comprised of six indicators designed to cover the educational process in its entirety. The indicators used are: the university's academic reputation, the employee's reputation, the faculty-student ratio, the number of citations per faculty, the international faculty ratio and finally, the international student ratio.

Academic Ranking of World Universities (ARWU): The ARWU ranking was developed by the Shanghai Jiao Tong University, and it was announced for the first time in 2003. Its methodology is comprised of six indicators mainly focused on research impact. The indicators are: the university alumni that have acquired a Nobel prize or a Field medal, the staff of the institution with the same distinctions, the highly cited researchers, the publications in Nature and Science, the number of publications that are part of the Science Citation Index (SCI) - Expanded and the Social Sciences Citation Index (SSCI), and, finally, the per capita academic performance of the institution.

For the purpose of the current study, ARWU was rejected since its indicators are focused mainly on research and reputation. Therefore, it does not provide an overall approach to the educational process. The QS and THE were split into two distinct indexes in 2009, and although their methodologies are diverging, they still contain significant similarities [2]. The main difference is that QS focus more on the international aspect of academic education, measuring international students and faculty members. Therefore, it is considered to provide a more well-rounded evaluation of educational institutions, and it was chosen to determine the top Universities in this research.

3.2   Data Collection and Analysis

For the data collection, initially, we identified some important fields/indicators, which are necessary for analysing the OGD-related university courses/programs. Our research plan was to analyse all the selected fields of the collected data to uncover their qualitative and quantitative aspects and to culminate in thorough results and conclusions. These important fields/indicators are:

- Program name
- The program is part of a degree/seminar/course
- Name of the institution
- Academic level
- Country of institution
- Program objectives and/or learning objectives
- Program Area of Specialization
- Program Overview
- Type of institution
- Program type
- Credits
- Entry requirements
- Content delivery
- Program cost
- Duration
- Language

- Comment
- URL

In the following paragraphs, we discuss the most important of them:

The program is part of a degree/seminar/course: This. Indicator was essential to identify whether the OGD-related teaching was provided independently or considered an aspect of a wider educational program (part of a master's or bachelor's).

Academic level:. The academic level was selected to identify in what tier of the educational process this teaching is conducted: undergraduate or graduate.

Country of institution:. The institution's country can provide essential information about the development of OGD in specific countries; however, the conclusions we can draw from this field/indicator are indicative, since we have collected data for the top 40 universities from a global ranking, and therefore we cannot make accurate comparisons between counties.

Program objectives and/or learning objectives, Program Area of Specialization and Program Overview: All these fields/indicators were used to understand the kind of educational content of the course, the type of the OGD targeted or used, or are part of the educational program and to identify their thematic categories.

Credits: Another metric we plan to examine is the credits of each course. However, this is indicative, since the universities from different countries have different systems/types of credits.

Content delivery: We distinguished two content delivery methods: in-person and online. After the identification of the main fields/indicators we need for each course/program, we proceeded to the discovery of the latter. Initially, the most widespread and popular method was used, the Google search engine. Harnessing search engines like Google (or Yahoo) for search optimisation with the help of keywords or strings is widely used in academic research, especially in webometric analyses [5, 8, 43, 54]. Furthermore, search engines, including Google Scholar, PubMed or Web of Science, are useful in conducting "(Boolean) searches with regards to precision, recall, and reproducibility" [16], which help in customised user-driven search [4]. Therefore, a query was constructed that contained three keywords, the university name, the term "open data", and the term "course"; the query was structured as "university name" AND "open data" AND course. However, the outcomes of this initial approach were not satisfactory, as it returned limited relevant results. The same query was also used in the search engines available on the university websites. Unfortunately, most universities did have their website search engine linked to Google, so we ended up with the same results. After this unfruitful attempt, we reconstructed our query by enhancing the second and third terms and the query was structured as "university name" AND ("open data" OR opendata OR open-data) AND (Bachelor OR "Executive Masters" OR Graduate OR "Higher Education" OR Masters OR MSc OR PhD OR Program OR Specialisation OR Training OR Undergraduate OR "Joint Master"). However, even with this enhanced query, the returned results, though there was some improvement, were not absolutely satisfactory, and therefore, we turned to new technologies, specifically the ChatGPT (Generative Pre-trained Transformer) application - a chatbot that OpenAI released in November 2022 - on account of the fact that ChatGPT is being increasingly used in academic research and practice which facilitates in easy access to information apart

from providing tailor-made real-time answers to the queries [14]. The query we used in ChatGPT included the university's name and a question to return the courses related to OGD. Unfortunately, ChatGPT could not provide direct results; still, it provided us with scientific fields where the university offered courses related to OGD. These results helped our research endeavours as we manually examined the courses and programs offered by the faculties associated with the specific scientific fields. This process was followed for each of the top 40 Universities.

4   Results

Following the first step of the above methodology (described in 3.1), we found 36 entries (courses or programs) in total in the above top universities. The most interesting finding is that open data was mentioned directly in the title of only 4 courses, and in the description or the curriculum of the remaining 32 (30 and 2 respectively). Therefore, there are only 4 courses in these 40 top universities having open data as their main topic:

– 'Astrophysics and Cosmology with Open Data', an undergraduate course, part of the Physics BSc of the California Institute of Technology (Caltech).
– 'Unlocking the Value of Open Data', a short course (1 day seminar) of the University of Hong Kong.
– 'Unleashing Open Data with Python', a postgraduate course, part of an MSc of the Johns Hopkins University.
– 'Challenges and Opportunities of Open Data', an undergraduate course, part of a BSc of the Faculty of Informatics of the University of Toronto.

All the other entries we found are courses, short courses or seminars, and also one MSc program, which include parts that concerning open data. Therefore, we can conclude that open data still have a very limited presence in the curricula of the examined top universities, which currently have quite limited educational activities towards the development of the required OGD human capital (knowledge and skills about OGD as well as its exploitation and the generation of value from them), despite their huge potential and possible contribution the development of the digital economy and society.

4.1   Quantitative Analysis

First, we investigated the academic level of the OGD-related educational courses/programs: how many of them are available at the undergraduate academic level, how many at the postgraduate or doctoral level, and how many at both (as they can be attended by both undergraduate and postgraduate student); also, we have summer schools and seminars that are not part of any academic level and therefore we identified them as non-applicable to this metric. The results are shown in Fig. 1 below. We can see that most (52,8%) courses/programs are postgraduate, but there is a considerable share (25%) of undergraduate ones.

The research then focused on the type of courses/programs offered, where we identified six distinct types.
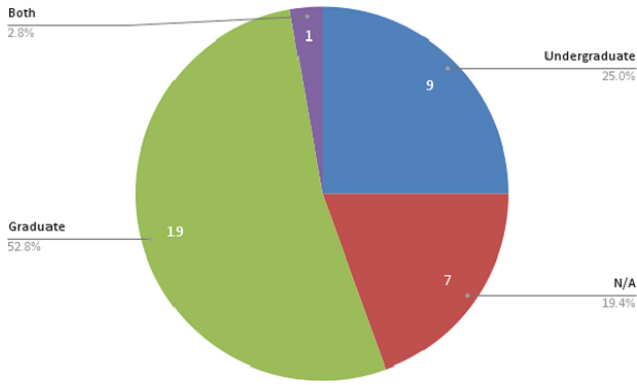
Fig. 1. Academic Levels

- Educational Module (Course) independent of any undergraduate postgraduate program
- Course Part of BSc
- Course Part of MSc
- Master's Program where most modules of the program are related to some form of open data. Summer schools
- Short Course: distance learning (online) without participation requirements
- Seminar for students or professionals
- Summer School for professionals

In Fig. 2 we can see the results: the most predominant type were courses that are part of MSc programs (44%), followed by courses that are parts of BSc programs (25%); furthermore, there also some short courses about OGD (14%).
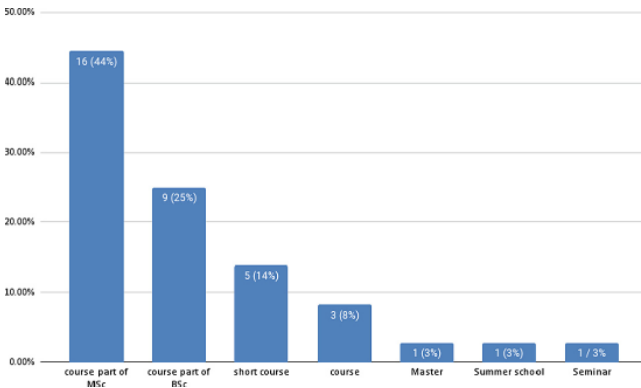

Fig. 2. Course/program Types

Next, we examined the Content Delivery methods of these OGD-related educational courses/programs, and the results are shown in Fig. 3: most of them (83%) are conducted

with physical presence (In Person), while much less (17%) – mainly short courses - are conducted through ICT-supported distance learning (Online).
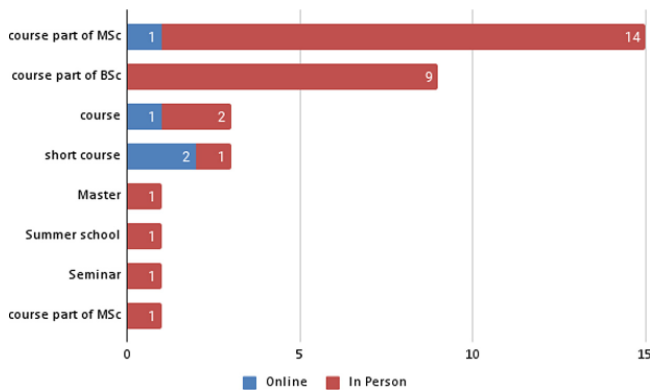

Fig. 3. Content Delivery methods per Type of Course/Program

Furthermore, with respect to the language used in these courses/programs, we have found that the overwhelming majority of them are in English language (94.4%), followed by Korean and French (2.8% each).

4.2 Qualitative Analysis

The qualitative analysis was based on the texts of the descriptions of the OGD-related courses/programs. Initially, we examined for each of them whether it concerned OGD of a specific thematic domain, or OGD in general, and the results are shown in Fig. 4. We can see that most of them concern a specific thematic domain (73%), mainly urban studies (27%), health (11%) and geospatial data (11%), while much less are generic (27%); this indicates that there is a lack of generic OGD courses, which can provide a complete and comprehensive in-depth view concerning the main OGD concepts, capabilities, frameworks as well as exploitation and value generation approaches (as courses concerning a specific thematic domain provide more limited views, focusing on the exploitation of OGD of this specific thematic domain).

It is worth mentioning these thematic OGD-related courses concern thematic domains in which large quantities of OGD are available, so it is necessary to develop knowledge and skills for exploiting them:

- **Urban:** data related to cities and urban areas, such as population, demographics, housing distribution, infrastructure, services, businesses, as well as traffic and transportation data.
- **Geospatial:** data related to location, geographic area, maps, etc.
- **Health:** data on epidemiology, diseases, public health services and healthcare (especially for COVID there is a wide availability of OGD).
- **Cultural:** cultural, historical and archaeological data
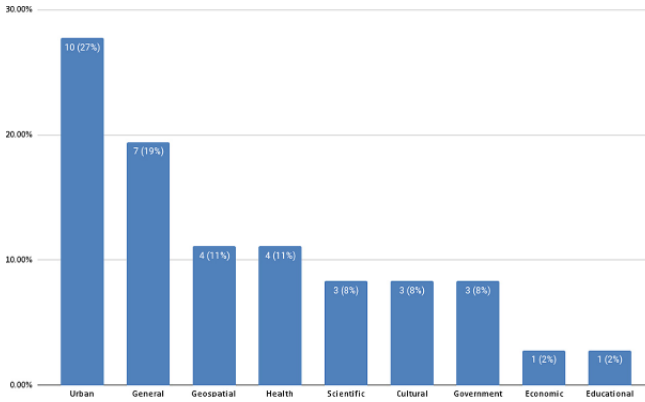- **Physics:** data used as part of research in the physics domain, like astrophysical data.

Fig. 4. Courses/programs thematic domains

- **Economic:** data on the economy, employment, business environment, growth and industry.
- **Chemistry:** chemistry-related data like molecular data.
- **Educational:** data about education, schools, students and teachers.

Next, we examined for each of these OGD-related courses/programs its main orientation with respect to the type of value (scientific, social-political, economic) generation it mainly targets. For this purpose, the classification of courses and programs was done using an open coding approach based on three fields of the collected data: the Program Objectives, the Program Area of Specialization and the Program Overview; additionally, in some cases, the curriculum of the program was also examined through the corresponding university web page. Our findings are presented in Fig. 5. We can see that most of the courses are targeting the generation a specific type of value, mainly scientific (41.7%), followed by the social–political (33.3%), and to a lesser extent (only 11,1%) economic value; the remaining (13.9%) are generic (i.e., do not focus on a specific type of value generation from OGD). Therefore, we can conclude most of the existing OGD-related courses/programs of these top Universities are oriented towards the scientific-academic exploitation of OGD (mainly for research); on the contrary, only a small share of them are oriented towards the generation of economic value from OGD (e.g., through the development of value added electronic services by combining several OGD datasets, provided by several different government agencies, and possibly private datasets as well), despite the emphasis that relevant literature (e.g. Charalabidis et al., 2018) [7] has placed on the huge potential of OGD use towards the creation of new economic activity and innovation.

Finally, we examined the content of these courses/programs, and we identified two main clusters: the smallest of them (38.9%) are dealing on the conceptual aspects of OGD (OGD concepts, capabilities, frameworks as well as exploitation and value generation approaches), while the largest (61.1%) focus on technical (mainly statistical and machine learning) methods and tools for processing OGD.
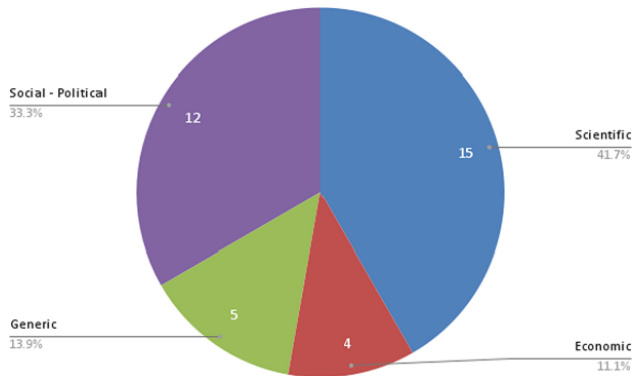
Fig. 5. Analysis based on the type of value generation from OGD

5 Conclusions

While previous OGD research has focused on the 'hard' aspects of OGD, dealing mainly with the massive OGD physical capital that has been developed by the governments of many countries, there has been limited research attention about the 'soft' aspects of OGD, and especially the OGD human capital (knowledge and skills about OGD), despite the importance of the later for the efficient and effective exploitation of the former. This study contributes to filling this important research gap, by analyzing the OGD-related programs and courses offered at the graduate and post-graduate levels across the 40 top universities of the world according to the QS World University rankings, 2023. Its theoretical foundation is the 'human capital' theory from economic sciences.

The main finding of our study is that there are only small number of courses concerning OGD (only 36) in these top 40 universities; therefore, these top educational institutions seem to make a quite limited contribution to the development of the required OGD human capital and have quite limited educational activities in this direction. Furthermore, a very small share of the identified OGD courses have OGD an main topic (only 4 out of 36), while most of them include only a part concerning OGD. This indicates that OGD is not regarded by the examined universities as a separate individual topic for teaching (though it is regarded as a separate individual topic of research); it is regarded (from a teaching perspective) rather as a part/aspect of other topics, or as a resource for researching them. Another interesting finding is that most of the identified OGD courses are thematic: they focus on the exploitation of OGD of a specific thematic domain (mainly urban studies and health); only a few deal with OGD in general. So, there is a lack of generic OGD courses, which can provide a complete and comprehensive in-depth view and knowledge concerning the main OGD concepts, capabilities, frameworks as well as exploitation and value generation approaches.

Furthermore, our study provided some interesting insights concerning the OGD-related courses and programs of the examined top universities. Firstly, there is a notable prevalence of postgraduate courses, offered mainly as part of MSc programs, and to a lesser extent courses offered as part of MSc study programs. Additionally, seminars and short courses for professionals are also present, albeit to a much lesser extent.

Secondly, our research indicates that from a thematic perspective courses concerning urban, general, geospatial and health OGD were the most prominent categories. Thirdly, most of these OGD-related courses and programs objectives concern the generation of scientific value from OGD, while a smaller number aim at the generation of social-political value, and only a much smaller number at the development of economic value. So, dominant is the orientation towards the academic-research use of OGD, but much less orientation towards economic activity and value generation using OGD.

Furthermore, the in-person lecture delivery is predominant the traditional academic levels (master, bachelor), an expected outcome since the online delivery of most courses during the COVID pandemic period resulted in a decline in their quality [11]. Finally, the majority of the courses that are targeted to professionals (e.g., short courses, etc.) use online teaching, which is also expected since they have to be adapted to the needs of the working individuals that are attending them.

The research presented in this paper has interesting implications for research and practice. With respect to research, it enriches the existing body of knowledge about OGD with useful new knowledge about the OGD human capital, and especially for the relevant educational activities for this purpose of the universities; furthermore, our research opens up new directions of research in the OGD domain concerning the existing OGD human capital as well its main formation mechanisms. With respect to practice, our findings can be very useful for the universities for the restructuring and the improvements of their curricula with respect to OGD, as they have a huge potential for the generation of not only scientific research value, but also: a) social-political value (by providing a sound basis for more substantial political debates concerning the main needs and problems of our societies), and b) economic value (by enabling the development of value added electronic services by combining several OGD datasets, provided by several different government agencies, and possibly private datasets as well). The universities have to devise means of generating interest of the students in OGD, perceiving OGD as a stratagem for furthering their employability prospects. Furthermore, our findings have implications for government agencies that are responsible for the design and implementation of policies concerning the opening/publishing government data; these policies have to include actions concerning not only the development of OGD physical capital (e.g., new servers, portals, datasets, etc.) but also OGD human capital as well, as the later is critical importance for efficient and effective exploitation of the former, and the generation of value from it (if the required OGD human capital is not developed they will run the risk of underutilization of the costly OGD infrastructures they have developed). Since the universities (at least the examined top ones) currently do not contribute considerably to the formation of the required OGD human capital, government should: i) on one hand facilitate the development of more OGD-related courses (both generic and thematically oriented) ay undergraduate and postgraduate level, though various incentives and OGD courses development financing programs; and ii) on the other hands develop other mechanisms of OGD human capital formation (e.g., OGD courses provision by national academies of public administration, free on-line some OGD-related courses, etc.)

Our study has limitations that need to be addressed by future research; beyond the basic one of having examined only 40 top universities, additional limitations are: (1)

During our data collection, we encountered several obstacles, but the most important one that has to be mentioned is the knowledge-based limit of ChatGPT, which is limited until September 2021, and most importantly, the language barrier as some universities, particularly in China, did not provide information in English about their degree programs and that resulted in their exclusion from the study; (2) Another impediment was the use of different credit types from universities, making the comparison a challenging undertaking. (3) Finally, the present research was limited in terms of the fact that stakeholders' perspectives were not factored into account, which would have been a significant contribution towards achieving a triangulation of the study findings.

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