APPLICATION OF RFID TECHNOLOGY IN PUBLIC SECTORS IN BRAZIL

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Abstract

RFID technology is a technology of 4.0 Industry that seeks to support logistical management by enabling data communication and allowing enhanced control of managed goods from a certain institution. One way of application is in Asset Management, granting a greater efficiency in public management, security, control and automation. This project aims to analyze the scientific production published in association to related aspects of the RFID technology at public agencies in Brazil. A systematic literature review was carried out in Science Direct and Google Scholar databases between the years 2015 and 2020. There was a total of 17 studies that addressed the RFID application in the management of mobile assets at public agencies in Brazil, which most of them being application proposals at Public Universities and Army, where the concentration of these chattel are bigger and demonstrates the efficiency of this technology on controlling tracked goods, exploiting all the advantages that this system makes possible.

Keywords: Property Administration. Public Management. Chattel.

1 INTRODUCTION

A chattel is any property that belongs to a public entity whether it is the Union, the State, a public company or an Autarchy, being of its responsibility the use, maintenance, conservation, control and registration of this goods. (SIDOU, 2015).

In Public Administration, the assets inventory is mandatory, as the legislation establishes that the general survey of movable assets will be based on the analytical inventory of each management unit and the elements of the synthetic bookkeeping of the accounting, in order to keep the records of the assets up to date, as well as the responsibility of the sectors where such goods are located. Therefore, the Public Administration must take to the inventory through physical and annual inspections, verifying the responsibilities for guard and confrontation alongside the accounting registration bookkeeping.

In this context, asset management has several aspects focused on procedures that include the identification, listing, location, counting, preservation and the disposal of goods leading to a large amount of information that must be processed for a better asset and administration management in order to reduce non-conformities and improve purchasing planning (BRITO *et al.,* 2019).

Thus, with the growth of Industry 4.0, the search for new Information and Communication Technologies (ICTs) has increased alongside with the need for greater efficiency and control of public

management, leading to the modernization of the Brazilian public sector (DINIZ *et al.,* 2009). An example of ICT that has been applied in asset management is RFID technology, *Radio Frequency IDentification*, a tool that includes asset inventory, distribution and storage logistics, control plus location of assets and recording events using through tipping platelets described as *tags* (DIAS *et al*., 2018), seeking to support logistical management and enabling data communication (GUARNIERI, 2018).

Studies such as Freitas (2020), Brito and collaborators (2019), Pedroso, Zwicker and Souza (2009), indicates that the advantages provided by this technology allow a more efficient public management control of movable assets with less labor demand. Based on this premise, this study aimed to analyze from the published scientific production the aspects related to the application of RFID technology in public agencies in Brazil between the years 2015 and 2020.

2 THEORETICAL REFERENCE

2.1 Radio Frequency Identification Technology - RFID

The RFID is an identification technology that captures signals transmitted via radio frequency waves which are stored remotely, RFID tags can be detected at a certain distance by a scanner. This way, RFID scanners transfer the data obtained to a computer network for processing. This technological innovation offers real-time data that greatly enhances the potential to identify useful patterns for an immediate decision. (GUARNIERI, 2018; TOMAR, GUICHENEY and KYARISIIMA, 2016; ROBLES, 2016).

Miranda (2014) list as main advantages of RFID technology:

- Elimination of data writing and reading errors;
- Data automation;
- Data collection in a faster way;
- Reduction of data processing and time;
- Greater security for the company

The use of radio frequency waves for object detection has been used since 1969, but was only in 2004 that it became commercially and technologically viable, as well as its applicability in various sectors of the industry (FREITAS, 2020). RFID technology comprises basically three main components: the tag, the reader and the antennas.

The tag has the function of storing data referring to the object to which it is attached, consisting of a chip connected to the antenna whom receives and sends the radio frequency signal, allowing communication between the tag and the reader. The reader, otherwise, receives the signal transmitted by the antennas, decodes them and then transfers these data to a software on a computer where this information will be stored (HESSEL and AZAMBUJA, 2011).

The RFID system can work by magnetic induction or electromagnetic radiation. In the first case, the reader generates an electromagnetic field, providing energy for the operation of the chip present in the tag, which, powered by alternating voltage supplied by the reader, will return with radio frequency waves the ID information. By electromagnetic radiation, the reader creates a propagated electromagnetic field that

is detected by the antenna on the tag, also returning the signal via radio frequency with the information encoded in it (WANT, 2006).

The cost of applying the RFID system is uncertain, once it involves the purchase of tags, readers and the cost of installation, maintenance and software (PEREIRA, 2009). Nevertheless, this technology allows a positive feedback at the end of the flow, having in the system all the information management and reinforced control of the managed assets (SOUZA, 2013).

2.2 RFID Applications in Asset Management at Public Services

Most of the works found display proposals to ease and improve the administration of movable assets of public institutions using RFID technology for asset management and control of goods.

Freitas (2020) proposed, for the entrance and exit control of the warehouse at the Federal Technological University of Paraná in Campo Mourão, a security system that uses RFID in all heritage equipment, of which with a single tag, they are monitored via antenna and reader, that use radio frequency and the data is assimilated by microcontroller ESP8266, by WIFI, thus making the system less costly and easily applicable. The proposal of this security system in the Academic Department allows a nimble, effective and cheap management, facilitating the work of those in charge of the asset inventory with more accurate reports.

The feasibility of deploying the RFID system listing pros and cons was analyzed by the Federal University of Vale from San Francisco (UNIVASF), where it was observed that the inventory is carried out manually and it is time consuming, also the implementation of an RFID system, which would considerably facilitate the work of the management team, would allocate an amount of only 0.78% for the institution's budgetary actions (BRITO *et al*., 2019). At the Federal University of Minas Gerais, it is possible to notice a lack of planning, training and disinterest by the servers in participating of the heritage administrative actions, the use of RFID comes as a solution to improve the control and assist in accomplishing the annual inventory, a better solution than barcode usage (SIMÕES, 2016).

The Federal University of Southern Frontier (Universidade Federal da Fronteira Sul), has a computerized system for the control and management of the institution's assets, however it has limitations that depend on the constant intervention of the information technology sector, but it has been the best management tool adopted alongside with the patrimonial responsibility of the agent involved. However, the proposal for a system with RFID technology allows a reduction in human wear and a broader control of goods, especially since a public university has a multitude of goods with a high economic value (SIMON, 2017). Still in the education sector, the lack of control of assets prevails, including the absence of an equity system and its standardization, which could easily be solved with the adoption of an RFID technology system, whom would reduce the loss and depreciation rates (LIMA JUNIOR, 2017).

At the Library of the Federal Academic Senator Luiz Viana Filho, RFID technology is already used, although it is not the technology responsible for the entire inventory and control of the institution, it is the most advanced and the most cost-effective, it is only used in the automation of assistance services (loans and returns), the making of the inventory and in the "maintenance" of documents in the collection, providing greater efficiency and considerably reducing human errors (FONSECA, 2019).

In the health area, studies seek to map the waste of electronic equipment through RFID technology, which allows for more efficient cataloging, less human labor and information accuracy, with adequate control of the memory used in the system and data location, model and reconditioning, in view of the administrative needs for the control of hospital assets (NÓBREGA, 2018).

Viana and Dall'Asta (2020) proposes as an intervention strategy the RFID technology, in order to contribute to the control of assets in the management of the Departments, Divisions and Sectors of the County of Cascavel, aiming the automatization of processes and reducing human errors.

Losi (2016) has elaborated an automated inventory prototype that can easily be applied in the public sector, this inventory consists of RFID technology that allows quick identification of heritage assets, using an identification via web interface and the development of a platform for the construction of a low-cost hardware with a great practicality that can easily be applied in public administration.

Guarnieri (2019) proposes RFID technology as a support for the Electronic Data Interchange (EDI) of an organization, because the specific software used for the translation and communication of data along with the RFID system, offers greater control and management of inventory, providing to EDI real numbers that allow greater control of the flow of goods, helping to reduce purchasing and inventory costs.

In the Brazilian Army it is also possible to observe the application of RFID technology for warehouse management, as in the case of a Command Provider Agency, applying in an invoice reading system, guide and standardization of materials and for works turned to logistics aiming cost reduction and supply control, as well as rationalization of personnel and improvement of technologies used by Military Organizations. In this context, RFID technology is also more efficient because it allows the serialization of a greater number of items, automatizing processes, minimizing the human load, increasing productivity and reducing the incidence of errors (ALMADA JUNIOR, 2018; FREIXO, 2020; RANGEL, 2020; YOST, 2018).

The RFID system can also be used for the control and tracking of transport, as shown in the model used by the bicycle sharing system in Fortaleza (LIMA, 2020), in surveys carried out by Moro and collaborators (2018) and in the management of the vessel traffic, which uses RFID to synchronize the arrival of cargo trucks with the loading of vessels in port areas (LOURENÇO, 2019).

3 METHODOLOGY

This is a descriptive study, characterized as qualitative and exploratory. Has been used Kitchenham (2004) methodology for the Systematic Literature Review (RSL), having the question defined and so on selecting, evaluating and extracting the informations presented in the researches identified as of interest to answer the question proposed according to the flowchart presented in the Figure 1.

Figure 1 - Procedure of systematic literature review
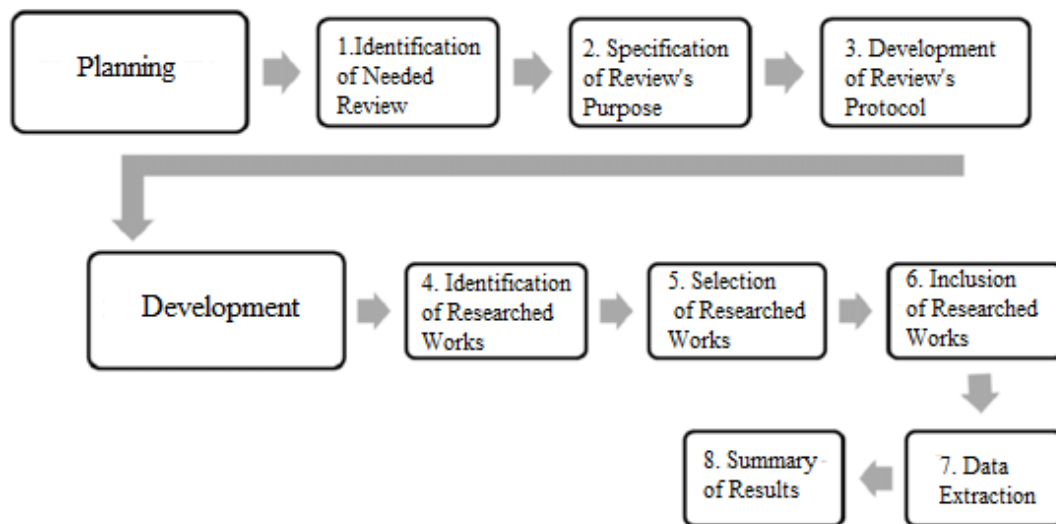
Source: Adapted from Kitchenham (2004).

From the identification of the research theme, "the application of radio frequency identification technology on the patrimonial control of public goods in Brazil", was formulated the question: how is RFID technology applied in the public management of chattel in Brazil?

Given the information of the question, the following keyword strings were used: "RFID"; "Public Administration"; "Chattel"; "Brazil" and "RFID"; "Wealth Management"; "Brazil", with the respective terms in Portuguese and English. Researches were performed in the ScienceDirect - Elservier and Google Academic databases, without language limitations, searching for papers between the years 2015 and 2020. Figure 2 illustrates the results of the search with the selected databases.

Figure 2 - Flowchart of the quantity of publications selected according to the filters used
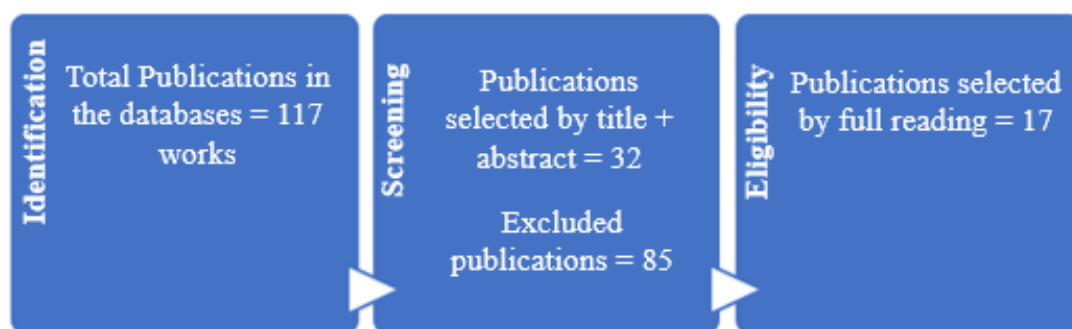
Source: Elaborated by the authors from publications, 2021

As inclusion criteria, it was first opted for the selection of studies within the stipulated date and that corresponded to the terms used in the research, dealing with property control in the public sector, public

management and the use of RFID technology. The reading of the titles and abstracts of each work were performed, selecting a total of 17 works.

After selecting the papers, a critical evaluation was carried out, which consisted of reading each one, extracting the information that satisfactorily answered the premises established in this review, organizing them in a chart by year, title and authors.

4 RESULTS

The search was fulfilled in March of 2021 on the ScienceDirect and Google Scholar platforms. The identified and selected publications presented an extensive study of RFID applications in different sectors and public bodies in Brazil. In such publications, the applied keywords were already found in the titles, correlating the searched terms with each other, allowing a more complete answer in relation to the question of this research "how is RFID technology applied in the public management of chattel in Brazil?".

In most of the researched papers (Chart 1), it is observed that the main application and objective of the use of RFID in public administration aims to expedite the management of chattels, exploring the advantages of this technology.

Chart 1 – Summary of Researched Papers

| Title	Authors	Year of Publication
The adoption of barcode and RFID technologies in Brazilian army	Fernando Barra Freixo	2020
Analysis of methods of control and sanitation from the heritage of a public institution	Lilian Wrzesinski Simon	2017
Analysis of the heritage procedures of the Dean of Research from the UFMG.	Josimary Conceição De Sousa Simões	2016
Barriers to bicycle sharing systems implementation: analysis of two unsuccessful PSS	Suzana R Moro; Aline C Imhof; Diego C Fettermann; Paulo A Cauchick-Miguel	2018
Asset control and Security by RFID in the academic department of electronics at UTFPR Campo Mourão	Reginaldo Benedito De Freitas	2020
Asset control: the use of SISCOFIS in the management of material for the AMAN intendence course	Marco Antonio De Almada Junior	2018
Comparative study between information and communication technologies that help control heritage in libraries: an analysis of the Academic Library Luiz Viana Filho.	Eduardo Rocha Ferreira Da Fonseca	2019

Smart tags in public administration: feasibility analysis in UNIVASF equity control	Cátia Valéria Dos Santos Passos Brito; Welson Barbosa Dos Santos; Cristiane Xavier Galhardo; Vivianni Marques Leite Dos Santos	2019
Fixed asset management in the education sector	José Adagnon Moreira Lima Junior	2017
Judicial Management: Contents and Subjects	Alexandre Maduro-Abreu, Maria Célia Orlato Selem	2018
Impacts of system implementation of a warehouse management system on an army command provider	Mauricio Da Silva Rangel	2020
Mapping of electronic waste in a public hospital: inventory and reverse logistics.	Patrícia Brito Souza Da Nóbrega	2018
Heritage operations in the county of Cascavel: control and management applied in the heritage area with a focus on governance	Elisete Dias Viana; Denis Dall'asta	2020
Automated inventory prototype with RFID	Rafael Antonio Losi	2016
Rio de Janeiro beyond 2016: A project for the new generation of transport infrastructure	Rosane S. Lourenço	2019
SISCOFIS and the demands for control of material by the Brazilian army.	Luiz Felipe Guimarães Souza Yost	2018
The sharing economy in transitions: legitimation dynamics in the urban mobility context in Fortaleza, Brazil	Sérgio Henrique De Oliveira Lima	2020

Source: Elaborated by the authors from publications, 2021

It is observed that studies based on the use of this technology in public service are recent, as most publications are concentrated between the years 2018 and 2020, about 76% of the publications found. Showing that, despite the application of this technology going back to the last century, its use has only been attributed and studied in the last years of this decade.

From Graph 1, it is possible to detect the different scopes, being these services, agencies or institutions that the selected works in this research applied the use of RFID.

Graph 1 - Different scopes of RFID application
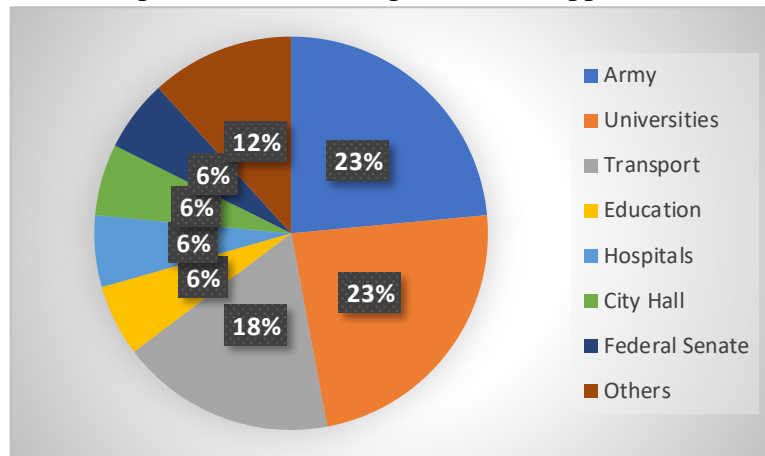
Source: Elaborated by the authors from publications, 2021

Among the 17 works, the Brazilian Army and the Universities stand out in the search to apply RFID technology, because, in these areas, the amount of chattel is greater and there is a bigger need for control, due to the large number of people who interact in these ways, aiming an improved security, avoiding errors and better administration of goods entering and leaving these areas.

Regarding the application areas of RFID within the public management of chattel, most apply to the warehouse where the administration of goods from some institutions takes place, however, it is not limited to this, including the administration of goods in warehouses and transport.

The evaluated works seek to explore the benefits and advantages proposed by RFID technology, being cited mostly the improvement in the management of chattel, reduction of losses and diversion of goods, greater efficiency in inventory operations, improvement in the management of demand for new goods, reduction of labor and goods costs and greater efficiency in management operations.

5 CONCLUSIONS

The overall aim was to evaluate the applications of RFID technology in public services in Brazil, demonstrating its importance and advantages when properly applied and how it is used in property administration, serving as a management and control tool, facilitating human work and reducing errors.

Nowadays, the use of technologies and automatization of services has grown, always aiming the cost-effectiveness and its advantages in order to reduce errors and avoid losses so that there is no damage to the public agency and diversion of goods, RFID technology, in this way, demonstrates that is the best technology to be used for these purposes in order to allow a better service by public bodies and avoid future expenses.

6 REFERENCES

ALMADA JÚNIOR, M. A. de. **Controle patrimonial: a utilização do SISCOFIS no gerenciamento de material do curso de intendência da AMAN**. 2018. Projeto Interdisciplinar - Curso de Bacharel em Ciências Militares. Resende, Rio de Janeiro. 2018.

BRASIL. Lei Federal n° 4.320, de 17 de março de 1964. Estatui Normas Gerais de Direito Financeiro para elaboração e controle dos orçamentos e balanços da União, dos Estados, dos Municípios e do Distrito Federal. Acesso em 30/03/2021.

BRITO, C. V. dos S. P.; SANTOS, W. B.dos; GALHARDO, C. X.; SANTOS, V. M. L. dos. Etiquetas inteligentes na administração pública: análise da viabilidade no controle patrimonial da UNIVASF**. ForScience: revista científica do IFMG,** Formiga, v. 7, n. 2, e00661, jul./dez. 2019.

DIAS, G.; NUNES, R.; SILVA, M. L. P.; NOGUEIRA, V. F. TECNOLOGIA RFID: PRODUTIVIDADE E AGILIDADE NO PROCESSO DE ARMAZENAGEM. **RETEC-Revista de Tecnologias**, v. 11, n. 1. 2018.

DINIZ, E. H.; BARBOSA, A. F.; JUNQUEIRA, A. R. B.; PRADO, O. O governo eletrônico no Brasil: perspectiva histórica a partir de um modelo estruturado de análise. **Revista de Administração Pública**, Rio de Janeiro, v. 43, n. 1, p. 23-48, jan.-fev. 2009.

FONSECA, E. R. F. da. **Estudo comparativo entre as tecnologias de informação e comunicação que auxiliam no controle de patrimônio em bibliotecas: uma análise da Biblioteca Acadêmico Luiz Viana Filho**. 2019. Monografia (Bacharelado em Biblioteconomia) – Universidade de Brasília, Brasília, Distrito Federal. 2019.

FREITAS, R. B. de. **Controle e segurança patrimonial por RFID no Departamento Acadêmico de Eletrônica da UTFPR Campo Mourão**. 2020. Dissertação (Mestrado em Inovações Tecnológicas) - Universidade Tecnológica Federal do Paraná. Campo Mourão, Paraná. 2020.

FREIXO, F. B. **A adoção de tecnologias de código de barras e RFID no Exército Brasileiro**. 2020. Trabalho de Conclusão de Curso (Especialização de Gestão em Administração Pública) - Centro Universitário do Sul de Minas, Salvador, Bahia. 2020.

GUARNIERI, P. **Gestão logística no serviço público**. In: MADURO-ABREU, Alexandre (Org.). Gestão judiciária: conteúdos e disciplina. Brasília: Editora IABS, 2018. p. 98-187.

HESSEL, F.; AZAMBUJA, M. **Etiquetas e Leitores RFID**. In: HESSEL, Fabiano, et al. Implementando RFID na cadeia de negócios: tecnologia a serviço da excelência / org. Fabiano Hessel, et al. 2ª ed. Porto Alegre: EDIPUCRS, 2011. p. 109-147.

KITCHENHAM, Barbara. Procedures for performing systematic reviews. **Keele, UK, Keele University**, v. 33, n. 2004, p. 1-26, 2004.

LIMA JUNIOR, José Adagnon. **Gestão de ativos no setor de ensino**. 2017. Dissertação (Mestrado em Gestão e Tecnologia Industrial) - Centro Universitário SENAI CIMATEC. Salvador, Bahia. 2017.

LIMA, S. H. O. **The sharing economy in transitions: legitimation dynamics in the urban mobility context in Fortaleza, Brazil**. 2020. 337 f. Tese (Doutorado em Administração e Controladoria)

– Programa de Pós-Graduação em Administração e Controladoria, Faculdade de Economia, Administração, Atuária e Contabilidade, Universidade Federal do Ceará, Fortaleza, 2020.

LOSI, R A. **Protótipo de inventário automatizado com RFID**. 2016. Trabalho de Conclusão de Curso (Graduação em Sistemas de Informação) - Universidade Regional De Blumenau, Blumenau, Santa Catarina. 2016.

LOURENÇO, R. **Rio de Janeiro Além de 2016: um projeto para a nova geração de Infraestrutura em transporte**. Instituto de Pesquisa Econômica Aplicada - Brasília : Rio de Janeiro : IPEA , 2015. (Texto para discussão).

MORO, S. R.; IMHOF, A. C.; FETTERMANN, D.C.; CAUCHICK-MIGUEL, P. A. Barriers to bicycle sharing systems implementation: Analysis of two unsuccessful PSS. **Procedia CIRP**, v. 73, p. 191-196, 2018.

NÓBREGA, P. B. S. da. **Mapeamento dos resíduos eletroeletrônicos em um hospital público: inventário e a logística reversa**. 2018. Dissertação (Mestrado em Engenharia Civil e Ambiental) - Universidade Federal da Paraíba, João Pessoa, Paraíba, 2018.

PEDROSO, Marcelo Caldeira; ZWICKER, Ronaldo; SOUZA, Cesar Alexandre de. Adoção de RFID no Brasil: um estudo exploratório. RAM. **Revista de Administração Mackenzie**, v. 10, n. 1, p. 12-36, 2009.

PEREIRA, Í. U. **Um estudo de viabilidade de implantação de etiquetas inteligentes como vantagem competitiva em supermercados**. 2009. Monografia (Especialização em Logística Empresarial) – Universidade Candido Mendes, Rio de Janeiro, 2009.

RANGEL, M. da S. **Impactos da implantação do sistema de gerenciamento de armazém em um Órgão Provedor do Comando do Exército**. 2020. Policy Paper (Especialização em Política, Estratégia e Alta Administração Militar) - Escola de Comando e Estado-Maior do Exército, Rio de Janeiro, Rio de Janeiro, 2020.

ROBLES, L. T. **Gestão Patrimonial e Logística**. 2016. Editora Seses. Rio de Janeiro. 2016.

SIDOU, L. **Bens públicos e suas especificidades**. Jusbrasil. 2015. Disponível em: <https://lucianasidou.jusbrasil.com.br/artigos/197368672/bens-publicos-e-suas-especificidades>. Acesso: 28/03/2021.

SIMOES, J. C. de S. **Análise dos procedimentos do patrimônio da pró-reitoria de pesquisa da UFMG**. 2016. Trabalho de Conclusão de Curso (Especialização em Gestão das Instituições Federais de Ensino Superior) - Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais. 2016.

SIMON, L. W. Análise dos métodos de controle e saneamento do acervo patrimonial de uma instituição pública. **Práticas em Gestão Pública Universitária**, Rio de Janeiro, ano 1, v. 1, n. 1, nov. 2016-maio, 2017.

SOUZA, D. A. M. de; SOUZA, H. R. de; SÁ, M. A. de L.; CINTRA, S. P. V. A logística na gestão de estoque por meio da identificação por rádio frequência (RFID). **SEGET–VI Simpósio de Excelência em Gestão e Tecnologia**, 2009.

TOMAR, L.; GUICHENEY, W.; KYARISIIMA, H. Z. T. Big Data in the Public Sector. Selected Applications and Lessons Learned. **Inter-American Development Bank**, October, 1–52. 2016.

VIANA, E. D.; DALL'ASTA, D. Operações patrimoniais no município de Cascavel: Controle e gestão aplicados na área de patrimônio com enfoque em governança. **Revista Competitividade e Sustentabilidade**, v. 7, n. 2, p. 477-490. 2020.

WANT, R. **An Introduction to RFID Technology**. IEEE Pervasive Computing, v. 5, nº 1, jan-mar, 2006.

YOST, L. F. G. **Siscofis e as demandas de controle de material do Exército Brasileiro**. 2018. Trabalho de Conclusão de Curso (Graduação em Ciências Militares) - Academia Militar das Agulhas Negras, Resende, Rio de Janeiro, 2018.