A RANKING OF COUNTRIES CONCERNING PROGRESS TOWARDS A SOCIETY 5.0

Classificação dos países em relação ao progresso em direção a uma sociedade 5.0

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ABSTRACT

The Fourth Industrial Revolution has arrived, and we are trying to adapt to the innovations. It is changing the way we interact in society, how we consume, live and work. But this agile process already presents a new stage that takes place in conjunction with the new digital age, involving people, technology, sustainability, risks and opportunities: it is the 5.0 Society. This article seeks to understand the impact of ongoing changes and the needs around sustainability, analyzing key indicators that include both movements. With this, we hope to obtain data on the possibility of building the new Sustainable Technology Society, besides investigating the next steps to make this happen in Latin America. In this study, 35 variables were analyzed a sample of 57 countries, including management, business, sustainability, technology, education and Society 5.0 dimensions, among others. We present an analysis of the relationship between the variables and the creation of a synthetic indicator, called S5I (Society 5.0 Index), which allows us to show the position of each country in this ranking. This is the discussion we present here.
Key words: Society 5.0, Smart society, Fourth industrial revolution, Industry 4.0, Imagination society.

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A ranking of countries concerning progress towards a society 5.0

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RESUMO

A Quarta Revolução Industrial chegou e estamos tentando nos adaptar às inovações. Está mudando a forma como interagimos na sociedade, como consumimos, vivemos e trabalhamos. Mas esse processo ágil já apresenta uma nova etapa que ocorre em conjunto com a nova era digital, envolvendo pessoas, tecnologia, sustentabilidade, riscos e oportunidades: é a Sociedade 5.0. Este artigo busca entender o impacto das mudanças em andamento e as necessidades em torno da sustentabilidade, analisando os principais indicadores que incluem ambos os movimentos. Com isso, esperamos obter dados sobre a possibilidade de construção da nova Sociedade de Tecnologia Sustentável, além de investigar os próximos passos para que isso aconteça na América Latina. Neste estudo, foram analisadas 35 variáveis em uma amostra de 57 países, incluindo as dimensões gestão, negócios, sustentabilidade, tecnologia, educação e Sociedade 5.0, entre outras. Apresentamos uma análise da relação entre as variáveis e a criação de um indicador sintético, denominado S5I (Índice da Sociedade 5.0), que nos permite mostrar a posição de cada país neste ranking. Esta é a discussão que apresentamos aqui.
Palavras-chave: Sociedade 5.0, Sociedade inteligente, Quarta revolução industrial, Indústria 4.0, Sociedade da imaginação.

INTRODUCTION

Society 5.0 is a term used in the Fifth Science and Technology Basic Plan, reviewed by the Japanese Government´s Council for Science, Technology and Innovation, and can be defined as a "Society of Intelligence", in which physical space and cyberspace are strongly integrated. Although focused on humanity, 5.0 refers to a new type of society where innovation in science and technology occupies a prominent place, with the aim of balancing social and societal issues that need to be solved, while ensuring economic development (Salgues, 2018).

Recently, Keidanren (Japan Business Federation) has defined Society 5.0 as the "Imagination Society", where digital transformation will be combined with creativity and values to develop a sustainable society. In the Fourth Industrial Revolution, as called by WEF - World Economic Forum (WEF, 2019), we are observing the fusion between distinct scientific worlds, where the discoveries are mixing and building new frontiers. The main subject is that "what makes the Fourth Industrial Revolution fundamentally different from the previous ones is the fusion of these technologies and the interaction between physical, digital and biological domains" (Schwab, 2016).

In this new brave world, we have to learn how to use correctly and fully the capacity of the new developments. It´s necessary a correct direction, for example in the IoT, BigData and AI application, where "like other general-purpose technologies, their full effects won't be realized until waves of complementary innovations are developed and implemented" (Brynjolfsson, E.; Rock, D.; Syverson, C., 2017).

In Germany, there were discussions about Industry 4.0. This term was created in 2011 at the Hannover fair to describe how smart factories will be and how to revolutionize the organization of value chains. At MIT, we can observe this information and concerns about its application when it was mentioned that the effect of these digital technologies will manifest itself with full force through automation and unprecedented things (Brynjolfsson, McAfee, 2014).

We can see in the table 1 the main disruptive technologies regarding the Industry 4.0.

Table 1: Main Disruptive Technologies of 4.0 Industrial Revolution

	Features	Reference
Artificial Intelligence	Machine Learning, Advanced Algorithmics, Avatars, Chatbots and Automatic Decisions	Kaplan, 2016 Brynjolfsson at. al, 2017
Advanced Mobility Wide World	SmartPhones, 4G/5G, QRC, NFC, Autonomous Car	Deloitte, 2017[1]
Internet of Things - IoT[2]	Monitoring of Digital and Physical information, Wireless Sensors, RFID, Beacons and BLE- Bluetooth Low Energy	Greengard, 2015 Kevin Ashton, 2009[2]
Big Data	Data Science, Analytics, Structured and No Structured Data	Thomas Davenport, 2014
Blockchain	Cryptocurrency, Digital Ledger	Swan, 2015
Smart Environment (SmartCities and Houses)	Controlling and Decision, by machines or by human commands	Glasmeier et. Al., 2015
Ubiquitous Computing	Global Access and Storage	Schwab, 2016
Wearable Clouths and Devices	Human action measurement, Remote health monitoring, diagnostics and decisions, emergency notification systems	Greengard, 2015

Source: prepared by authors - adapted from references.

As a result, all industries have the potential to create new value through disruptive innovation and Advanced Mobility[1], both in terms of creating innovative products and services and improving supply efficiency. The key features of core technologies such as IoT[2], Big Data, and Artificial Intelligence are the common technology foundations in all industries, not only in the manufacturing process problem, but also in a wide range of industries across industry boundaries where most likely it will have an impact. As a result, there may be unforeseen rapid changes in the industrial structure and work structure itself, and new opportunities may be spread globally, but concerns about labor migration will be a concern. For this reason, in advance of this change, redesign of the entire economy and society including various legal systems has become essential to become more humane (Fukuyama, 2018).

Society 5.0 will be an Imagination Society, where digital transformation combines with the creativity of diverse people to bring about "problem solving" and "value creation" that lead us to sustainable development. It is a concept that can contribute to the achievement of the Sustainable Development Goals (SDGs, 2018) adopted by the United Nations (Nakanishi, 2019)[3].

More broadly, it is defined that a Smart Society as one where digital technology, thoughtfully deployed by governments, can improve three broad outcomes: the well-being of citizens, the strength of the economy and the effectiveness of institutions (Chakravorti, 2017)[4].

A bibliographic survey was carried out on the topic using the Web of Science database, and only 14 articles mention the theme of Society 5.0. Only a few of them actually work the core theme. This demonstrates the importance of addressing the issue, facing the challenge of achieving sustainable development around the world.

We have important issues that are appearing during this process, such as: what are the major components of society 5.0? Can we consider some countries as models for such societies? What kind of variables can we suggest monitoring and analyze this new model of society?

1 THEORETICAL REFERENCE

The studies on society 5.0 involves the search for new models and solutions to the main global challenges of today´s society on the context of the 4th Industrial Revolution - World Economic Forum, (WEF, 2019). Within these models we can highlight the Japanese model, presented at the last WEF, where he presents the transition from society 4.0 to society 5.0, through the following dimensions:

Table 2: Transitions Dimensions from Society 4.0 to Society 5.0

Dimension	Description
1 - Economies of scale	Problem solving & value creation: a society where value is created
2- Uniformity	Diversity: a society where anyone can exercise diverse abilities
3- Concentration	Decentralization: a society where anyone can get opportunities anytime, anywhere
4- Vulnerability	Resilience: a society where people can live and pursue challenges
5- High environmental impact Mass consumption of resources	Sustainability & environmental harmony: a society where humankind lives in harmony with nature

Source: prepared by authors - adapted from Nakanishi, 2019[5].

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[1] https://www2.deloitte.com/br/pt/pages/manufacturing/articles/futuro-da-mobilidade.html

[2] https://www.rfidjournal.com/articles/view?4986

[3] https://www.weforum.org/agenda/2019/01/modern-society-has-reached-its-limits-society-5-0-will-liberate-us/

[4] 48https://hbr.org/2017/10/the-smart-society-of-the-future-doesnt-look-like-science-fiction

[5] https://www.weforum.org/agenda/2019/01/modern-society-has-reached-its-limits-society-5-0-will-liberate-us/

Inside this model, we can find some indicators suggested by the authors, such as:

- **Problem Solving & Value Creation:** Wealth to growing populations, diversity, digital technologies, satisfying individual needs, solving problems, and creating value.
- **Diversity:** Diversity, discrimination by gender, race, nationality, etc.
- **Decentralization:** Concentration of wealth and information (or distribution), opportunities to study and work, population distribution, etc.;
- **Resilience:** Damage caused by earthquakes and floods, vulnerabilities, public security, growing social anxiety about terrorism and other crises, damage caused by cyber-attacks, resilience, unemployment and poverty, level of medical care, etc.
- **Sustainability & environmental harmony:** Energy efficiency, water supply and waste management, food wastage, etc.

In the study of smart society presented by Chakravorti and Chaturvedi (2017), other dimensions were also considered with other group of variables, such as: (1) Citizens/People: inclusivity, environment and quality of life, state of talent and the human condition, talent development. (2) Economy Components: global connectedness, economic robustness, entrepreneurial ecosystem, innovation capacity. (3) Institutions Components: freedoms offline and online, trust, safety and security, public services.

This article aims to compile, compare and suggest some important variables within the discussion of society 5.0, as a way to understand and make contribution in the development of the theme. Thus, we search for possible relations between variables related to the skills of the future (Coursera, 2019) and a set of variables linked to other dimensions of development of society that are aligned with the model proposed by the Japanese Keidanren. Below we can check the **34 Indicators** selected for this work:

- **Skills for the future**: Data Science, Data Management, Data Visualization, Machine Learning, Mathematics, Statistical Programming, Statistics, Business Global Ranking (BGR), Accounting, Communications, Finance, Management, Marketing, Sales, Technology, Computer Network, Databases, Human Capital Index (HCI), Operating Systems, Security Engineering, Software Engineering.
- **Society**: Global Innovation Index (GII), Global Innovation INPUT, Global Innovation OUTPUT, Control of Corruption, Environmental Performance Index (EPI), Well Being, Democracy, Vulnerability, Susceptibility, Peace, Governance, GINI Index.
- **Development Index**: Human Development Index (HDI), Social Progress Index (SPI).

2. METHODOLOGY

This is an exploratory study that seeks to contribute to the discussion of variables important to society. For this proposal, 57 countries were selected and divided into 3 regions: AIBER (Iberian American Region), AVECO (Advanced Economy Countries) and OTHERS (Other sample countries), as follows:

- **AIBER (12)**: Argentine, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Mexico, Peru, Portugal, Spain;
- **AVECO (22)**: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Rep. of Korea, Sweden, Switzerland, United Kingdom, United States;
- **OTHERS (23)**: Bangladesh, Belarus, China, Egypt, Hungary, India, Indonesia, Kenya, Malaysia, Nigeria, Pakistan, Philippines, Poland, Romania, Russian Federation, Saudi Arabia, Singapore, South Africa, Thailand, Turkey, Ukraine, United Arab Emirates, Vietnam

Using Minitab as statistical analysis software and data collected by the ORIBER and Global Skills Index Report (Coursera, 2019), we examined the possible dimensions of Society 5.0. The selection considered 35 synthetic indicators that were normalized (0-100) and positivized (the higher the better), out of which 10 were selected for being more representative; moreover for Saudi Arabia, Singapore, Vietnam and the United Arab Emirates, regression was used to estimate some missing values in the Welfare and SPI variables.

In our final analysis, using PCA (Principal Component Analysis) and Stepwise Regression, a **Society 5.0 Index -S5I** was developed, to represent our final model integrating the variables, and defining a ranking of the countries (see table 4).

It is important to emphasize the limitations of our study. The countries were selected according to their similarities in each group and the availability of data on these countries, in the many variables selected by us. As an exploratory study, it is an initial step that will require further analysis and further research in the future. It is, therefore, a proposal for a new approach in our academic environment.

3 RESULTS AND DISCUSSION

Figure 1: Dendrogram of the Level of Similarity of the 9 Indicators More Relevant
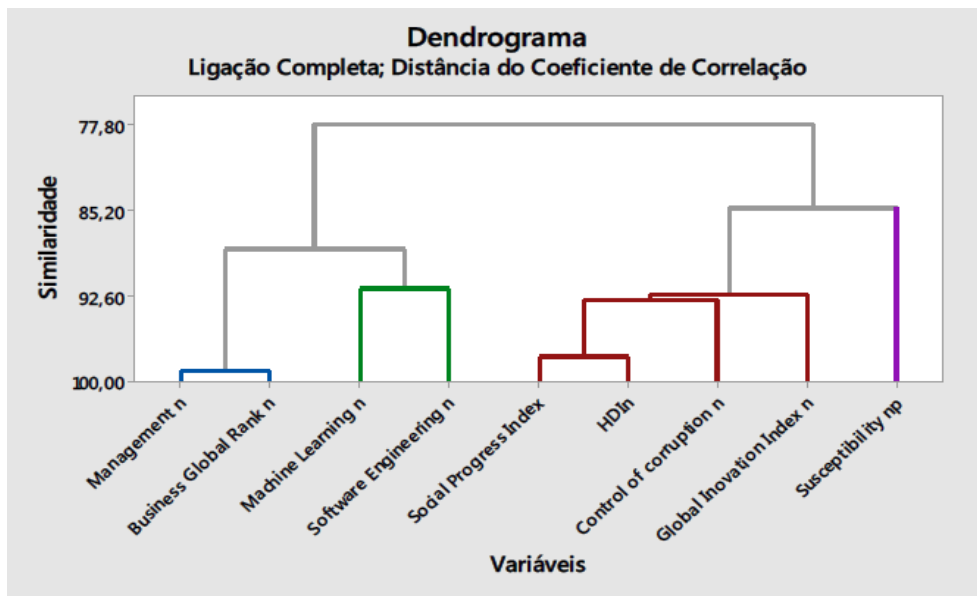
In the dendrogram it is possible to visualize some interesting relations. One may consider three main sectors of variables are present in the dendogram: Skills for the future –Sector A (4 variables), Society – Sector B (4) and Development – Sector C (2).

On the left side, Sector A it is possible to notice that the Management and the BGH (Business Global Ranking) run closely together (99.14) as well as Software Engineering and Machine Learning do (92.03) being technical tools. Actually, both groups seem to be closely connected (88.60). This scenario indicates the importance of human actions in the decisions of how to use technological evolution.

Then we have also high similarity between HDI and SPI (97.89), that correspond to Sector B related to main indicators for human development, the final goal to the sustainable society.

It is also interesting to observe three other variables in sequence. Control of Corruption, with of

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similarity with Sector B as well as 92.51 with GII (Global Innovation Index); all of these with 84.97similarity with Susceptibility. This scenario may indicate the strong systemic dependence between human development, the use of technological solutions and the government actions. It is worth remembering that the GII means how to deliver Innovative Solutions and how to build Cooperation between countries around the world and the control of Susceptibility means resilience, the ability to react quickly to crises and unforeseen events. It is sector C.

Moreover one may see a similarity of 77.80 between subgroups A and B/C; so we may consider some real needs of working for management and business using technology to achieve social and developmental outcomes in society. It is important to highlight that Management and HDI are the main variables in this study representing 70.2% of the results in our model.

There is an approximation between Democracy and subgroups A/B/C (69,03), what seems to indicate that it is necessary to have conditions of preservation of freedom, right of expression and security in the strengthening of an environment capable of sustaining a development of other variables.

It was observed that it is possible to relate the groups of variables that stood out most in the study with the Keidanren model, as described below:

- **Problem solving & value creation**: with the variables of *Management*, *Business*, *Machine Learning* and *Software Engineering*, which indicates the importance of a conscious management of business and technology in the generation of value to society, as is the case of HDI and SPI. Here, we show the dynamics of governance and transparency in organizations so that there is an alignment in the search for solutions to global challenges.
- **Resilience and Decentralization**: with the variables of *SPI, HDI, Control of Corruption, Global Innovation and Susceptibility,* that indicates that human development is important in the generation of skills and environments capable of generating a better response to crises, disasters and situations of risk. In this sense, *innovations* enter as a tool of collaboration in the process creating paths of greater connectivity and access to information. The idea is to create environments with greater opportunities for the people.
- **Diversity**: with the variables of *democracy, SPI and HDI*, that connects to environments of political stability, respect for diversity and freedom, economic stability and security, defending the freedom of individuals, strengthening the "being who they are" and being responsible for their choices.

Now from the point of view of the countries Table 3, bellow, shows the comparison of the 3 regions for each one of the 10 variables by using ANOVAs.

Table 3: Summary of Data (ANOVAs)

| Region	Management	Business	Machine Learning	Software Engineer	SPI	HDI	Control of Corruption	Global Innovation	Susceptibility	Democracy
		47,92								
AIBER	42,08		29,67	47,33	60,61	59,07	39,06	26,45	67,52	64,73
		75,55								
AVECO	77,09		76,32	68,14	93,90	91,62	86,27	71,42	88,00	83,15
		28,13								
OTHERS	29,83		36,91	36,52	42,00	50,04	39,35	30,33	63,53	38,67
		27,65								
F - value	28,86		24,19	7,93	48,18	33,95	28,87	40,04	10,80	46,66

Source: prepared by authors

The value of "F" in Table 3represents the degree of approximation between the regions was added (the larger the F value the greater the difference). The most important difference between regions is SPI (48,18) and the one that makes less difference is Software Engineering (7,93).

We have the following outliers by indicators: Republic of Korea (Management and Business, may be

because the country has had a quick development in the last decades), Israel (Susceptibility by the geographic region) and Singapore (Global Innovation, with superior indicator in OTHERS). Moreover considering the 3 Regions, these approximations and differences may be seen in the figure 2.

Figure 2 Variables by Regions
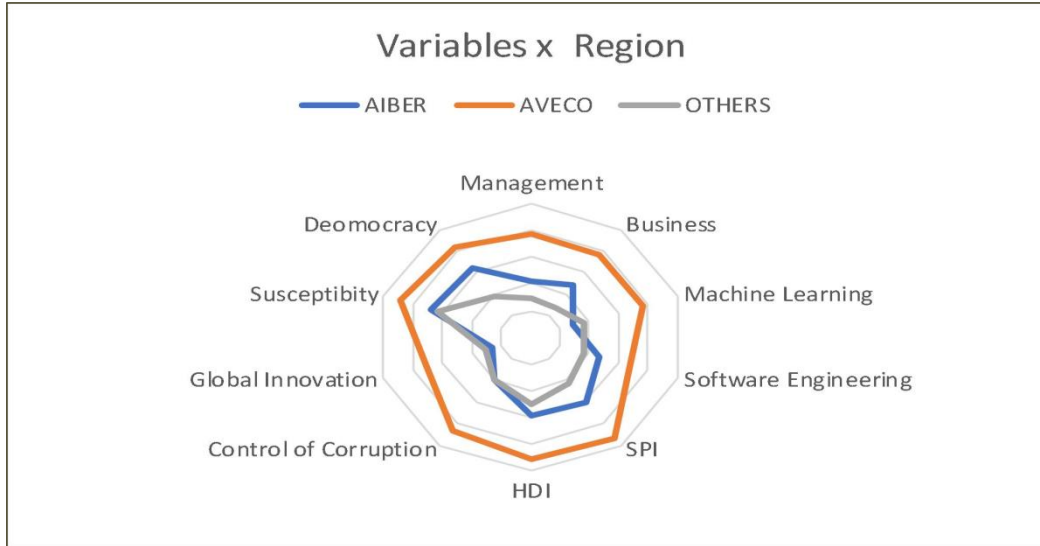
Comments:

✓ In the chart it is possible to notice that the ***AVECO region*** represents the best Indicators of the whole, distancing itself from the other groups of countries mainly in *innovation, human development (SPI and HDI),* and particularly *Corruption.* Most likely due to lack of Governance.

✓ The second group with the best performance is the ***AIBER region***: it emerges in the dimension of *democracy, medium indicator for SPI and HDI, software engineering and business* but presents the lowest score in the *Global innovation index and Machine Learning*. It is necessary pay attention because it is possible find out opportunities in this situation.

✓ In addition, AIBER approaches the ***OTHERS region*** in the issue of *susceptibility* which may indicate a greater need for investment under conditions of less exposure to risks and crises. The ***OTHERs region*** is the one with the lowest performance in the sample studied.

Main differences observed:

Susceptibility: This is the indicators where the ***AIBER*** and ***OTHER*** regions are very close, presenting as Outlier Israel (1) that is in the region AVECO. The highest indicator of the ***AIBER*** and ***OTHER*** regions was the susceptibility. This can be explained by the greater vulnerability of these countries to external influences. We need to reinforce that the low "F" factor (10,80) indicates that this susceptibility variable is the one of greater proximity and similarity between the three groups.

Global Innovation: Within the 10 variables, innovation was the dimension that presented one of the lowest performances and the greatest impact for the three regions, being the only dimension where the AIBER region was inferior to the OTHERS region. However, it is one of the indicators of lower adhesion in all regions surveyed with factor "F" 44.04. It may be that developing countries do not need more collaboration than they already have with other countries, and AIBER and OTHERS need more than they

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can get at this moment.

Democracy and business: For these indicators, it is clear that the AIBER region moves radically away from the OTHERS region in these two points.

SPI and HDI: These are the best indicators presented in the AVECO region. They present with the largest individual indicators of the study (93,90 and 91,62), where we can associate issues of health, education and income development.

Software Engineering: The lowest indicator of the AVECO region is related to technology (68,14). In the other hand, they are the countries where the advances are in the state of art with disruptive technologies. Is a point to research on future studies.

Business: This is the lowest indicator in the OTHERS region (28,13).

Finally, as shown in Table 4, using Principal Component Analysis and then selecting weights for the variables using Stepwise Regression it was possible to define what we are calling a Society 5.0 Index – SSI that lead us to define a Ranking as shown in Table 5, where one could observe that **regarding the Society 5.0 Index Spain is doing a little better than the United States as well as Brazil a little better than China… the two greatest powers today.**

Table 4: Ranking of Countries for S5I – Society 5.0 Index

Countries	Region	S5I - Index	Ranking	Countries	Region	S5I - Index	Ranking
Switzerland	AVECO	100	1	Romania	OTHERS	51,38	29
Austria	AVECO	94,71	2	Japan	AVECO	50,48	30
Finland	AVECO	94,46	3	Costa Rica	AIBER	47,76	31
Belgium	AVECO	92,3	4	Greece	AVECO	43,49	32
Sweden	AVECO	62,2	5	**Brazil**	**AIBER**	**43,27**	**33**
Germany	AVECO	91,13	6	**China**	**OTHERS**	**40,22**	**34**
Netherlands	AVECO	90,21	7	South Africa	OTHERS	39,36	35
Australia	AVECO	85,7	8	Ukraine	OTHERS	38,36	36
New Zealand	AVECO	84,1	9	Peru	AIBER	38,02	37
Czech Republic	AVECO	83,89	10	Malaysia	OTHERS	34,22	38
United Kingdom	AVECO	83,28	11	United Arab Emirates	OTHERS	33,47	39
Norway	AVECO	82,79	12	Colombia	AIBER	33,15	40
Canada	AVECO	81,35	13	Thailand	OTHERS	32,78	41
France	AVECO	80,93	14	Viet Nam	OTHERS	29,72	42
Israel	AVECO	80,71	15	México	AIBER	28,97	43
Denmark	AVECO	78,55	16	Rep. of Korea	AVECO	27,59	44
Singapure	OTHERS	76,03	17	Philippines	OTHERS	26,86	45
Poland	OTHERS	75,77	18	Ecuador	AIBER	24,14	46
Spain	**AIBER**	**75,04**	**19**	Guatemala	AIBER	22,65	47
United States	**AVECO**	**74,92**	**20**	India	OTHERS	22,58	48
Hungary	OTHERS	71,67	21	Dominican Republic	AIBER	22,14	49
Portugal	AIBER	66,42	22	Saudi Arabia	OTHERS	17,93	50
Ireland	AVECO	66,37	23	Turkey	OTHERS	17,58	51
Italy	AVECO	66,26	24	Indonesia	OTHERS	16,96	52
Argentina	AIBER	65,48	25	Kenya	OTHERS	15,73	53

Russian Federation	OTHERS	60,53	26	Egypt	OTHERS	8,28	54
Belarus	OTHERS	58,13	27	Nigeria	OTHERS	2,25	55
Chile	AIBER	57,18	28	Bangladesh	OTHERS	0,93	56
				Pakistan	OTHERS	0	57

Source: prepared by authors

The final average per region, for synthetic indicator S5I (Society 5.0 Index), is showing in the table number 5.

Table 5: Average by Region

S5I	Average
AIBER	43,68
AVECO	78,43
OTHERS	33,51

Source: prepared by authors

It is important to note that AVECO is almost twice the AIBER average (1,8) and 2.5 times the OTHERS average (2,3). This distance means a huge effort to develop new approaches and be close to the developed countries. This situation highlights the urgency of developing public and private policies for this purpose.

In the chart below (Figure 3) it is possible to visualize the pairs, within the sample surveyed, that stood out the most for these variables. The darker regions represent the places with the best performance. In general, the countries of the AVECO region (developed countries) presented the best results.

Figure 3 Dimensions that Favour the Development of Society 5.0
for the Countries of this Study

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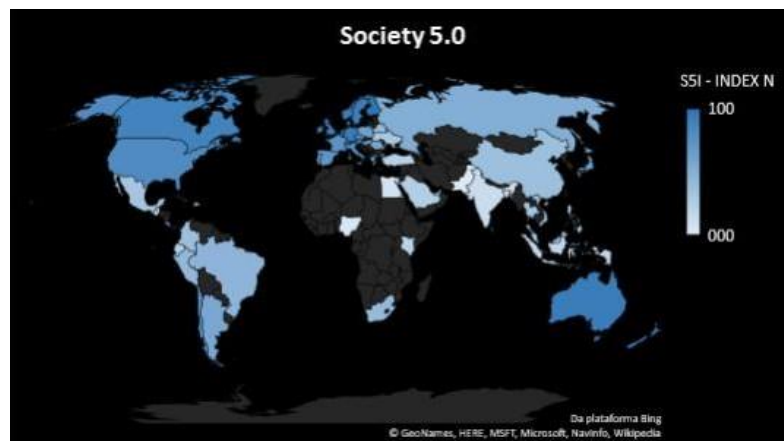
CONCLUSION

There are many directions in which society may advance through technological development. While technology could help improvements such as higher living standards may also have negative impacts, such as unemployment, increasing disparity, and uneven distribution of wealth and information. It's up to all of us to choose which direction we should go. We need to consider what kind of society we want to create rather than try to predict what kind of society it will be (Nakanishi, 2019), and try to foster a more Human Centered Development as recommended by Klaus Schwab of the World Economic Forum.

The use of technology is directly responsible for the success of the business and management, as everyone knows; but one need to highlight the connection between Management, BGH (Business Global Ranking), GII (Global Innovation Index) and Control of Corruption with HDI e SPI, Human Development indicators as a signal to get our total attention, because it means results that have a direct impact on the whole society. The appropriation of disruptive technology and government actions are the way to achieve the necessary inclusion and prepare the new generation for the Digital Age, following the United Nations Development Goals (SDGs, 2018) for a more sustainable society. What stands out is that the economic, social and environmental dimensions are revolving around the technological axis and that "the revolution now is to change our way of thinking and a way of living in greater harmony with nature" (Senge, 2008).

This theme is only at the beginning of its academic discussion and depends on concrete actions to be integrated to the society and to be part of the political agenda for sustainable growth, which is so much sought. In other words, government rules and policies need to include specific studies to prepare each state, culture, and society to figure out how to apply technology, where to apply the digital solution, and how to spend money. These indicators, studied here, show that there is a connection between management, technology and social outcomes.

On the other hand, the distance between the countries of AVECO and those of AIBER / OTHERS in Global Innovation shown figure 2 and the table 5, is very worrying, given that the time to address and manage modern technologies will take longer AIBER and OTHERS. Moreover timming is critical and leaders of the technologically advanced world that are mostly controlled by highly Concentrated Financial Systems. We are talking about software application such as Artificial Intelligence that do not require an industrial park to be developed, such as 4.0 Industry. But surely, it requires a better educational system and a strong leadership of nations and business leaders to watch out for these issues. A good example of this process is the Nagoya University in Japan, as mentioned recently by its President Seiichi Matsuo, regarding a new Educational Philosophy to help moving into a Society 5.0 Culture (Matsuo, 2019).

It will be almost impossible to deploy Society 5.0 in AIBER, at the same time with the rest of the developed world, if the ecosystem and the necessary positive conditions have not been prepared before.

We understand that society 5.0 is clearly linked to the SDGs (2018) in the most of dimensions. We suggest that new variables studies should be development with these directions also for a more Eco-systemic Strategic Public Management, using technology and data as a tool to identify the indicators that may help guiding to build better world for all. We could see from this study that these variables have a strong relation among them, so that these indicators may be considered in future studies to monitor and create models for the Society 5.0.

Acknowledgement

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