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"Exploring the Relationship between Scientific Research and Economic Development in Algeria: current status and Obstacles"

البحث العلمي والتنمية الاقتصادية في السياق الجزائري: الراهن والتحديات

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Abstract: *Scientific research is a crucial component in the development of economies, and it is commonly used as a benchmark to measure a country's level of development. Many countries prioritize scientific research by allocating substantial amounts of national income towards universities and research centers, with the aim of becoming a leader in this field. However, some countries face challenges that impede optimal investment in scientific research. This study aims to investigate the state of scientific research in Algeria, specifically focusing on universities and identifying the obstacles that hinder the evaluation of research outcomes. The research concludes that scientific research outputs in Algeria are insufficient, as evidenced by various economic indicators, and that the research product remains low in the international rankings, despite significant efforts to promote scientific research. These shortcomings call for intensified efforts to promote scientific research and enact reforms that foster applied research, while making universities a key player in society.*

Keywords: *scientific research, economic development, university,*
Jel Classification Codes: I23, O330

الملخص: يعد البحث العلمي ركيزة أساسية لتحقيق التنمية الاقتصادية للدول، فيعتبر أهم المعايير المستخدمة لقياس مدى تطور الاقتصاديات. ففي حين تولي بعض الدول اهتماما كبيرا له وذلك من خلال تخصيص نسب هامة من دخلها الوطني لتمويله بالجامعات ومراكز البحث، وتتنافس لتحقيق مركز الصدارة في هذا المجال. نجد بعض الدول تعاني العديد من المعوقات تحول دون الاستثمار الأمثل في هذا المجال. تهدف هذه الدراسة إلى الكشف عن واقع البحث العلمي في الجزائر بالتركيز على المؤسسة الجامعية والبحث عن أهم المعوقات التي تحول دون تثمين نتائجه. وتوصلت الدراسةإلى ضعف مخرجات البحث العلمي وهذا ما تجلى من خلال بعض المؤشرات الاقتصادية، وأن المنتوج البحثي لا يزال يحتل مراتب متأخرة على المستوى الدولي وذلك رغم المجهودات الكبيرة المبذولة لتعزيز البحث العلمي.تستدعي هذه النقائص إلى تكثيف الجهود للتعزيز البحث العلمي والقيام بإصلاحات تعمل على التجسير بين البحوث النظرية والتطبيقية وتجعل الجامعة فاعل أساسي في المجتمع.

كلمات مفتاحية: البحث العلمي، التنمية الاقتصادية، الجامعة، تثمين مخرجات البحث العلمي.
تصنيفاتJEL: I23, O330

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1- Introduction

Economic development is regarded as the foundation and the primary engine for societal progress. It's related to the expansion of capacities that contributes to the advancement of society through the realization of individuals, firm, and communities' potential. (feldman, theodora, & lauren, 2016). It consists of many factors, including the capital, human resources, scientific and technological progress, political, social, and cultural conditions, and the level of consciousness among members of society. In other words, it is not confined to material requirements; however, it also includes the availability of human capital. As a result, all countries strive for development that is centred on knowledge and higher education. The latter is linked to the focus on human capital as an aspect of economic growth and investment in it, as it can offer the market the necessary labour, which has a high level of competence, and boost productivity and face advancementsthrough knowledge transfer between scientific research, industry, and society that represents the translation of scientific research into economic development through valorisation of its findings. This transfer of knowledge is considered as a powerful engine of progress and inclusive growth.

Therefore, achieving development is relied on the university's continued existence as an educational institution that works on providing highly qualified people of all spheres of social life.

Universities play an important role in the formation of human capital.Furthermore, they are engaged in research as part of their mission in learning and discovering.

One of the most significant university occupationsis scientific research. It is impossible to talk about development without mentioning the importance of scientific research as the starting point for all development initiatives and the foundation for making any kind of scientific, social, or economic advancement. Accordingly, it was essential for the university to conduct and generate strategies that increase scientific production, promote and stimulate research which is a majorkey to future prospects.

Given the importance of scientific research, developed countries invest in high-quality research. While some countries are vying for the top spots in the list of global rankings by making investments in this area and developing strategies to gain a competitive advantage, we find that other countries are experiencing numerous issues and barriers that prevent them from improving their nation development capabilities.

The high education and scientific research in Algeria has achieved many improvements. However, it still suffering from manydifficulties that are accompanied by several challenges especially interms of knowledge valorisation of research results and bringing added value to economy and society.

Based on the aforementioned, we opted to ask the following question:

- What isthe reality of scientific research in Algeria, and what are the major challenges and barriers to the valorisation of research results?

To answer this question, we followed an analytical descriptive approach to the various indicators of scientific research aiming to shed light on the reality of this sector in Algeria, as well as to identify the most significant barriers that prevent the use of scientific research results in the service of economic development.

2.Economic Development:

The term economic development is often conflated with development and growth. However, Economic growth has a strong theoretical grounding and is easily quantified as an increase in aggregate output. Economic growth is easily measured, while economic development is more qualitative and “has meant all things to all men and women”. Economic development is focused on quality improvements, risk mitigation, innovation, and entrepreneurship that place the economy of a higher growth trajectory. While economic growth is tied to macroeconomic conditions and a function of market forces, economic development represents the conditions that determine the microeconomic functioning of the economy, affecting both the quality of

inputs and the opportunity set for firms. Economic development is associated with institutions, social capital, labour and capital mobility, and income and wealth equity. Economic development requires collective action and large-scale investments with long time horizons. Infrastructure projects, a traditional concern of economic development, now extends to the digital realm. The standard of literacy is expanded at a time when labour force participation requires a bachelor's degree with the expectation of continued lifetime education and training.(feldman, theodora, & lauren, 2016)
From the above, we conclude the importance of human capital in effectingeconomic development through expanding skills and knowledge of its people and improving social well-being.

2.1. Scientific research definition.

The implementation of the scientific method to produce knowledge is carried out by scientific research:
- Scientific research is the process of investigating natural phenomena using the scientific method for the purpose of discovering new facts and developing scientific theory.

Scientific research also aims at the review of facts, laws and theories in view of newly discovered facts, and the practical applications of such facts, laws and theories. Therefore, scientific research is the continuous search for knowledge and understanding of reality carried out through the scientific method. Its result is scientific knowledge.(Silva, October 2022)

2.2.University functions:

There is no doubt that the university plays an important and necessary function in society. Its role extends beyond training and graduating human cadres to industry and knowledge production, as well as providing accurate scientific mechanisms that allow society and state leaders to base their decisions on a scientific basis that contributes to the advancement and community development. Following this, it may be stated that the university's functions are divided into three categories.

- The university propagates knowledge through education and teaching, and provides students with various sciences, knowledge, and skills in order to prepare human cadres in various disciplines that society requires, which significantly contributes to the economic development process.
- The university has an essential and pivotal role in the process of scientific research in various fields of human knowledge and its scientific and technological applications, as it contributes to the advancement of the economic development process and the discovery of quick and effective solutions to the problem of delayed economic development.
- The university's role is to serve the community through its teaching and advisory function, participation in delivering social services, cultivating and spreading awareness, developing social trends, and promoting and protecting social values. (Boumedienne, 2016)

The influence of universities is obvious in their active contribution to scientific and knowledge production, as well as their role in fostering growth, development, and wealth in developed countries. In light of the high level of competition in international markets, university professors are attempting to highlight their capabilities through productive research that pushes to establish projects that create wealth and raise the level of employment, particularly in light of the emergence of international classifications, which necessitate the provision of exemplary, practical, direct services to society.

2.3.Standards and features of world university rankings.

Studying international academic rankings of universities requires an understanding of numerous categories, as well as the criteria and data that underpin each classification. Universities rely on the results of these classifications to correct their mistakes by learning from the performance of other universities. As a result, we will attempt to present the most well-known classifications by identifying the evaluation methodology on which each of

these classifications is based, as well as the features and indicators on which the evaluation process is based.

The QS World University Ranking, Shanghai Ranking, and Times Higher Education Ranking; are the most famous and most common classifications in the scientific and academic community, and below are more details about these classifications.

2.3.1.Times higher education: THE Rankings were created to assess University performance on the global stage and to provide a resource for readers to understand the different missions and success of higher education institutions. The World university rankings provide the definitive list of the world's best universities with an emphasis on the research mission. it is the only Global University League table to judge research on towns of universities across all of their core missions: teaching (the learning environment); research (volume, income and reputation); citations (research influence); industry income (knowledge transfer) and international Outlook (staff, students and research). It uses 13 carefully calibrated performance indicators to provide the most comprehensive and balanced comparisons. The overall list is accompanied by 11 subject-specific rankings. (world university rankings)

2.3.2.The Academic Ranking of World Universities (ARWU): ARWU uses six objective indicators to rank world universities, including the number of alumni and staff winning Nobel Prizes and Fields Medals, number of highly cited researchers selected by Clarivate, number of articles published in journals of Nature and Science, number of articles indexed in Science Citation Index Expanded™ and Social Sciences Citation Index™ in the Web of Science™, and per capita performance of a university. More than 2500 universities are actually ranked by ARWU every year and the best 1000 are published.(academic ranking for world universities)

2.3.3.QS Ranking: it is published by Quacquarelli Symonds Company and started ranking from 2004 along with the partnership of Times Higher Education (THE) but from 2010 it started its own ranking. QS

Rankingsfollow six indicators, Scopus databases and university portfolio survey is the main source of its data.(Chowdhur & Ziaur , 2021)

Table1 : Features and indicators of World University Rankings

Parameters	Academic Ranking of world university (ARWU)	QS World University Ranking	Times Higher education world university ranking (THE)
Year of establishment	2003	2004 (partnership with THE till 2009 from 2010 its own)	2004
Country of origin	China	United Kingdom	United Kingdom
Ordinal ranking	Single ranks up to 100 then groups (such as 101-150, 151-200)	Single ranks till 500 then groups (such as 501-510, 511- 520)	Single ranks to 200 then groups (such as 201-250,251- 300)
Area of Coverage	1800+ Universities	1500+ Universities	1000+ Universities
Criteria or weightage	-Quality of Education 30% -Quality of Faculty 40% -Research Output 20% -Per capita performance 10%	-Teaching 30% -Research 30% -Citation impact 30% -International outlook 7.5% -Industry Income 2.5%	- Academic Reputation 40% -Employer reputation 10% - faculty-student ratio 20% - Citation perfectly 20% -International faculty ratio 5% -International student ratio 5%

Source:*Arpita Roy Chowdhury,Ziaur Rahman (2021), Global Ranking framework &*Indicators of Higher Educational Institutions: A Comparative Study, Library Philosophy and Practice (e-journal).

The existence of these classifications compels us to act on the situation of the Algerian University and scientific research, but first, we will briefly discuss the efforts made in the field of scientific research and attempt to link them to economic development.

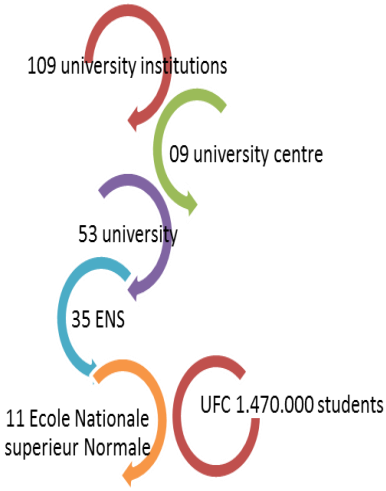
3.Efforts to promote scientific research.

Prior to actually delving into the realities of scientific research and its valorisation in Algeria and the international standing of Algerian universities, we shall first explore the expansion of the university network.

3.1.University network expansion in Algeria:

Algeria's higher education and scientific research sector has seen exceptional growth in terms of the expansion of the university network, which encompasses 109 (June 2021) university institutions, as shown in the figure below.

Figure 1: University network expansion



Source: The outcome achievements of the higher education and scientific researchsector from July 2020 to June 2021.**https://services.mesrs.dz/download/bilan2021/bilan_mesrs_2021.pdf**

As for the registered students, their number reached 1,469,984 students enrolled in graduation, and 76,259 students registered after graduation. The number of professors rose to 61,277.
As of March 2023, scientific research networks under tutelage have reached 1,472 laboratories, 12 units, 19 centers, and 6 agencies. (Rersearch entities' network)

3.2. Establishment of the National Council for Scientific Research and Technology: It is in charge of developing the national policy for scientific research and technical development in science, technology, and the social sciences, as well as determining priorities among national research programs and coordinating and evaluating their implementation. It aspires to enhance scientific research and value its products to benefit the national economy, as evidenced by the agreement which was signed with Sonatrach in March 2023.

3.2.1.The CNRST a synergy of skills for sustainable development: Through its multidisciplinary component from different backgrounds (largest national companies, research and development centers, universities, agencies), the CNRST constitutes a promising constellation of national capacities representing 43 different public institutions. The contribution of this community based abroad and of CEO from national companies is the essential complement to think out of the box and will foster the dynamics necessary for a fruitful research-industry partnership. This strategy, to be put in place will require the effective commitment of all women and men of good will.

3.2.2.The cooperation agreement between the Sonatrach Group and CNRST (February 2023): This convention aims according to the promotion of applied research and innovation to respond to multiple issues, such as the processing of seismic data, the modeling of reservoirs, the production, the exploitation, the transport of hydrocarbons, refining, as well as petrochemicals, but also renewable energies, including hydrogen and biofuels. This will involve setting up research and training programs to

improve understanding of systems in the context of energy transition and global climate change

These two parties have good human capacities to be mobilized to create an environment for consultation and collaboration "allowing Sonatrach to invest in the cutting-edge fields of scientific research and innovation". Building a knowledge-based economy "inevitably" involves research capable of proposing innovative solutions that generate economic progress and social well-being, he said (CNRST, 2023).

4.Scientific research output indicators and their relationship to economic development:

Finding out Algeria's actual international ranking within the various world indicators is crucial for referring to economic development and social welfare. In this area, scientific research outputs can be analysed through several indicators, whether those related to the classification of Algerian universities at the international level or through some economic indicators related to the system of scientific research and innovation, which are very important to know the extent of Algeria's progress in development.

4.1.The position of Algerian universities in international rankings:

THE ranking: Three Algerian universities have been classified in the THE ranking for the year 2022. The University of Farhat Abbas Setif 1 ranked first nationally (rank: 501-600), followed by the University of Oran 1 (rank: 601-800), then the University of Abu Bakr Belkaid Tlemcen (rank: +1201). (world university rankings 2022, 2022)

According to this ranking, Oxford University came first, followed by California institutions, and American universities dominated the top 10 universities, with the presence of two British universities ranked among the top 10.

ARWU ranking: The University of Djilali Eliabes in Sidi Bel Abbes was able to enter the world rankings as the first Algerian university in the

"*Shanghai Academic Ranking of World Universities"*in terms of specialization, moreover, this is in three different fields related to civil engineering 101-150, mechanical engineering 201-300, material science and engineerings 301-400. (2022 Academic Ranking of World Universities)It was the only one at the African level to be introduced in this ranking in terms of specialization.

QS ranking: By browsing the ranking of universities within each of the QS rankings for the year 2022, we clearly noticed the complete absence of Algerian universities.

Hirsch index: The h- index is a bibliometric indicator for assessing research output of scientists based on the publication and the corresponding citations. Due to the original characteristics of easy calculation and immediate in intuitive meaning, this indicator has become very popular in the scientific community. (Franceschini & Domenico , JUNE 2010)

The level of scientific production is one of the important indicators that demonstrate the level of scientific and technological research development that must be considered, as the number of scientific publications reached 93,727, of which only 213 are registered in the Hirsch index, which is designed to assess the productivity and impact of the researcher.

That being the case, it can be said that within the classification or ranking of the research product, the Algerian universities are in the bottom of the ranking, in addition to their complete absence in some classifications.

4.2.Global Competitiveness Index: Algeria ranked at low level according to the Global Competitiveness Index (GCI) rating from 2013 to 2019, with the period 2014-2015 being the best period in which Algeria recorded the best position (79 out of 144 countries). It should be noted that the United Arab Emirates rated 25th, Qatar ranked 29th, and Saudi Arabia ranked 36th, all of which are regarded as advanced international rankings in 2019.(Schwab & world economic forum, October 2019)

On the other hand, we decided to rely on the innovation index within the "Global Competitiveness Report" report as an indicator of the country's innovative capacity, which stems mainly from the scientific research system with all its entities and structures, whether in the public or private sector, and whether it is an innovative or normal system. It should be emphasized that the major innovation indicator is separated into two sub-indicators, the innovation index and the business environment development index. This is also the case for Algeria in the 2018 GII Global Innovation Index study, which has the slogan "Activate the world through innovation." (Table2) While some Arab countries rank high, such as Qatar, which ranks 51st, Kuwait 60, Saudi Arabia 61, Tunisia 66, and the Sultanate of Oman 69, Algeria rated 110th out of 126 countries in 2018. (Ahmed, 2018-2019)

Table 2: Algeria's ranking according to the Global Competitiveness Index in the period (2012-2018)

International ranking indicators year	Ranking according to the General International Index (GCI) for the number of countries	Difference in ranking	Ranking according to the main indicator: innovation and development of the business environment		
			Ranking according to the main indicator:	Sub-indicator: innovation	The sub-indicator: the development of the business environment
2012/2013	144/110	34	/	/	/
2013/2014	148/100	48	/	/	/
2014/2015	144/79	65	/	/	/
2015/2016	140/87	53	140/124	119	128
2016/2017	138/87	51	138/119	112	121
2017/2018	137/86	51	137/118	104	122

Source: Makhlouf Ahmed, The impact of scientific research outputs on local development in Algeria, Faculty of law and political sciences, department of political sciences? University of Batna 1, PHD thesis, Algeria, 2018-2019.

4.3. Human development index.

Algeria's Human Development Index value for 2019 was 0.748, placing the country in the "high human development" category and 91st out of 189 countries and territories. From 1990 to 2019, Algeria's Human Development Index improved from 0.572 to 0.748 (a rise of 30.8%). Table (3) shows the progress made by Algeria for some human development indicators since 1990. (united nations development programme , 2020)

Table 3: Evolution of the human development index in Algeria

	Expected length of schooling	Average years of schooling	HDI value
1990	9.6	3.6	0.572
1995	9.8	4.7	0.595
2000	10.9	5.9	0.637
2005	12.3	6.9	0.685
2010	14.0	7.1	0.721
2015	14.2	7.9	0.740
2016	14.2	7.9	0.743
2017	14.4	8.0	0.745
2018	14.5	8.0	0.746
2019	14.6	8.0	0.748

Source: united nations development programme, rapport sur le développement humain et l'anthropocène. Algérie, 2020.

It should be noted that HDI has been maintained at almost the same level, reaching 0.745 in 2022.

4.4.Number of patents realised by Algerian universities and researchers.

The DGRSDT has launched an operation to identify invention patents with ninety-one (91) establishments and research centers in all sectors, including:

− Sixty-nine (69) institutions of higher education (universities, university centers and national higher schools);

− Twelve (12) twelve research centers under of MESRS;

- Ten (10) research centers and institutes outside of MESRS.

We should notice that higher education institutions have the highest number of patent applications, with a number ranging from 55 patents in 2009 to 139 in 2019; followed by MESRS research centers with a total number of patents ranging from 32 patents in 2009 to reach 117 in 2019. (dgrst, 2019)

From the above, we notice that Algeria has been striving to develop the innovation system by encouraging the patent application, and even though university institutions have registered a high level, but they still havenot found their main channels, and still haven't reached international levels.

5.Reasons behindthe weak valorisation of scientific research.

Reasons due to the specificity of the Algerian university:Higher education in Algeria is distinguished by democracy and free education, which explains the increase in social demand for it and the increase in the number of students attending university.Increasing demand for higher education, which resulted in an increase in the number of students commensurating with the number of framers.

Supervising ratio: Despite the quantitative development in the number of professors in Algerian universities, the supervising ratio remained weak, as it was estimated at one professor for every 25 students. The supervising rate is one of the criteria that enables us to judge the quality of education in university institutions. The smaller this rate, the better and reflects the better quality of the educational process.

- The emigration of qualified people.
- The absence of incentives and the semi-bad conditions experienced by the university professor.
- The absence of sectors that finance research activity: Scientific research in the Arab world is funded by the state in general, and in Algeria, scientific research is funded by ministries or the National Fund for Scientific Research and Technological Development.
- A low level of research centers: the number of research centers that conduct scientific research are low. Algerian scientific research suffers from atrophy since all research is geared toward scientific promotion in order to gain certifications, rather than research with the goal of practical application, limiting its effectiveness as well as its contribution to the development process.(Dehane & Bouatrous , 2017)

Low level of government spending on scientific research: The Algerian government has allocated budgets spent on scientific research, whether for the training of human personnel or for the purchase and import of technical equipment, but the budget allocated for scientific research in Algeria is still very weak and is much less than international levels.

Table: Evolution of the management budget allocations to the higher education sector

Unit: 10 Algerian dinars

The year	*Budget appropriation For the management Of higher education sector*	*Budget appropriations overall management of the state*	*Percentage*
2010	*173 483 802*	*2 837 999 823*	*6,11%*
2011	*291 441 690*	*4 291 181 180*	*6,79%*
2012	*277 173 918*	*4 608 250 475*	*6,01%*

2013	*264 582 513*	*4 335 614 484*	*6,10%*
2014	*270 742 002*	*4 714 452 366*	*5,74%*
2015	*300 333 642*	*4 972 278 494*	*6,04%*
2016	*312 145 998*	*4 807 332 000*	*6,49%*
2017	*310 791 629*	*4 591 841 961*	*6,77%*
2018	*313 336 878*	*4 584 462 233*	*6,83%*
2019	*317 336 878*	*4 954 476 536*	*6,41%*
2020	*364 283 132*	*4.893.439.095*	*7,44%*
2021	*370.596.356*	*5.314.506.529*	*6.97%*
2022	*400.051.187*	*6.311.532.437*	*6.38%*

Source: AlgerianOfficial journal from 2010 to 2022.

The data in the table shows the financial magnitude of management budget allocations to the higher education and scientific research sectors from 2012 to 2022. The sector of higher education and scientific research ranks first in terms of budgetary coverage in the Algerian state budget.

It should be highlighted that between 2015 and 2021, spending on scientific research and development reached approximately 57 billion DZD, at a rate of more than 8 billion DZD each year. (APS, 2022)Although expenditure levels have improved, they are still somewhat far from international averages in terms of spending on RD, with the research and development expenditure (%of GDP) world average of 2.13% in 2017 according to World Bank data, with 0.53% in Algeria. (the world bank).Furthermore, in 2023, 14240466000 DA was allocated to the scientific research and technological development, representing 2.51% as a proportionof the budget appropriation for the management of higher education.

Notwithstanding these deficiencies, this spending has had a positive impact on scientific research centers, for example, the Algerian Space

Agency's centers have made great strides through the various national space programs that have been prepared and implemented, which are regarded as a model to be followed in applied research projects and the development of strategic mechanisms and tools in the service of developing vital sectors such as the agricultural sector and providing it with technical solutions in order to monitor resources and protect from Natural hazards and other areas of vital dimension. (APS, 2022)

Provided that funding ratios for scientific research are one of the important indicators used to classify universities, it reflects the extent to which countries support and promotes higher education and scientific research, as well as the diversity and extent of funding sources for this research and its development. Considering the importance of funding for higher education and scientific research, the percentages dedicated to scientific research are considered low.

6.Conclusion:

The university carries the biggest duty for producing human resources, which are the source of driving energy and the driving force for societal development and advancement. As a result, the university tries to prepare competent human capital to be a source of wealth and a creator in order to achieve progress. Algeria, for its part, has sought to boost investment in the university area, establishing several fundamental research structures, expanding research centers and laboratories, and increasing human resource monitoring.

Regarding "the results achieved in the field of scientific research, in addition to the large investments made by the state in the field of developing scientific research," the results in this field "do not currently rise to the level of international universities, and they cannot carry out a true transfer of knowledge and promotion of research results in the economic sector." and

society, as evidenced by the poor quality of scientific research results in Algeria.

Inadequacies and constraints necessarily require the need to strive to enhance the classification of our universities and research institutions within a studied framework and a clear vision, as well as to work on taking new steps that lead to a qualitative shift in the education sector, establishing a generation of creative people in order to produce a high-quality educational product that compete globally, by activating research teams, encouraging scientific work, and providing facilities for those interested in knowledge production in relation to research teams, as well as implementing reforms that connect theoretical and applied research and make the university institution a significant actor in society. Finally much effort must be made to deepen the university's move to expand partnership frameworks with the economic and social environment.

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