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Data Science, Business Intelligence, and the Internet of Everything: A Scientometric Education Perspective with a Mountain Focus

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Abstract: *This paper delves into the intricate interplay of the Internet of Everything within the dynamic landscape of evolving data science and business intelligence, scrutinized through the discerning lens of scientometrics within the broader context of education social responsibility. The author posits that the primary objective of the Internet of Everything is to not merely bridge, but transcend the gap between business, education, and science, thereby fortifying the indispensable role of corporate sustainability in shaping societal paradigms. The meticulously validated results affirm the credibility of the proposed hypothesis and indicators. Notably, information technology, particularly within the expansive realms of the Internet and Internet of Things subdivisions, emerges as the paramount dimension influencing the underdevelopment of mountainous areas. The triad nexus established in this study remarkably diminishes the pervasive disparities between science, education, and business, with a singular focus on advancing people and human sustainability. Proposing seven innovative indicators within the triad, the research not only contributes to the existing body of knowledge but also envisages a transformative impact. Furthermore, the paper advocates for the adoption of common data science governance models across diverse country groups globally, fostering a collaborative approach to technological and societal advancement.*

Keywords: *Business Intelligence, Science education responsibility, Data Science, Internet of Everything, Mountain Entrepreneurship, Scientometry.*

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Introduction

The paper mainly develops the scientometric perspective of the Internet of Everything (IoE) as it reveals the importance of science education responsibility (SER) in the economic development of society, especially the business environment (Fernández-Gago et al., 2020). The founders of scientometrics, including Derek J. de S. Price and Eugene Eli Garfield, understood not only the importance of the quantitative approach to scientific management but especially the qualitative one by establishing coherent science policies (Yagi et al., 1996). Scientometric policies are intended to deductively insert data science and business intelligence feedback into science, and IoE to establish a solid bridge between science and public and private governance in order to perform SER (Ferramosca & Verona, 2020).

Reducing the gaps between science and the business environment is the main goal of highlighting the importance of value-added chains with a major impact on current human development (Blasi & Sedita, 2022). Business closer to the consumer is a present reality and not mythical wishful thinking. IoE can structurally change business and the way value is created, especially through research oriented to the micro, meso, and macro levels of the economy.

Objectives and Scope of the study

The perspective of mountain SER is necessary because the world of mountains presents more pronounced technological problems than hilly or plain areas. The difficult access of people, but especially of private and public governance, to information, gives the mountain area an increased development handicap compared to the other areas. The IoE represents a network of truly addressable connections between people, processes, smart things, and data/information flows (Langley et al., 2021).

The idea of reducing the differences between science and the business environment, business intelligence (BI), through data science (DS) has as a result strengthened the management process. Entrepreneurs become resilient for SER and against socioeconomic chaos through triad application. DS nexus BI will develop SER more than in the present. To achieve IoE, through the prism of scientometrics, data science and business intelligence must be accompanied by IT, especially the Internet and Internet of Things.

Research on data analytics and BI (Allam, 2021) proposes to connect the business environment to data science through the most important

current social platforms, such as Facebook, Linkedin, Twitter, Youtube, etc. The access of the business environment to data science, through such social networks, would increase the efficiency of SER, as well as the popularization of scientific production.

The topics of interest presented capture the importance of DS, BI, and IoE in SER and scientometric science. The authors propose some hypotheses, that will be verified during the paper.

Hypothesis (H) of the paper presents the influence of the DS and IoE in BI, respectively:

H1. DS & IoE influence the society (indicators A, D & D')

H2. DS & IoE influence the business environment by developing BI (indicators B & B')

H3. BI is influenced by researchers' visibility (indicators C & C')

Literature review

An empirical Brazilian study on DS, carried out on 211 relevant subjects (Medeiros et al., 2020), confirms the many advantages of science connected to business intelligence. The favorable arguments for this interrelation aim at ensuring support for DS and the rapid generation of results, developing a culture based on DS, creating an environment conducive to understanding the two main dimensions of IoE – DS and BI, promoting public and private governance.

A group of European researchers from Croatia and Spain (Škare et al., 2022) capture the importance of creativity, communication and leadership in the development of the business environment in correlation with science. In this study, they reveal, by applying methodologies such as VosWiever, Biblioshiny and the Page Rank algorithm, that more than half of the top authors' publications from 2004-2022 were made after 2016. This statement leads to the idea that in recent years' science has connected much better to the business environment than before 2016. Competencies related to SER, specifically the entire staff of an economic entity and not just managers, are becoming important topics for the global entrepreneurial ecosystem. As a result of the development of science in connection with SER, the entire staff becomes more active not only in the performance of tasks, but also in the complex development of the economic entity to which it belongs.

According to other Chinese and Australian researchers (Ram et al., 2016), study conducted in China on 40 relevant respondents, BI represents the ability of a company to properly use data collected from daily activity, with the aim of identifying new opportunities, highlighting potential threats,

establish new business perspectives, improve decision-making processes, etc. In the same study it is shown that a survey conducted by Thomson (now Clarivate) in 2004 suggests the major advantages of BI in making quick and clear reports (81%), improving business decisions (78%), customer loyalty (56%) and increase in profits (49%).

A group of Indonesian and Indian researchers (Purnomo et al., 2020) have captured the importance of the digital economy, especially digital business, in the nexus between DS and BI. The research was based on the scientometric analysis of 933 scientific documents from 1978 to 2019. The results reveal the increase in the number of digital business publications, which confirms the need for the business environment to mix more and more with DS. Favorite topics of digital business papers cover IT, e-commerce, digitization, management, business ecosystem, industry, benchmarking.

Australian professors (Klarin & Suseno, 2021) used a dataset containing 2229 academic papers from the Web of Science in the field of economics. The research reveals a common typology of the interdependent concepts of economics. Among the pillars of the typology of current economic research penned by these professors are independent work and its implications, transportation and solutions for sustainable development, user experience and collaborative consumption, respectively tourism and hospitality. There are themes in which public and private governance must get involved considerably in the coming years.

Two groups of international researchers from Finland, Qatar, France and Singapore (Mustak et al., 2021) and China (Wang et al., 2022), believes that the emergence of AI gives marketing practice and academic research interesting opportunities to connect with the business environment. Marketing is the science closest to the masses of the population, which is why DS and BI are closer than in any other science. Through dynamic algorithms, automatic learning, respectively the application of natural language processing, it was possible to decipher the consumer's behavior. The topics on the connection between DS and BI in marketing refer to understanding consumer emotions, analyzing industrial opportunities related to AI, painting the picture of customer satisfaction, electronic transmission of information, improving market sustainability, using AI, brand development, creating the real picture of customer loyalty, establishing the degree of interrelation between the development of AI and new services, the use of AI to improve customer relations and the establishment of main coordinates on the nexus between AI and strategic marketing.

Methodology and Conceptual framework

The research in the present material was conducted both inductively and deductively, following similar patterns such as (Allam, 2021). Inductive research developed by understanding the implications of DS in BI, by deepening the conceptual foundations of DS, BI and IoE. Inductive research followed the path of the scientometric laws. The deductive research was carried out through empirical methods, testing the hypotheses of the paper associated with the indicators A, B, B', C, C', D & D'.

Quantitative data from different databases were analyzed through SPSS–ANOVA (descriptive statistics), and forecasting techniques were applied. The qualitative approach was pursued through a thematic analysis line.

The values of the paper will be expressed as a unitary value (the variation between two years in percentage, divided by 100), not as a percentage. The analyzed years are the final – n and the initial – 1. The authors consider that the development of IoE should be realized according to DS intercalated with BI, the final purpose being the sustainability of the business environment.

Value added of the journal articles – α, represents the variation between two years of the published journal articles from a country or a region.

$$\alpha = \left[\left(\prod_n \frac{\beta_n}{\beta_1} \times 100\right) - 100\right]/100 \quad (1)$$

Value added of the internet access– γ, represents the variation between two years of the population internet access from a country or a region and shows the value added to DS. It will be expressed as a unitary value (the variation between two years in percentage, divided by 100), not as a percentage.

$$\gamma = \left[\left(\prod_n \frac{\delta_n}{\delta_1} \times 100\right) - 100\right]/100 \quad (2)$$

Value added of the population's access to DS journal articles – A (H1), represents the product of the *Value added of the journal articles* – α and *Value added of the internet access*– γ.

$$A = \prod \alpha \times \gamma \quad (3)$$

Value added of the listed companies – ε, represents the variation between two years of the listed companies from a country or a region.

$$\varepsilon = \left[\left(\prod_n \frac{\theta_n}{\theta_1} \times 100\right) - 100\right]/100 \quad (4)$$

Value added of the DS journal access in listed companies – B (H2), represents the product of the *Value added of the population's access to DS journal access* – A and *Value added of the listed companies* – ε.

$$B = \prod A \times \varepsilon \quad (5)$$

Value added of the researchers' visibility – ϑ, represents the variation between two years of the researchers from a country or a region.

$$\vartheta = \left[\left(\prod_n \frac{\mu_n}{\mu_1} \times 100\right) - 100\right]/100 \quad (6)$$

Value added of the DS researchers' visibility in listed companies – C (H3), represents the variation between two years of the researchers' visibility in listed companies from a country or a region.

$$C = \prod B \times \vartheta \quad (7)$$

Value added of the publication visibility – σ, represents the variation between two years of the entire publication products from a country or a region.

$$\sigma = \left[\left(\prod_n \frac{\tau_n}{\tau_1} \times 100\right) - 100\right]/100 \quad (8)$$

Value added of the DS publication visibility in listed companies – D (H1), represents the variation between two years of the entire publication products visible in listed companies.

$$D = \prod C \times \sigma \quad (9)$$

Specific for the mountain area, the paper proposes the DS & IoE penetration to the business environment through specific mountain SER.

Value added of the mountain enterprises – ε', represents the variation between two years of the mountain enterprises from a country or a region.

$$\varepsilon' = \left[\left(\prod_n \frac{\theta_n}{\theta_1} \times 100\right) - 100\right]/100 \quad (10)$$

Value added of the DS access in mountain enterprises – B' (H2), represents the product of the *Value added of the population's access to DS* – A and *Value added of the mountain enterprises* – ε'.

$$B' = \prod A \times \varepsilon' \quad (11)$$

Value added of the DS researchers' visibility in mountain enterprises – C' (H3), represents the variation between two years of the researchers' visibility in mountain enterprises from a country or a region.

$$C' = \prod B' \times \vartheta \quad (12)$$

Value added of the DS publication visibility in mountain enterprises – D' (H1), represents the variation between two years of the entire publication products visible in mountain enterprises.

$$D' = \prod C' \times \sigma \quad (13)$$

Data of the paper, processed from the World Bank (indicators A, B, C & D) and Eurostat (indicators B', C' & D') and simulated in SPSS or Excel, returned valid values for the World Bank country groups in Africa Western and Central, Africa Eastern and Southern, Arab World, East Asia & Pacific, Europe & Central Asia, European Union, Latin America &

Caribbean, Middle East & North Africa, North America, Sub-Saharan Africa, World, respectively European mountain countries Austria, Bulgaria, Croatia, Czechia, France, Italy, Poland, Portugal, Romania, Slovakia & Spain. European mountain countries have been taken into consideration because the European Commission reports data for the mountain regions, different from other countries or groups which do not have mountain reports. ANOVA (descriptive statistics) and forecasting techniques were applied. Qualitative data were observed, following a thematic analysis idea, namely DS, BI & IoE. Some data are incomplete (some of them were constructed by the authors through forecasting techniques or the principle of the most appropriate year to replace, exactly the adjacent year to analyze), the reason for the validation of the model calibration. Data results from Excel and SPSS (transposed to Excel), were deposited with DOI https://doi.org/10.5281/zenodo.7264586.

Results and Discussion

In similar research carried out on 331 articles by researchers from Chile and Spain it was found that research institutes form clusters, having common relevant topics, the aim being the delivery of scientific information (DS) to the population and the business environment (BI) (Contreras-Barraza et al., 2021). In the same line of research, researchers from China and Hong-Kong, using CiteSpace, analyzed 13068 cited references in 285 articles, finding that cluster is the best way to develop IoE through DS and BI (Zhai et al., 2020).

Other researchers in China and Hong-Kong found that the multitude of public services required the development of e-participation. 1322 articles were analyzed, finding that scientists collaborate intensively with public and private governance, the articles from the last 20 years being intensively oriented towards applied solutions, theoretical research being placed in the background. (Qi et al., 2018)

The results of the empirical research from the current paper have been validated through the presented indicators, taking into account the revealed hypothesis.

The first hypothesis of the paper suppose that DS & IoE influence the society (indicators A, D & D') (table 1).

Table 1. The nexus of the DS – BI – IoE at the world level, 2010-2020

Indexes/Countries	Africa Western and Central	Africa Eastern and Southern	Arab World	East Asia & Pacific	Europe & Central Asia	European Union	Latin America & Caribbean	Middle East & North Africa	North America	Sub-Saharan Africa	World
α	1,2779	0,8656	2,0694	0,6863	0,2006	0,0718	0,5896	1,2049	0,0280	1,0728	0,3831
γ	3,7125	4,1419	1,6619	1,0198	0,4695	0,2336	1,1234	2,1092	0,2615	3,8863	1,0717
A	4,7440	3,5851	3,4392	0,6999	0,0942	0,0168	0,6623	2,5415	0,0073	4,1694	0,4105
ε	0,0573	-0,1088	-0,0060	0,4188	-0,3649	-0,1465	0,0146	-0,0390	-0,2500	-0,0030	-0,0041
B	0,2717	-0,3900	-0,0206	0,2931	-0,0344	-0,0025	0,0097	-0,0991	-0,0018	-0,0127	-0,0017
ϑ	0,7018	0,3302	0,2333	0,2556	0,1773	0,3770	0,0815	0,4245	0,2178	0,3250	0,2454
C	0,1907	-0,1288	-0,0048	0,0749	-0,0061	-0,0009	0,0008	-0,0421	-0,0004	-0,0041	-0,0004
σ	0,5798	0,3505	1,0885	0,6461	0,3426	0,3369	0,5429	0,4000	0,1567	0,4075	0,2263
D	0,1106	-0,0451	-0,0052	0,0484	-0,0021	-0,0003	0,0004	-0,0168	-0,0001	-0,0017	-0,0001

Source: Authors according to (Eurostat, 2022), (World Bank, 2022)

According to table 1, the world DS insertion in the business environment developed considerably in the last decade (2010-2020), the forecasting for 2030 revealing the sustainability of the DS and IoE in BI.

Value added of the journal articles – α, shows that in 2010-2020 period Africa Western and Central, Africa Eastern and Southern, Arab World, Middle East & North Africa and Sub-Saharan Africa (values in 1-2 interval) developed considerably the impact of journal publication, the other group of countries being already developed at this indicator (values under 0,2). The recommendation for Africa Eastern and Southern, East Asia & Pacific, Europe & Central Asia and Latin America & Caribbean (values in 0,2-1 interval) refers to more emergency in journal publication and visibility.

Value added of the internet access– γ, reveals that Africa Western and Central, Africa Eastern and Southern, Middle East & North Africa and Sub-Saharan Africa (values in 2-5 interval) become more resilient to internet access. Arab World, East Asia & Pacific and Latin America & Caribbean (values in 1-2 interval) have to implement more politics in internet access in order to increase the IoE. The other groups of country developed the internet access to population before 2010 (values under 1). At the World level the internet access raised considerably, especially due to the first analyzed groups increasing.

Value added of the population's access to DS journal articles – A, presents increasing regions values for Africa Western and Central, Africa Eastern and Southern, Arab World, Middle East & North Africa and Sub-Saharan Africa (values in 2-5 interval). In these regions the journal scientific production developed significantly in the analyzed decade. The regions East Asia & Pacific and Latin America & Caribbean (values in 0,5-1 interval) increased the journal scientific production more than in the others decades.

Hypothesis 2 DS & IoE influence the business environment by developing BI (indicators B & B') and hypothesis 3 BI is influenced by researchers' visibility (indicators C & C') deepens the sustainability of the mixture between DS and BI.

Value added of the listed companies – ε, shows that in the analysed period the number of the listed companies, which can be impacted by DS, increased moderately or decreased. In regions such as Africa Eastern and Southern, Arab World, Europe & Central Asia, European Union, Middle East & North Africa, North America, Sub-Saharan Africa and World (values under 0) decreased the number of the listed companies, with effect of the DS penetration in enterprises. Thereby, the indicators related to DS penetration in listed companies have negative values to the reminded indicators, respectively *Value added of the DS journal access in listed companies* – B,

Value added of the DS researchers' visibility in listed companies – C and *Value added of the DS publication visibility in listed companies* – D. The other regions Africa Western and Central, East Asia & Pacific and Latin America & Caribbean (values over 0) increased the number of the listed companies, a fact that can be considered beneficial for DS penetration. As seen, the indicators *Value added of the DS journal access in listed companies* – B, *Value added of the researchers' visibility* – ϑ, *Value added of the DS researchers' visibility in listed companies* – C, *Value added of the publication visibility* – σ and *Value added of the DS publication visibility in listed companies* – D present highly increased values for Africa Western and Central, moderate increasing for East Asia & Pacific and low raising for Latin America & Caribbean. In the analyzed decade, the DS access to the listed companies increased for the hole indicators, even if the number of the listed companies decreased. Horizon for the following decade, 2020-2030, reveals that the DS journal access (B) and DS scientific publication (D) penetration will increase considerably. Thus, the forecasting of the DS insertion in the business environment present increased values for the entire publication activity, only in two regions the journal access being decreased, as following Africa Western and Central B +119,30 %, Arab World B +136,85% and C +49,98%, East Asia & Pacific B +74,47% and C +33,72%, Europe & Central Asia B +1,49% and C +23,36%, Latin America & Caribbean B +41,47% and C +32%, Middle East & North Africa B +63,58% and C +14,91%, Sub-Saharan Africa B +60,04% and World B +30,77%. The journal access in business environment will decrease in European Union B –22,76% and C +23,06% and North America B –8,46% and C +15,65%. The forecasting of the B indicator reveals normal values, even for the European Union and North America due to them continuous development from the last century. The positive values of the C indicator, for the entire indicators and regions, reveals that books and other electronic scientific publications, except for journals, will impact more the business environment than the journal articles. Consequently, the DS organizations could invest more in e-books and similar scientific products. (Eurostat, 2022; World Bank, 2022)

According to tables 2, results presented for the European mountain countries and areas reveal that the indicators have positive values in the European analysed countries.

Table 2. The nexus of the DS – BI – IoE at the EU and mountain regions level, 2010-2020

Indexes/Countries	Bulgaria	Czechia	Spain	France	Croatia	Italy	Austria	Poland	Portugal	Romania	Slovakia
α	0,2601	0,2399	0,1132	-0,0348	0,1070	0,2146	0,1129	0,4407	0,3502	-0,0024	0,4919
γ	0,5176	0,1819	0,4165	0,0973	0,3850	0,3130	0,1644	0,3348	0,4683	0,9648	0,1877
A	0,1346	0,0436	0,0472	-0,0034	0,0412	0,0672	0,0186	0,1476	0,1640	-0,0023	0,0923
ε	-0,3359	0,2500	-0,1810	-0,2593	-0,5667	0,0724	-0,2360	0,3719	-0,2308	0,1096	-0,2556
ε'	0,4506	-0,2859	0,1912	0,7809	0,4730	0,0818	0,0596	-0,1071	0,3594	2,2402	0,9341
B	-0,0452	0,0109	-0,0085	0,0009	-0,0233	0,0049	-0,0044	0,0549	-0,0378	-0,0003	-0,0236
B'	0,0607	-0,0125	0,0090	-0,0026	0,0195	0,0055	0,0011	-0,0158	0,0590	-0,0052	0,0862
ϑ	0,6245	0,4881	0,0837	0,2719	0,3524	0,5326	0,3222	0,9537	0,3307	-0,0138	0,1263
C	-0,0282	0,0053	-0,0007	0,0002	-0,0082	0,0026	-0,0014	0,0523	-0,0125	0,0000	-0,0030
C'	0,0379	-0,0061	0,0008	-0,0007	0,0069	0,0029	0,0004	-0,0151	0,0195	0,0001	0,0109
σ	0,2571	0,4370	0,3452	0,1287	0,2485	0,4778	0,0496	0,7185	0,9293	0,2821	1,2149
D	-0,0073	0,0023	-0,0002	0,0000	-0,0020	0,0012	-0,0001	0,0376	-0,0116	0,0000	-0,0036
D'	0,0097	-0,0027	0,0003	-0,0001	0,0017	0,0014	0,0000	-0,0108	0,0181	0,0000	0,0132

Source: Authors according to (Eurostat, 2022), (World Bank, 2022)

Specific for the European mountain countries, the indicators show that DS publications increased considerably in the last decade, and will rise in the following decade. *Value added of the journal articles* – α, shows that France and Romania decreased the production of journal publication (values under 0). The other countries present increasing amounts of the journal articles (values in 0-1 interval). *Value added of the internet access*– γ, reveals that Bulgaria, Spain, Portugal and Romania granted special attention to the internet access in the last decade (values in 0,4-1 interval), while the other countries reduced the rhythm of internet access. *Value added of the population's access to DS journal articles* – A, presents decreasing in France, Austria and Romania, the other countries being in the timeline of the DS insertion in BI (values under 0,02). *Value added of the listed companies* – ε, shows that in Czechia, Italy, Poland and Romania (values over 0) increased the number of the listed companies, while the others reduced or underdeveloped this indicator. Thereby, the indicators of the DS penetration in listed companies from Bulgaria, Spain, Croatia, Austria, Portugal, Romania and Slovakia have negative / null values for the indicators *Value added of the DS journal access in listed companies* – B, *Value added of the DS researchers' visibility in listed companies* – C and *Value added of the DS publication visibility in listed companies* – D. *Value added of the researchers' visibility* – ϑ, presents positive values for the mountain countries, except Romania. This country case is due to layoffs of some researchers on the background of the abolition of some Romanian research centers/institutes. *Value added of the publication visibility* – σ, show that the mountain countries of Europe sustain the scientific production intercalation in business environment.

Differently from the situation of the listed companies, the entire mountain SER (*Value added of the mountain enterprises* – ε') present highly increased values for the European countries, except for Czechia and Poland. The research qualitative show that this decreasing is due to the fact that companies were artificially created (which did not perform any activity), and then there were considerable liquidations because the legislation required the fulfillment of certain minimum conditions that could no longer be respected afterwards. The indicators *Value added of the DS access in mountain enterprises* – B′, *Value added of the DS researchers' visibility in mountain enterprises* – C′, and *Value added of the DS publication visibility in mountain enterprises* – D′, reveals that the highly developed European mountain country – Italy – could represent a model of mountain SER mixed with the DS. The latest purpose of the DS inserted in BI being the sustainability of the IoE in European mountain area.

In the analyzed decade, the DS access to the listed companies increased for the entire indicator due to internet access, even if the number of the listed companies decreased. Horizon 2030 reveals that DS journal access (B indicator) and DS scientific publication (D indicator) insertion in the business environment are positive and will sustain mountain SER. The forecasting values sustain the development of the mountain area, namely Bulgaria 0,3510, Czechia 0,2402, Spain 0,3069, France 0,4811, Croatia 0,3568, Italy 0,1951, Austria 0,1007, Poland 0,3269, Portugal 0,8957, Romania 0,5140 and Slovakia 0,4858. The forecasting of the B indicator reveals normal values, even for the European Union and North America due to the continuous development from the last century. The positive values of the C indicator, for the entire indicators and regions, reveal that books and other electronic scientific publications, except for journals, will impact more the business environment than the journal articles. Consequently, in Europe, the DS organizations could invest more in e-books and similar scientific products. (Eurostat, 2022; World Bank, 2022)

Conclusion

The authors of this paper find that DS impacts the business environment, developing IoE, at micro, meso and macro levels. Similar to research carried out by other teachers, from Holland, UK and Germany (Langley et al., 2021), the mentioned perspectives in the paper develop different externalities. From a micro perspective, DS develops both the provision of services to the consumer and the way frontline staff work. At the meso level, it is observed that the added value chain is sustainable under the conditions of the integration practices of resources and actors on each link in the created framework. At the macro level, DS in correlation with BI subsumes IoE as intelligent things and smart development change the ecosystem value of economic sectors and the interconnections between them.

The final goal of the DS in conjunction to BI in the context of IoE suppose the realization of the employee involvement in the entrepreneurial process and to become masters in their work field. DS helps managers and employees in SER resilience implementation.

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