Revista Jurídica vol. 02, n°. 74, Curitiba, 2023. pp. 340 - 363

THE TECHNOLOGIAL ORDERS AS A MECHANISM OF HIRING INNOVATIVE SOLUTIONS FOR SMART CITIES

OS PEDIDOS TECNOLÓGICOS COMO MECANISMO DE CONTRATAÇÃO DE SOLUÇÕES INOVADORAS PARA CIDADES INTELIGENTES

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ABSTRACT

Objective: it aims to answer if the legal institute of technological orders, introduced into the domestic legal system by Law) Nr. 10.973/2004, is a feasible alternative to

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

solve complex public problems of smart cities, notably in innovative solutions for the public sector.

Methodology: in a first moment, the international modalities and the respective lived experiences, which served as inspiration for this innovation were analyzed, making a historical examination on the origins of the technological orders. Subsequently, in a more particular way, the constant apparatus in the current Brazilian legal system was investigated. At this point, the practical challenges involving the theme were developed, as well as the objective parameters to establish limits in their respective application.

Results: it was identified that the technological order is an important instrument that helps to reduce bureaucracy in the relations between the public and private sectors, being relevant to the public and social interest, in addition to strengthening innovation as a public policy.

Contributions: after the studies carried out, it was identified that the first limits are the existence of a specific problem to be solved and the lack of available alternative. Regarding direct results, it was known that there are borderline situations in which the public manager may encounter practical difficulties regarding the definition of the existence, or not, of a certain technological solution. In these hypotheses, the use of the ISO 16290:2013 system was recommended, responsible for establishing parameters of the technological level and the respective evaluation criteria which, despite having been developed for aircraft and space vehicle system hardware, is a precise guideline provision for other scientific domains.

Keywords: Technological ordering; Law Nr. 10.973/2004; Innovative solutions.

RESUMO

Objetivo*: busca-se investigar se o instituto das encomendas tecnológicas, introduzidas no sistema jurídico pátrio por meio da Lei n. 10.973/2004, são alternativas viáveis para a solução de problemas públicos complexos de cidades inteligentes, notadamente em soluções inovadoras ao setor público.*

Metodologia*: em um primeiro momento, analisou-se as modalidades internacionais e as respectivas experiências vividas, as quais serviram como inspiração a essa inovação, fazendo um exame histórico sobre as origens das encomendas tecnológicas. Posteriormente, de modo mais particularizado, investigou-se o aparato constante no atual ordenamento jurídico brasileiro. Nesse ponto, foram desenvolvidos os desafios práticos que envolvem o tema, bem como os parâmetros objetivos para estabelecer limites em sua respectiva aplicação.*

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

***Resultados**: identificou-se que a encomenda tecnológica é um importante instrumento que auxilia na desburocratização das relações entre o setor público e o privado, sendo relevante ao interesse público e social, além de fortalecer a inovação como política pública.*

***Contribuições**: após os estudos realizados, identificou-se que os primeiros limites são a existência de um problema específico a ser resolvido e a carência de alternativa disponível. No que tange aos resultados diretos, soube-se da existência de situações limítrofes nas quais o gestor público pode encontrar dificuldades práticas quanto à definição de existência, ou não, de determinada solução tecnológica. Nessas hipóteses, recomendou-se a utilização do sistema ISO 16290:2013, responsável por estabelecer parâmetros do nível tecnológico e os respectivos critérios de avaliação que, apesar de ter sido desenvolvido para hardware de sistema de aeronaves e veículos espaciais, é uma precisa disposição orientativa para os demais domínios científicos.*

***Palavras-chave:** Ordenamento tecnológico; Lei nº. 973/2004; Soluções inovativas.*

1 INTRODUCTION

The technological orders – *Encomendas Tecnológicas* (*ETEC*) is a mechanism created with the goal of presenting a concrete solution to complex problems of the public administration, which is featured mainly by public incentives to science, technology and innovation.

In sum, it's a technological development policy in which administrative entities define the result to be reached through direct purchases in which, despite of their technological risks, can incentive private company's proposals[1].

Therefore, it is put on schedule a new perspective, contrasting with the traditional acquisition systems of the administration, since these were designed for available offers within the market. The new hiring way, in contrast, alter this logic to act

[1] LEITE, Breno Ricardo de Araújo; MUSSI, Renato Galvão da Silveira; SANTOS, Renato de Lima; NEVES, Edvaldo Antônio das; FREY, Irineu Afonso. **Encomenda Tecnológica em projetos de pesquisa e desenvolvimento: realidade palpável após a regulamentação do Marco Legal?**. Conferência Inovação na UFSC. Florianópolis: Innovation Summit Brasil, 2019, p. 815. Disponível em: https://www.researchgate.net/publication/336999962_Encomenda_Tecnologica_em_projetos_de_pesquisa_e_desenvolvimento_realidade_palpavel_apos_a_regulamentacao_do_Marco_Legal. Acesso em: 13 jun. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

in new demands in which the State seeks a result to be provided by the private sector, according to its priorities and the public will.[2]

Thus, the technological order is an important instrument that helps in the debureaucratization of the relations between the public and private sectors, through the knowledge developed by the scholars, being relevant to the public and social interests, as well as a boost in the public policy of innovation[3].

Its goal (development of innovative solutions for social and public problems) adds to the principle of smart cities, which, as point out the specialized doctrine, technological, human and scientific resources available are used to serve in the Best possible way the citizens, in a humanized and inclusive way. Thus, there is a synergy with essential services provided for a society, specially urban mobility, energy supplying and infrastructure[4].

Recently, the Union Accounts Court has published an unprecedented call for hiring through technological order, which its project should focus on a way of using artificial intelligence to support denounces instruction and representations in the realm of this court. Its goal was, therefore, to promote speed in procedures, aligning it to reducing costs and raising benefits to society[5] which, due to its novelty will be analyzed in the right moment.

Due to the potentialities of this instrument (*ETEC*), this paper will research about the possibility of technological orders being viable alternatives for complex public problem solving in smart cities, since they could develop innovative solutions for the public sector.

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[2]RAUEN, André Tortato; BARBOSA, Caio Márcio Melo. **Encomendas tecnológicas no Brasil: guia geral de boas práticas.** Brasília: IPEA, 2019, p. 11.

[3] ABGI BRASIL. **O que são as Encomendas Tecnológicas?** Disponível em: https://brasil.abgi-group.com/radar-inovacao/o-que-sao-as-encomendas-tecnologicas/. Acesso em: 19 maio 2022.

[4] BLIACHERIENE, Ana Carla; ARAUJO, Luciano Vieira de**. Inovação no Setor Público e o Futuro das Instituições de Controle.** In: Edilberto Carlos Pontes Lima. (Org.). Os Tribunais de Contas, a pandemia e o futuro do controle. 1ed. Belo Horizonte: Editora Fórum, 2021, v. 1, p. 76.

[5] TRIBUNAL DE CONTAS DA UNIÃO (TCU). **TCU lança edital inédito para contratação por Encomenda Tecnológica.** Disponível em: https://portal.tcu.gov.br/imprensa/noticias/tcu-lanca-edital-inedito-para-contratacao-por-encomenda-tecnologica.htm. Acesso em: 19 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

2 ORIGINS AND FOUNDAMENTS

In the school of André Ramos Tavares, there is a constitutional matter in the Law of Science and Technology (art. 218 CF/88) and, in this perspective, the State "does not exclude itself from this relation, since, through law, seeks to incentive and foment the private agent into research investment"[6].

The doctrine points out that the current Brazilian system for technological orders has inspiration in the Pre-commercial procurements (PCP) and the Public procurements of innovation (PPI)[7], broadly defended and applied by the Organization for Economic Co-operation and Development (OECD)[8] and by the European Union[9].

Initially, before examine these modalities, its interesting to understand the definition of innovation. According to OECD, its comprehended as the implementation of a new, or significantly enhanced product (good or service), marketing method, organizational, technological and commercial instruments or business practices[10].

In this context, the Pre-commercial procurements is a method of acquisition of results for goods or services, being viable if comprehended the standards of non-existence and lack of prior trade, for which research, development and innovation are needed. To fulfill these criteria, the public branches must describe their orders to be fulfilled through a bid or firm invitation, to be able to present proposals of development of the enhancement asked. Finally, will be celebrated contracts with the best proposals

6 TAVARES, André Ramos. Ciência e Tecnologia na Constituição. **Revista de Informação Legislativa: RIL**, Brasília, DF, v. 44, n.175, p. 7-20, jul./set. 2007, p. 16.

7 TRIBUNAL DE CONTAS DA UNIÃO. **Proposta de atuação do Controle em contratações de Encomendas Tecnológicas (ETEC**).Edição Revista. Brasília: Instituto Serzedello Corrêa, 2021, p. 01.

8 ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD). **Public Procurement for Innovation: Good Practices and Strategies**. Paris: OECD Publishing, 2017. Disponível em: https://doi.org/10.1787/9789264265820-en. Acesso em: 20 abr. 2022.

9 EUROPEAN COMISSION. **Public Procurement of Innovative solutions**. Disponível em: https://digital-strategy.ec.europa.eu/en/policies/ppi#:~:text=What%20is%20Public%20procurement%20of,on%20large%20scale%20commercial%20basis.Acesso em: 20 abr. 2022.

10 ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD). **Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data**, 3rd Edition, The Measurement of Scientific and Technological Activities. Paris: OECD Publishing, 2005, p. 18. Disponível em: https://doi.org/10.1787/9789264013100-en. Acesso em: 25 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

presented by suppliers[11].

The factors to be considered on PCP regard the high risks and complexity in developing a non-existent solution, without any guarantee of success of the demand. In addition, the required capacity needed to conduct the works, as well as the market scope in testing and producing resources and procedures to be applied[12].

The examples of successful cases conceived by the European Union through PCP are mixed, namely, in the health Field the project THALEA as well as tele-medicine for patients of intensive care and high risks; in transportation, the V-COM, that optimized the road infrastructure through virtual modeling; and in energy supplying, the PRACE 3IP, responsible for raising energetic efficiency with high performance processing[13].

The connection between the process of PCP and PPI is given by the effort in investing in research and development (R&D) of products and services. The differences, though, are connected to the existence, or not, of new solutions on research and development, since PCP demands the creation of a new solution not yet developed, while PPI requires a solution being implemented in the market of in a small quantity, even though it does not fulfill the requirements of the public sector for a great scale implementation. On PPI, in addition, there are cases in which none research is required to solve the problem[14].

In short, on PCP, the public sector buys a project of R&D to give a north for further solutions to its needs, amassing knowledge about possible alternatives. On PPI, by its turn, the administration works as a “day one client” or the first buyer of

[11] THE RESEARCH COUNCIL OF NORWAY.**Pre-commercial procurement**. Disponível em: https://www.forskningsradet.no/en/apply-for-funding/who-can-apply-for-funding/public-sector/Pre-commercial-procurement/. Acesso em: 20 abr. 2022.

[12] THE VICTORIAN GOVERNMENT. **Pre-commercial procurement - goods and services procurement guide.** Disponível em: https://www.buyingfor.vic.gov.au/pre-commercial-procurement-goods-and-services-procurement-guide. Acesso em: 20 abr. 2022.

[13] EUROPEAN COMMISSION. **Innovation Procurement The power of the public purse**(2021).Disponível em: https://digital-strategy.ec.europa.eu/en/library/innovation-procurement-power-public-purse. Acesso em: 20 abr. 2022.

[14] PROCUREMENT INNOVATION FOR CLOUD SERVICES IN EUROPE (PICSE). **Pre-commercial Procurement (PCP) vs Public Procurement of Innovation (PPI).**Disponível em: http://www.picse.eu/pre-commercial-procurement-pcp-vs-public-procurement-of-innovation-ppi. Acesso em: 25 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

innovative products and services, which are in a early stage of trade availability[15].

3 NATIONAL LEGAL SYSTEM: REGULATION OF ETECS

In the domestic realm, the Technological Order (*ETEC*) was introduced to the public sector by nº 10.973/2004 (Technological Innovation Incentives Law – in the Portuguese language's acronym, *LIIT*)[16], after important alterations provided by *Lei* nº 13.243/2016, in special regard to art. 19, § 2º, V.

In a nutshell, the normative text predicts that is due to the federative entities the promotion and incentive to research and development of innovative products and services from Brazilian firms. This foment will be done through the concession of resources of human, infrastructure and financial natures, which will attend to the domestic interests[17].

The aforementioned Law has been regulated by *Decreto* (Decree) nº 9.283/2018, which, by ruling the technological orders in the federal public administration, has predicted that can be hired directly the private entities, either isolated or in joint ventures, aiming to research, development and innovation activities

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[15] PROCUREMENT INNOVATION FOR CLOUD SERVICES IN EUROPE (PICSE). **Pre-commercial Procurement (PCP) vs Public Procurement of Innovation (PPI).**Disponível em: http://www.picse.eu/pre-commercial-procurement-pcp-vs-public-procurement-of-innovation-ppi. Acesso em: 25 abr. 2022.

[16] BRASIL. **Lei nº 10.973, de 2 de dezembro de 2004**. Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo e dá outras providências. [S. l.], 3 dez. 2004. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.973.htm. Acesso em: 19 abr. 2022.

[17] *Art. 19. The Union, States and Federal District, Municipalities and ICTs, and their foment agencieswill promote and incentive the research and development of products, services and innovative processes in brazilian firms and brazilian not-for-profit private Law entities, through the concession of finnancial, human and material ressources or infrastructure to be adjusted thorugh specific instruments to be destined to support activities of research, development and innovation to fulfill priorities of industrial and technological domestic policies.*
(...) § 2º. Are instruments of incentive to firm innovation, when applicable, among others:
(...) V – technological ordering. BRASIL. **Lei nº 13.243, de 11 de janeiro de 2016**. Dispõe sobre estímulos ao desenvolvimento científico, à pesquisa, à capacitação científica e tecnológica e à inovação e altera a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 6.815, de 19 de agosto de 1980, a Lei nº 8.666, de 21 de junho de 1993, a Lei nº 12.462, de 4 de agosto de 2011, a Lei nº 8.745, de 9 de dezembro de 1993, a Lei nº 8.958, de 20 de dezembro de 1994, a Lei nº 8.010, de 29 de março de 1990, a Lei nº 8.032, de 12 de abril de 1990, e a Lei nº 12.772, de 28 de dezembro de 2012, nos termos da Emenda Constitucional nº 85, de 26 de fevereiro de 2015. [*S. l.*], 12 jan. 2016. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/lei/l13243.htm. Acesso em: 19 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

that regard technological risks for obtaining the solution for specific problems[18].

In this context, hiring a technological order understood as a public investment on research and development of a specific technological solution and not acquisition of the technology itself. In other words, it's a direct hiring aiming to seek a solution, through innovative Technologies, for a specific public administration demand, which present a technological risk or uncertainty about the results to be achieved.

In the same sense, the General Guide of Good Practices of the Institute for Economic Applied Research - *Guia Geral de Boas Práticas do Instituto de Pesquisa Econômica Aplicada* (IPEA), bound to the Economy Ministry, states that "in general, ETEC is a public purchase aimed to find a solution to a determined problem through technologic development"[19], in which the situations are highly specific.

According to the concepts above, the possibility of hiring through *ETEC* means that the public administration can acquire the means for research activities to develop a specific technological solution for its purposes, either it being a product or a service.

As for the technological risk, the existing condition in these hiring's, refers to the uncertainty that it will be fulfilled the results wanted, taking in account the employ of unprecedented Technologies of Unknown feasibility, as well as failures in the development process for solutions and their consequences. Thus, its understood that, in technological orders, the effort is the object of hiring and not the product itself.

Its due that "the new Technologies allow to surpass the individualizes working

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[18] *Art. 27. The branches and entities of the public administration can hire directly ICT public or private, not-for-profit private entities or firms, in isolation or joint ventures, aimed for activities of research and recognized technological capacitating in the sector, to fulfill activities of research, development and innovation that regard technological risks, to solve specific technical problems or to purchase innovative product, service or process, in the terms of art. 20 of Lei no 10.973, de 2004, and XXXI of art. 24 of Lei nº 8.666, of 1993*. BRASIL. **Decreto nº 9.283, de 7 de fevereiro de 2018**. Regulamenta a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 13.243, de 11 de janeiro de 2016, o art. 24, § 3º, e o art. 32, § 7º, da Lei nº 8.666, de 21 de junho de 1993, o art. 1º da Lei nº 8.010, de 29 de março de 1990, e o art. 2º, caput, inciso I, alínea "g", da Lei nº 8.032, de 12 de abril de 1990, e altera o Decreto nº 6.759, de 5 de fevereiro de 2009, para estabelecer medidas de incentivo à inovação e à pesquisa científica e tecnológica no ambiente produtivo, com vistas à capacitação tecnológica, ao alcance da autonomia tecnológica e ao desenvolvimento do sistema produtivo nacional e regional. [*S. l.*], 8 fev. 2018. Disponível em: planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/d9283.htm. Acesso em: 19 abr. 2022.

[19] RAUEN, André Tortato; BARBOSA,Caio Márcio Melo. **Encomendas tecnológicas no Brasil: guia geral de boas práticas.** Brasília: IPEA, 2019, p. 15.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

methodology, that nowadays has been mainly used by control branches"[20], reason why the regulating decree of technological orderings defines the risk as a "possibility of unsuccessfulness in developing a solution, through a procedure in which the result is uncertain due to the scientific-technological knowledge of the time in which was opted by the action performance" (art. 2º, III)[21].

In short, the technological orderings are special kinds of public purchasing destined for specific challenges solving through the development of products, services os systems that are not available yet in the market or do not exist, and that present a high level of uncertainty if will be reached the wanted result.

In Brazil, due to the epidemiologic crisis of SARS-CoV-2, the investment on research for vaccines, to prevent or cure new pathologies, development has become an example of technological orders. Therefore, the risk is featured by the uncertainty of an efficient output, regarding the technological complexity and the high technical knowledge required for its development, as well as the lack of knowledge about the new pathology.

In addition, it's important to mention that the risk will be found as well in cases where the demands, in which solutions are pre-existent, whereas they need a technological focus shift, aiming its improvement, as well as the development of innovations through the joint application of available technologies, in a way alike the PPI examined above. The example below is given by the Applied Economic Research Institute – *Instituto de Pesquisa Econômica Aplicada* (*IPEA)'s* Guide:

[20] ISHIKAWA, Lauro; ALENCAR, Alisson Carvalho de. Compliance inteligente: o uso da inteligência artificial na integridade das contratações públicas. **Revista de Informação Legislativa: RIL**, Brasília, DF, v. 57, n. 225, p. 83-98, jan./mar. 2020, p. 92.

[21] BRASIL. **Decreto nº 9.283, de 7 de fevereiro de 2018**. Regulamenta a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 13.243, de 11 de janeiro de 2016, o art. 24, § 3º, e o art. 32, § 7º, da Lei nº 8.666, de 21 de junho de 1993, o art. 1º da Lei nº 8.010, de 29 de março de 1990, e o art. 2º, caput, inciso I, alínea "g", da Lei nº 8.032, de 12 de abril de 1990, e altera o Decreto nº 6.759, de 5 de fevereiro de 2009, para estabelecer medidas de incentivo à inovação e à pesquisa científica e tecnológica no ambiente produtivo, com vistas à capacitação tecnológica, ao alcance da autonomia tecnológica e ao desenvolvimento do sistema produtivo nacional e regional. [*S. l.*], 8 fev. 2018. Disponível em: planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/d9283.htm. Acesso em: 19 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

> The technological risk also will be present in the case of problems already solved, though they demand a new technological approach. As for example, the industrial process with challenging indexes of carbon dioxide generation, pharmaceuticals produced with other technological routes and lesser collateral effects, control of traffic signs through artificial intelligence, etc. In such cases, there are alternative solutions, though, for one reason or another, these are not considered fitted and therefore, demand a new development. Innovations that require new integration of components that already exist, for instance, in the internet field of things (IfT), also feature an elevated technological risk. That's because of new protocols must be created and every new architecture of interoperability must be developed. Which is, almost every time that technology allows and efficient communication, autonomous and in real time it need to be created according to the specificity of the solution[22].

Thus, it would not be adequate to affirm that technological orders act only in cases of lack of solution. That's why its possible that the constellation of the existence of a determined resolution that, nevertheless, needs another approach, due to the prior one is not considerate efficient of practical anymore. These reasons justify the investment in R&D to propel new technologies, even in pre-existent cases.

4 PRACTICAL CHALLENGES

In order to clarify the scope of the subject, it must be examined the limitations of technological orders, through the description of situations in which this instrument can be applied and cases in which it cannot be applied as *ETEC*.

It is an effort that may lead to great possibilities, especially regarding smart cities. This city framework is featured by a system of people interacting and using electricity, materials and services to enhance the economic development and make life

[22] RAUEN, André Tortato; BARBOSA, Caio Márcio Melo. **Encomendas tecnológicas no Brasil: guia geral de boas práticas.** Brasília: IPEA, 2019, p. 16.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

better[23].

The interaction fluxes of these locations are considered smart in the sense that they use strategically the infrastructure and information services in planning the urban management, enabling them to answer social and economic needs.[24].

These are the exact reasons that justify the use of technological orders. These are important instruments of development of technological and innovative solutions to unlock the development of management, communication and infrastructure of Brazilian smart cities[25].

There are many successful cases in mixed fields around the world. The project "Stop + Go", for instance, happened in the beginning of 2018 with the Spanish, UK and Netherlands health prosecutors, in which an acquisition through technological ordering by PPI (*Public Procurement of Innovation*) was made, which has elaborated a service of tele-assistance that allows taking care of vulnerable aged people that have multiple conditions, as cardiac insufficiency and diabetes at the same time. In Barcelona for instance, there war a reduction of 9,8% of hospitalizations and a reduction of 29%[26] on death risk.

The "IMAILE" project, by its turn has regarded the development of learning environments, featured for primary and secondary schools in Sweden, Spain, Germany and Finland in 2018. In this case, the technological order has been made through PCP (*Pre-commercial Procurement*), resulting in two solutions that offered a learning experience close to gaming, in which behavior patterns from students were assessed through artificial intelligence. The tests showed that the measures presented have turned the students from 55% to 75% more motivated and well succeeded in the

[23] FGV PROJETOS. **O que é uma cidade inteligente?** Disponível em: https://fgvprojetos.fgv.br/noticias/o-que-e-uma-cidade-inteligente Acesso em: 20 maio 2022.

[24] FGV PROJETOS. **O que é uma cidade inteligente?** Disponível em: https://fgvprojetos.fgv.br/noticias/o-que-e-uma-cidade-inteligente Acesso em: 20 maio 2022.

[25] CÂMARA DOS DEPUTADOS. **Cidades inteligentes [recurso eletrônico]: uma abordagem humana e sustentável** / relatores Francisco Jr. (coordenador)[et al.]; equipe técnica Leandro Alves Carneiro...[et al.] (organizador). – 1. ed. – Brasília : Câmara dos Deputados, Edições Câmara, 2021, p. 295.

[26] EUROPEAN COMMISSION. **Innovation Procurement The power of the public purse** (2021), p. 40. Disponível em: https://digital-strategy.ec.europa.eu/en/library/innovation-procurement-power-public-purse. Acesso em: 20 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

fields of mathematics, technology and sciences[27].

Back to the limitations of ETEC, as aforementioned, when verified that de desired solution for a specific problem has not been available to purchase in market, the use of technological order to hire researches and studies technologically complexes, aiming for the development of a product that fulfill the specific needs of the hiring party.

Thus, the first limitations are the existence of a specific problem to be solved and the lack of an available alternative which, under extremely relevant conditions, can differ ETECs from the traditional investments in researches guided by technological curiosity, such as grants, direct investment and others that do not have a pre-determined object to be achieved.

As for the direct results of technological orders, there is a peculiar feature in the fact that they constitute themselves upon *ad hoc* reports of prototypes. In other words, it is not fulfilled through the supply of trade goods or services on scale, even though this production can be possible afterwards if contractually agreed.

Therefore, as stated in *Guia de Boas Práticas* (Good Practices Guide), are not within the scope of *ETECs* specialized professional technical services; the purchase on scale of goods and services, even if they are considered as innovative; project bids; purchase of products and services destines for R&D by scientific technology and innovation institutions; purchases with technological compensation (*offset*), even though the *ETEC* can demand technology transfer; the covenants and agreements of cooperation between scientific institutions and firms; and, finally, the common works with known features, even if destines for scientific infrastructure[28].

That's because, in the hypothesis that a solution already exist and it's not offered by the lack of a consumer market or when its introduction in the market demands efforts for adaptation, there is no technological risk verified, being only

[27] EUROPEAN COMMISSION. **Innovation Procurement The power of the public purse** (2021), p. 48. Disponível em: https://digital-strategy.ec.europa.eu/en/library/innovation-procurement-power-public-purse. Acesso em: 20 abr. 2022

[28] RAUEN, André Tortato; BARBOSA, Caio Márcio Melo. **Encomendas tecnológicas no Brasil: guia geral de boas práticas.** Brasília: IPEA, 2019, p. 19.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

possible to use purchasing/acquisitions procedures known in the daily life of the public administration, incentive its insertion in the market and fulfilling the public need.

There are, though, cases in which there are grey areas where the public manager can find practical hardships in defining the existence, or not, of determined technological solution. In these cases, its recommended the use of the ISO 16290:2013, system, which is responsible for establishing the Standards for technological levels, and criteria of evaluation, which, despite of being developed for *hardware* of air planes and special ships, its a precise disposition for guidance of other scientific realms[29].

The levels of technological readiness of ISO 16290:2013 are divided in nine cycles. The first refers to the basic research, in which are observed and reported the main fundaments of a knowledge in an academic perspective, it could be done either through software or mathematic formulations, without conceptual definitions (TRL 1 – Basic principles observed and reported). The following step approaches the appliance of this new knowledge formulated, being understood as a applied research through algorithms and synthetic data, though, not necessarily checked (TRL 2 – Tecnology concept and/or application formulated)[30].

The third to sixth levels are regarded as the experiment development cycle, beginning with the proof of the analytic and experimental concept of features or critical functions of appliance, validating concepts and predictions (TRL 3 – Analytical and experimental critical function and/or characteristic proof-of-concept); passing to the functional verification of components or subsystems in laboratorial environments through prototype in early stage (TRL 4 – Component and/or breadboard functional verification in laboratory); directing the verification of the aforementioned critical function of the component or subsystem in a relevant environment, though still in pilot

[29] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). **ISO 16290:2013 - Space systems — Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment.** Disponível em: https://www.iso.org/obp/ui/#iso:std:iso:16290:ed-1:v1:en. Acesso em: 27 abr. 2022.

[30] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). **ISO 16290:2013 - Space systems — Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment,** p. 32.Disponível em: https://www.iso.org/obp/ui/#iso:std:iso:16290:ed-1:v1:en. Acesso em: 27 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

scale (TRL 5 – Component and/or breadboard critical function verification in a relevant environment); for, in the end, elaborate a prototype model of systems in a realistic environment, with the fulfillment of final tests for appliance and trade either in existent hardware or software (TRL 6 – Model demonstrating the critical functions of the element in a relevant environment)[31].

The seventh and eight steps happen in the stage of manufacturing, in which the demonstration of the prototype of system in an operation environment is required, using real Standards and the development for problem solving on technologic performance (TRL 7 – Model demonstrating the element of performance for the operational environment) and, afterwards, to the real system developed and approved for operation (TRL 8 – Actual system completed and accepted for flight)[32].

The final stage it about the analysis of quality of the product and its commercialization, in which the real system is developed and approves through operations considered as successful (TRL 9 – Actual system "flight proven" through successful mission operations)[33].

These levels can be organizes in "life cycles" of a Project of technological innovation, in which the flux of maturation can be classified as basic research (TRL 1), applied research (TRL 2), experimental development (TRL 3 a 6), manufacturing (TRL 7 a 8) and production and commercialization (TRL 9)[34].

Based in these information's, the public manager can evaluate the precise path of the technological phase of a product or service. Therefore, as the TRL reached numeration gets smaller, greater will be the technological risk featuring the

[31] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). **ISO 16290:2013 - Space systems — Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment,** p. 35-40.Disponível em: https://www.iso.org/obp/ui/#iso:std:iso:16290:ed-1:v1:en. Acesso em: 27 abr. 2022.

[32] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). **ISO 16290:2013 - Space systems — Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment,** p. 42-43.Disponível em: https://www.iso.org/obp/ui/#iso:std:iso:16290:ed-1:v1:en. Acesso em: 27 abr. 2022.

[33] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). **ISO 16290:2013 - Space systems — Definition of the Technology Readiness Levels (TRLs) and their criteria of assessment,** p. 45.Disponível em: https://www.iso.org/obp/ui/#iso:std:iso:16290:ed-1:v1:en. Acesso em: 27 abr. 2022.

[34] ABGI BRASIL. **TRL: Recursos financeiros por níveis de maturidade tecnológica.** Disponível em: https://brasil.abgi-group.com/radar-inovacao/artigos-estudos/trl-recursos-financeiros-por-niveis-de-maturidade-tecnologica/. Acesso em: 28 abr. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

technological order. By the other hand, as the solution approaches the final stage, the actuation of the demanding party gets stronger to seek how much this solution can fulfill its requirements, aiming for its acquisition and insertion within the market.

We realize that, to assess a technological order, the pré-existent solution must reach, ultimately, the certification of TRL 7 or the begining of the manufacturing cycle, being the previous stage to the commercialization itself, since the existence requirement, though in smaller scale, of a technological risk according to art. 20 of *Lei* n. 10.973/2004[35].

In the same way, would be unfitting the acquisitions of services that did not reach TRL 1 of the basic research cycle, given that, as the theoretical or experimental works about the acquisition of knowledge or observable phenomenon have not been made, they would be guided only by curiosity[36].

Once the aforementioned conclusions about the previous features of technological orders were made, the next step will be de hiring of the intellectual effort procedure of an innovative solution development.

The decision for its adherence requires a great caution from the public manager, thus, despite of every public contract regards some risks, only *ETECs* have the so called technological risk, or uncertainty of the result, element not traditionally accepted by society and by the traditional model of hiring from the Public Administration, in which the payment happens according to the obligation's fulfillment.

Due to this, as well as the fact of being a public hiring, the use of technological orders can be justified and planned, observing all procedures legally demanded by *Lei* n. 10.973/2004.

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[35] Art. 20. The branches and entities of the public administration, in matters of public interest, can hire directly ICT, not-for profit private Law entities or firms, themselves or in joint ventures of research with notorious technological capacity in the field, aiming activities of research, development and innovation with technological risks, to solve an specific technical problem or acquisition of a product, service or innovative process (Text given by Lei nº 13.243, de 2016). BRASIL. **Lei nº 10.973, de 2 de dezembro de 2004**. Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo e dá outras providências. [S. l.], 3 dez. 2004. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.973.htm. Acesso em: 28 abr. 2022.

[36] RAUEN, André Tortato; BARBOSA, Caio Márcio Melo. **Encomendas tecnológicas no Brasil: guia geral de boas práticas.** Brasília: IPEA, 2019, p. 26.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

5 THE HIRING PROCEDURE

Once the previous considerations were made, its now necessary to highlight how happen, even if in nutshell, the procedure of hiring in the federal level of technological orders, in the terms of *Decreto* n. 9.283/2018.

Firstly, its predicted the existence of preliminary studies that must describe the need of hiring, the global view of the product, the technical problem at stake and the research of potential market and wanted results[37]. In this phase, in addition, its possible to be adopted actions that may be needed for the environment of the hiring branch adaptation, by creating an innovative friendly environment regarding the personnel in the Public Administration, according to art. 6º do *Decreto* n. 9.283/2018[38].

Moreover, in the previous phase to the contracting act, the hiring branch can consult the potential hiring parties to obtain additional information to define the order to be made, in which questions and answers must be attached in the procedure of hiring, except for information protected by manufacturing, technological or trade secrecy[39].

Through that, the hiring party will define the minimum acceptable standards for the use and development of the wanted solution in the order. The manifestation of

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[37] "*Art. 27 (...) § 3º The hiring party will be responsible for describing the needs in order to allow the interested to identify the nature of the existent technical problem and the broad view of the product, service or innovative process to be obtained, except for technical specifications of the object, due to the complexity of the research activity, development of innovation not available in the market*". BRASIL. **Decreto nº 9.283, de 7 de fevereiro de 2018**. Regulamenta a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 13.243, de 11 de janeiro de 2016, o art. 24, § 3º, e o art. 32, § 7º, da Lei nº 8.666, de 21 de junho de 1993, o art. 1º da Lei nº 8.010, de 29 de março de 1990, e o art. 2º, caput, inciso I, alínea "g", da Lei nº 8.032, de 12 de abril de 1990, e altera o Decreto nº 6.759, de 5 de fevereiro de 2009, para estabelecer medidas de incentivo à inovação e à pesquisa científica e tecnológica no ambiente produtivo, com vistas à capacitação tecnológica, ao alcance da autonomia tecnológica e ao desenvolvimento do sistema produtivo nacional e regional. [*S. l.*], 8 fev. 2018. Disponível em: planalto.gov.br/ccivil_03/_ato2015-2018/2018/decreto/d9283.htm. Acesso em: 26 maio 2022.

[38] *Idem*.

[39] *Art. 27 (...) 4º In the phase prior to the hiring of the contract, the branch or tentity of the public administration must consult the potential hiring parties to obtain the necessary information to define the order, according to the following:*
I – the need and way of consulting must be defined by the branch or entity of the public administration;
II – the consulting will not imply in ressources dispendure from the branch or entity from the public administration, neither prefference in the supplier or executing party choosing; and
III – the consults and answers of the potential hiring parties, when made formally, must be annexed in the hiring procedure, except for information of industrial, technological or trade natures that must be treated under secrecy". Idem.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

interest will occur through a public calling with the hearing of potential suppliers namely, about problems, viability of the order, costs, benefits, risks and deadlines[40].

In the act of negotiation with one or more potential interests, aiming for obtaining advantageous conditions for the administration, there must be observed the directives of transparency and the greater probability of reaching the wanted results which, according to art. 27, §8º, III, of *Decreto* n. 9.283/2018, does not necessarily imply being the lesser cost or price[41].

Defined the performer, the superior authority ratifies the dismissing of public bid and publishes the respective term in the official press, according to art. 20, §4º of *Lei* n. 10.973/2004[42].

In the end, there will be the contract firming, being defined the criteria technical, goals and intellectual property configuration as other rights and legal obligations.[43]

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[40] RAUEN, André Tortato; BARBOSA, Caio Márcio Melo. **Encomendas tecnológicas no Brasil: guia geral de boas práticas.** Brasília: IPEA, 2019, p. 35.

[41] "*Art. 27 (...) § 7º The hiring party will define the minimum standards to be accepted for the use and performance of the solution, product or service or procedure object of the order.*
§ 8º The public administration will negotiate the hiring of the technological order with one or more potentially interested, aiming to obtain the most advantageous conditions for the hiring, regarding the following:
I – the negotiation will be transparent, with the bonded documentation attached to the hiring procedure files, except for industrial, technological or trade nature information that must be kept under secrecy;
II – the choice of the hired party will be oriented for the greater probability of reaching the wanted result by the hiring party and not necessarily by the lesser price or cost, the public administration can use, as a choosing factor, the technical competence, management competence and previous experiences, the quality of the presented project and other criteria for evaluating the hired party;
III - o projeto específico de que trata o § 9º poderá ser objeto de negociação com o contratante, permitido ao contratado, durante a elaboração do projeto, consultar os gestores públicos responsáveis pela contratação e, se houver, o comitê técnico de especialistas". Idem.

[42] "*Art. 20. The branches and entities of the public administration, in matters of public interest, can hire directly ICT, not-for-profit private entities or firms, alone or in joint ventures, aimed for activities of research and with notorious technological expertise in the field, for obtaining research, development and innovation activities for solving a specific technical problem or purchase of product, service or innovative procedure. (...) § 4º The supply on scale or not, of innovative product or procedure resulting from the activities of the research, development and innovation ordered in the way of the head of this article can be hired through bid dismissing, even if with the developer of the order itself, observing the disposition of specific regulations*". (Included by Lei nº 13.243, de 2016). BRASIL. **Lei nº 10973, de 2 de dezembro de 2004**. Regulamento Dispõe sobre incentivos à inovação e à pesquisa científica e tecnológica no ambiente produtivo e dá outras providências. [S. l.], 2 dez. 2004. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.973.htm. Acesso em: 26 maio 2022.

[43] RAUEN, André Tortato; BARBOSA, Caio Márcio Melo. **Encomendas tecnológicas no Brasil: guia geral de boas práticas.** Brasília: IPEA, 2019, p. 35.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

6 UNION ACCOUNTS COURT CASE: PUBLIC CALL FOR HIRING THROUGH TECHNOLOGICAL ORDER

Recently, the Union Accounts Court - *Tribunal de Contas da União* (*TCU*) has made a public call for research and development projects (R&D) receiving, focusing in presenting a solution of artificial intelligence to support the assisted instruction of complaints and representations in the realm of that court[44].

It's an unprecedented public call, which its goal is to promote a digital transformation in that administrative court in the sense that, in addition to be a new acquisition of R&D, it has as its goal the hiring of a "Instruction supported through Artificial Intelligence" module.

This module has three stages. The first is mainly procedural, containing the detection of procedure files, the identification of allegations and therefore, the examination of admissibility and probability calculation of cautionary measures. The following its about the jurimetrics of procedures, including its hierarchy and precedents. And, finally, seeks to reach the files writing and generation of communication for stakeholders with the synthesis of thesis and technical predictions[45].

It's estimated that, if the demand is fulfilled, this technological solution will proportionate a public saving of R$ 112,5 million per year. In addition, there would be more efficiency in procedure assessing and productivity gains thus, usually, the legal operators can reduce 25% of their work with the use of artificial intelligence and, specifically to this ETEC, this index can reach levels of 70%[46].

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[44] TRIBUNAL DE CONTAS DA UNIÃO (TCU). **TCU lança edital inédito para contratação por Encomenda Tecnológica.** Disponível em: https://portal.tcu.gov.br/imprensa/noticias/tcu-lanca-edital-inedito-para-contratacao-por-encomenda-tecnologica.htm. Acesso em: 29 abr. 2022.

[45] TRIBUNAL DE CONTAS DA UNIÃO (TCU). **Edital de Chamamento Público para Encomenda Tecnológica de Instrução Assistida por Inteligência Artificial**, p. 01.Disponível em: https://portal.tcu.gov.br/data/files/68/36/8E/7F/6296E71054CD4BD7E18818A8/16%20-%20Edital%20PUBLICADO.pdf. Acesso em: 29 abr. 2022.

[46] (...) *1) Detecting the meaning of procedural files. Include the identification of allegations, exam the admissibility, calculate probability of cautionary measures concession. 2) Panel of jurimetrics. Includes prioritizing procedures and comparison to prior cases. 3) File writing. Include the generation of communication to stakeholders and instruction containing the summarizing of thesis and prediction of technical analysis as answers of forwarding.* TRIBUNAL DE CONTAS DA UNIÃO (TCU). **Edital de Chamamento Público para Encomenda Tecnológica de Instrução Assistida por Inteligência Artificial,** p. 01/02**.** Disponível em:

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

This order will have as its focus the processing of representations and denounces, diminishing the work of ombudsmen in these procedures and which execution will be predicted in thematic bundles, namely, (i) public acquisitions, (ii) other subjects and (iii) future public acquisitions under the new public bid law - *Lei de Licitações*[47].

In this public call it will be allowed the participation of firms of private law of any size, not-for-profit private entities, science and technology institutions (ICT) and respective foundations or joint ventures, in which the R&D projects will be negotiated by a Selection Commission and selected by an Experts Technical Committee[48].

Were received eighteen projects from firms, ICTs and joint ventures for the negotiation and proof of habilitation requirements step. In June 28th of 2022, the TCU has declared as the first place, to hire the technological order, the NEURALMIND TERRANOVA[49] joint venture, which will be responsible for executing the ETEC.

7 FINAL REMARKS

As seen, the technological orders were created as na alternative way of public hiring, which, through the foment of research and development projects in fields of science, technology and innovation, can contribute for innovative solutions to the public administration.

It's something unprecedented in Brazilian Law, since it escapes the traditional acquisition system – priory focused only in available solutions in the market (and which, some times, was not able to attend the complexity of public sector's demands). In

https://portal.tcu.gov.br/data/files/68/36/8E/7F/6296E71054CD4BD7E18818A8/16%20-%20Edital%20PUBLICADO.pdf. Acesso em: 29 abr. 2022.

47 TRIBUNAL DE CONTAS DA UNIÃO (TCU). **Edital de Chamamento Público para Encomenda Tecnológica de Instrução Assistida por Inteligência Artificial**, p. 02. Disponível em: https://portal.tcu.gov.br/data/files/68/36/8E/7F/6296E71054CD4BD7E18818A8/16%20-%20Edital%20PUBLICADO.pdf. Acesso em: 29 abr. 2022.

48 TRIBUNAL DE CONTAS DA UNIÃO (TCU). **Edital de Chamamento Público para Encomenda Tecnológica de Instrução Assistida por Inteligência Artificial**, p. 02-03. Disponível em: https://portal.tcu.gov.br/data/files/68/36/8E/7F/6296E71054CD4BD7E18818A8/16%20-%20Edital%20PUBLICADO.pdf. Acesso em: 29 abr. 2022.

49 TRIBUNAL DE CONTAS DA UNIÃO (TCU). **Encomenda Tecnológica (ETEC)**. Disponível em: https://portal.tcu.gov.br/data/files/A4/84/A0/82/98BA18102DFE0FF7F18818A8/ETEC%20-%20Edital%20de%20Resultado%20da%20Selecao.pdf. Acesso em: 27out. 2022.

[Received/Recebido: novembro 21, 2022; Accepted/Aceito: janeiro 25, 2023]

contrast, the ETECs prioritize the creation of tailored and innovative solution for the needs of the public administration. Which is, the public management presents a problem to the private sector, and it will, by its turn, supply innovative and technological options to seek an effective solution.

Is must be highlighted that the technological orders are still a underused instrument in Brazil, since it's a relatively newly regulated modality in the domestic legislation. That's the exact reason why it's necessary to foment the study about the subject, to improve its effectiveness in developing innovative solutions.

Therefore, the incentive to its use will promote the raise in more effective solutions for complex public problems, contributing to the construction of smarter (*smart cities*), inclusive and humanized cities.

Summarizing, it's about the connection of the government expertise in public policies, with the state of art technology, as well as artificial intelligence of the private sector, along with techno-scientific knowledge from the scholarships to propose the construction of a viable solution for more complex demands within the Brazilian State. Therefore, it's a very relevant tool for social development.

This model of hiring of ETECs was inspired in the mechanisms of public acquisitions used in the European Law, known as *Pre-commercial procurements* e *Public procurements of innovation*, in which results and experiences are broad and notable, impacting fields such as health, roads infrastructure, and energy supplying, as aforementioned in this work.

It was, introduced in Brazil in 2004 through *Lei* n. 10.973 and regulated in 2018 in the federal level by *Decreto* n. 9.283. In the practical realm, it has as limitation the lack of available solutions for hiring in the domestic market, or, at least, a lack of trade viability on large scale. Which means that, the *ETEC* hiring's depends on the pre-existence of a challenge/technological risk to be dealt with.

Therefore, its still a underexplored mechanism, since are scarce the public branches interested in adhere to this modality. So far, its paradigmatic the public call promoted by the Union Account's Court, since it's the first to be done in Brazil in this magnitude, which has as its object to seek for an artificial intelligence solution for

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supporting the instruction of denounces and representations, which has the potential or promoting efficiency and productivity gains in the realm of that Court.

The case of TCU, which uses ETEC hiring to enhance its digital inclusion and through this its own mission effectiveness as public management controller, proves the relevance and potential of the subject, which its use deserves to be considered as a priority by Brazilian municipalities in a way of making cities smarter and turn public services more efficient.

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