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RESEARCH ARTICLE

GAMIFIED APP THAT MAPS COLLECTION POINTS AND PLACES OF ACCUMULATING SOLID WASTE IN THE URBAN ENVIRONMENT OF THE CITY OF MANAUS (AMAZONAS)

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Abstract

This article discusses as the main theme the environmental awareness applied to technological advent through the implementation of the prototype of an app (mobile application), we used a study based on solid waste, gamification and technology. Solid residues present great concentration when accumulating rapidly in the urban environment due to population growth, its incorrect disposal causes several problems both for nature and for humans immediately. Fulfilling the objective of the study with the aid of a mobile application, it was identified a viable possibility of gradually circumventing and reducing this problem, presenting an opportunity to implement a technological solution with free or low cost tools, but that fulfills the proposal to organize the collection, routes and map the points destined to the correct disposal of these residues. Due to the lack of applications for this purpose, the feasibility becomes more evident with gamification, because it generates more user engagement through the differential in offering rewards that can be redeemed within the platform, thus positively influencing its use by benefiting users by contributing to a cleaner and more pleasant city, watching over the environment and boosting other sectors present in the city of Manaus, Amazonas (Brazil).

Introduction:-

The population increase is increasing, consequently the volume of garbage generated in urban centers has also increased, according to Antenor and Szigethy (2020), Brazil is one of the countries that generates the most solid waste. The impacts of irregular treatment are diverse, including new diseases disseminated by urban pests, atmospheric, water and visual pollution, in certain locations can directly affect the infrastructure due to the incorrect disposal of certain solid waste (VGR, 2020), for this reasonthe lgu these impacts occur immediately than others, such as the decomposition process that occurred in certain residues, which can take from months to centuries.

Plastic is one of the solid wastethat takes the longest to decomplant, this process takes around 400 years for matter to cease to exist completely, until this occurs continues to generate numerous impacts to the environment, these being mainly water (WWF, 2019). The problems of this incorrect disposal have caused a snowball effect for nature and the human being himself, such as the damage caused by the problematic floods of heavy rains, resulting in direct impacts on infrastructure and public health, for example (Environmental Dynamics, 2018). Delimiting this global problem to regional in the city of Manaus (Amazonas),it was noticed that the numbers are significant, because according to data released by the Municipal Department of Urban Cleaning (Semulsp), about 731 thousand tons of

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solid waste were collected in the city only in 2020, with an average daily collection of 2400 tons, in addition the city presents several water problems caused by the pollution of the interconnected stream and rivers in the northern region.

Applications focused on the environment are scarce and little used by the population, because they do not generate the necessary attention to encourage the user to use it in their daily lives, different from the emerging technologies that explore this aspect bringing with them the objective of implementing viable solutions for the most diverse difficulties faced in everyday situations. Gamification drives the popularity of more specific applications, attracting more user attention, and the fact that environmental awareness is also present, making it a viable emerging technology. Its implementation is based on a study process to add technology in the gradual improvement and sunution of the treatment and collection of solid waste. There are applications aimed at various sectors of the industry, there are also opportunities that are not only aimed at profit but also to use awareness or a philanthropic idea for beneficial purposes and specific solutions for a large group of individuals.

The idea of developing areturn tothe environment through the prototype of this work is to present a technological solutionthat reducesthe environmental impacts caused by the accumulation of solid waste in urban centers, bringingan innovative proposal in order to gain the attention of the local population through the intuitive features included in the app. Itprovides the user with an integrated system with gamification, consequentlygenerating motivation to use the application by granting rewards for contributing to the platform. Finally, the application aims to achieve the goal of bringing the importance of environmental awareness through technology, integrating the interaction of users to gradually improve urban environmental problems in the environment where they are inserted.

Theoretical Framework

The theoretical framework was divided into cinco topics, based on addressing the classification and data of the research on solid waste, incorrect disposal of solid waste and its impacts, taking into account the limitations that the city of Manaus faces in trying to overcome these problems. Finally, it was addressed in how a technological proposal with gamification presents a great incentive for greater acceptance of usersbeforethe functionalities of the application.

Solid Waste (RS)

Solid Waste (RS) is the remaining materials that have gone through the process of activity carried out by humans or companies, which have reached the end of their useful life and no longer add value to them (VGR, 2020).

Rating

The classification of solid waste requires a process involving the identification of the activity performed that gave rise to and its constituents, the characteristics and comparison of these constituents, presenting a list of residues and substances that have impacts on the health and the environment registered. The classification follows according to ABNT NBR 10004, classifying hazardous waste as class I waste and non-hazardous waste is classified as class II, these are subdivided into class II A, which are non-inert waste and class II B, which are inert waste (VR, 2018).

Impacts And Problems Generated By Incorrect Disposal Of Solid Waste

The rapid growth of urban centers, due to the migration of industry and population increase, as well as cultural factors and consumption habits influence the socio-environmental problems that human beings and nature currently face. Incorrect and ineffective disposal, accumulation in inappropriate places, failure in collection management, lack of awareness and public policies on the subject have generated impacts such as diseases, soil contamination, in addition to air pollution, water, visual, etc. (NASCIMENTO E FILHO, 2021).

Solid Waste Management In The Urban Environment Of The City Of Manaus

In this topic we used the data released by Semulsp (2020), being divided into the common and household collection, stating that from January to October 2020, 731 thousand tons of Municipal Solid Waste (US) were collected from the city of Manaus, a daily average of 2,395 tons, with a per capita collection of 1,083 kg per day. In the period from 2013 to 2020, the Manaus Urban Cleaning collected 7.2 million tons of municipal solid waste, with a growth rate of 1% per year in the monthly collection of USC.

The Household Collection was responsible for the removal of 497,000 tons in 2020, the modality with the highest participation, about 67.4% in relation to the total waste collected in the city. The daily average reached 1,630 tons,

with a per capita rate of 737 grams per day of waste collected in households, small industries, commerce, banks, schools. In the period from 2013 to 2020, household collection moved 4.7 million tons, an increase of 1% per year in the monthly collection of household collection.

Gamificação

Gamification is a relatively recent subject, its concept emerged in the 70s and 80s with the popularity of ATARI, a video game pioneer in innovating video games and consoles as they are now known. In 2003 the term Gamification was defined by programmer Nick Pelling, but only in 2010 was it actually used with the popularity and technological innovation that smartphones brought with them through mobile applications.

Gamification is to explore the strategy used in the games, arousing the creativity and attention of the participants by applying this methodology in the activities of work, school and specific purposes. Learning is driven during the process, and creates a great sense of reward (BALDISSERA, 2021). This innovative methodology is evident in several sectors of the industry as being flexible, interdisciplinary and having prominence mainly in the technological sector as a requirement in the development of applications. Its main objective was to generate greater engagement to an idea, activity or product of a company, in addition to motivating employees to increase the efficiency of constant processes by making them less monotonous and more interesting (MOREIRA, 2018).

Gamatized Mobile Apps

Mobile apps are created by developing mobile software. Its development process varies according to the platform available and the manufacturer used for each smartphone device, most mobile applications are present in the environment of virtual stores and require the user to have an account on the platform, two stand out in the current market, Google's Android and Apple's iOS (JUNIOR, 2018).

In view of technological evolution through smartphones and social media, the use of gamification became popular, becoming present in applications, thus covering all audiences and contemplating various purposes. Technological gamification has been used primarily in gaming applications, wellness, e-commerce, urban mobility and teaching platforms. The benefits offered to users are diverse, in addition to holding their attention for longer, generating engagement through daily/weekly activities, providing rewards when performing tasks and fulfilling challenges with achievements, all this is characterized in the gamification criterion (TEIXEIRA, 2016).

As an example of an application with gamification that was established in Brazil, the Chinese e-commerce store shopee stands out in this medium, where the company's strategy and differential to win users are the mini-games present on the platform, these reward the user with coins that can be exchanged for discount coupons and free shipping (ANDRION, 2021).

Matter And Methods:-

To achieve the proposed objectives and test the experimental hypotheses formulated, a field and experimental study was carried out for the development of the application prototype. All modeling was done based on the city of Manaus as a reference of tests and applications for the evolution of the App, thus maintaining the interaction with the improved user.

React native is a framework developed by meta company (former facebook group) that consists of converting the programmed language based on the JavaScript library for both Android and iOS natively, using it to make the graphical interface and also functionalities of the application such as, actions that such a button will do, etc.

Figure 1 shows the home screen on which the user logs in with their username and password, you can also log in through the google account, facebook and outlook.

Figure 1:- Application initial interface display.

Source: Authors (2022).

Mysql Database

Database is a collection of information that is stored on servers for use within the application for specific reasons. SQL is a programming language used by almost all relational databases to query, manipulate, and define data and provide access control.

Using the database (MySQL) plus mobile data and the GPS location of smartphones, the application will be able to locate the recycle bins closest to your location, where the user can trace a destination to the recycle bin, that which was provided by another user who has already mapped within the application in which it was passed by a verification system to be approved within the system, after approval the system rewards the user with points (blockchain).

MySQL is a SQL-based relational database management (DBMS) system. It is designed and optimized for web applications and can run on any platform. As new and different requirements have emerged with the internet, MySQL has become the preferred platform for web developers and web-based applications.

Figure 2 shows the collection points scattered throughout the city, with code information and their respective locations.

Figure 2 - Display of the registration interface of collection points

Source: Authors (2022).

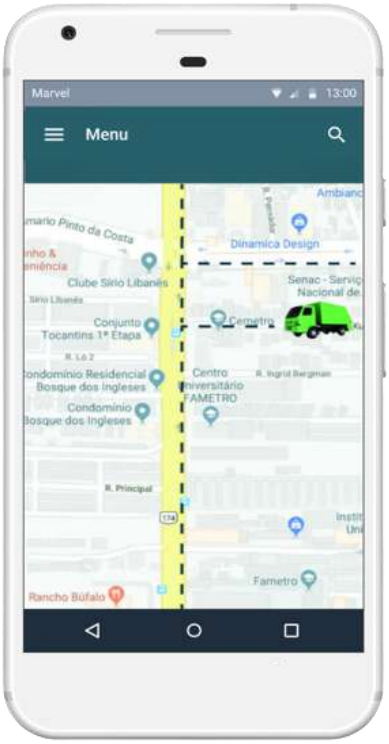
Api Google Maps

The expression Application Programming Interface originated the acronym Application Programming Interface (API). APIs are "translators" with the function of connecting systems, software and applications. In this way, you can deliver a more familiar user experience to people. APIs allow the end user to use an application, software, or even a simple spreadsheet, querying, changing, and storing data from multiple systems, without the user having to access it directly. The purpose of an API is to exchange data between different systems, most of the time these data exchanges aim to automate manual processes and/or allow the creation of new features (COSTA, 2022).

Google Maps API provides geolocation within the app so the user can see the map in real time while moving, using this API linked to the database in MySQL, it is possible to map all recycle bins registered by users, which are visible to users where they can interact with it by clicking on top of the trash icon.

Figure 3 shows the route path and location of garbage trucks that collect solid waste daily, and shows the estimated time to the destination of a given collection point, application consuming Google Maps API

Figure 3 - Map display on garbage truck route



Source: Authors (2022).

Implementing An Api In The App

The implementation of the API is done in a simple way since it is an application already implemented and by the company google, after you generate an api key that is customized for each application, giving the freedom of you to be able to make specific modifications to meet the need of the project. What we need to do is create the request url, access it, save the data in json format to an object, and convert it to a data frame. The function: "get_googlemaps_data()" fulfills this goal. More specifically, it receives the parameters performed in the search, an API key returns a data frame with the geolocation data (latitude and longitude) of the results that were found (TRECENTI, 2017).

Figure 4 shows the integration of the google API with accurate images of the waste collection points, so that the user can view the icon that represents the trash cans (mainly) and clicking the image, similar to the street view, will be shown.

Figure 4:- Displayof information about collection points.

Source: Authors (2022).

Users

The project aims to deliver a complete experience using a simplistic and minimalist design so that any user can have ease in the use of the functions proposed by the app. But also to have a more complete experience the app will offer monthly plans for the user to have an ad-free experience within the platform, also ensuring extra points for actions performed within the app and greater rewards for correctly discarded items in companies and trades project partners.

Figure 5 shows the gamification screen where the user can redeem the rewards using their points earned on the platform.

Figure 5:- Gamification Interface Display, Exchange of Points for Rewards.

Source: Authors (2022).

The methodology used arose from a quantitative satisfaction survey, in which it was applied during "Inovatech", a technological innovation fair held by the University Center - Fametro. The main purpose of the application was presented in its initial stage of prototyping, only with its login interface and some functionality related to map icons simulating the collection points scattered throughout the city and integrated with the Google API. Finally, the evaluators, teachers and public present at the event gave feedback after the end of the exhibition, to address the improvements in the subsequent process of developing the prototype.

For data collection and the basis of the study to optimize the application in fulfilling its proposal without difficulties, complementary research was used through scientific articles and reports published by the Municipal Department of Urban Cleaning of Manaus (Semulsp), as a differential the gamification system is still in the process of identifying the best viable way of its implementation, the last functionality and interface to be implemented in the prototype.

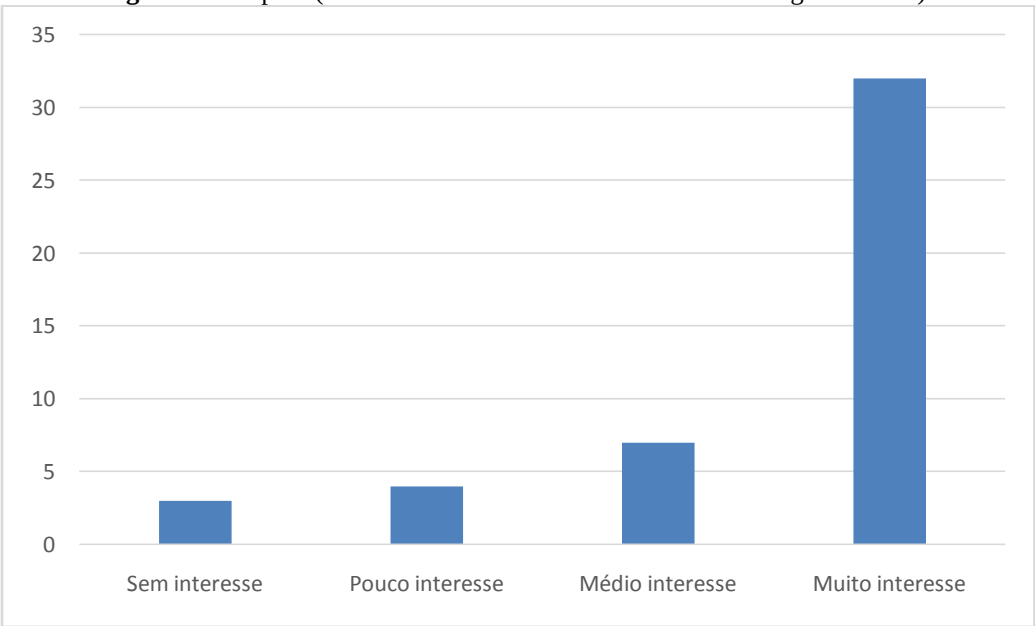
The application is in the process of modeling and prototyping complementary to the rest of the functionalities and interfaces, where the collection of the remaining requirements for the documentation and identification of the tools necessary for the effective implementation of the prototype, temporarily named "Transformers 4.0" takes place. The prototyping process was idealized from the beginning to preferably use technological resources with free and free license, aiming to enhance the expense of financial resources imposed on the project only for tools and frameworks essential for complementary performance functionalities, graphical interface and usability, in view of limited development due to having a relatively small team.

Results:-

The results present positive data based on the current progress of the prototype development, in addition to the feedback regarding its exhibition held at the technological solutions fair of the University Center Fametro, "Inovatech". The prototype has fulfilled the proposal to present a pleasant interface and with easy understanding by the user. The total cost of final development can be reduced gradually through partnerships with public agencies, such as manaus prefecture, or even private companies to which the proposal of this application interests. The result of the prototype feedback survey was outlined in graphs according to the opinionated questions about features and interface of the prototype, in total 46 respondents were obtained.

In graph 1 of Figure 6, respondents were asked how little they wanted to know the time of collection of waste near their address, 32 respondents showed great interest, 7 showed medium interest, another 7 stated little or no interest.

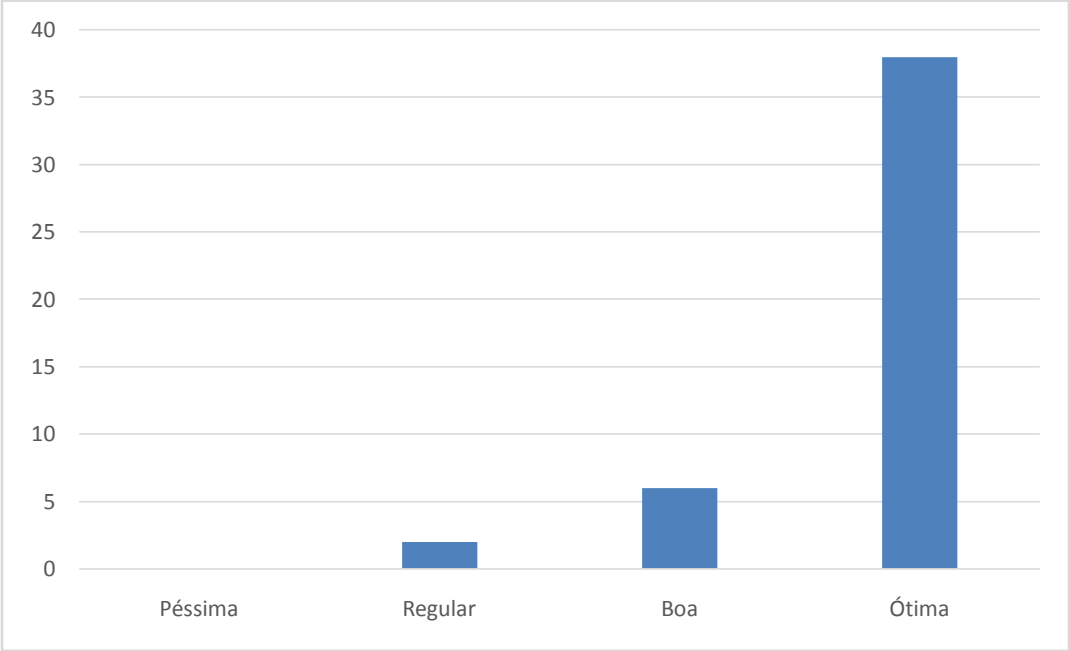
Figure 6:- Graph 1 (Index of indication on collection time in neighborhoods).



Source: Authors (2022).

Graph 2 in Figure 7 shows the result of respondents' opinions on how they classify the application interface, with the options being bad, regular, good and great. About 38 people rated the interface as optimal, just under 6 said it was good and 2 rated it as regular.

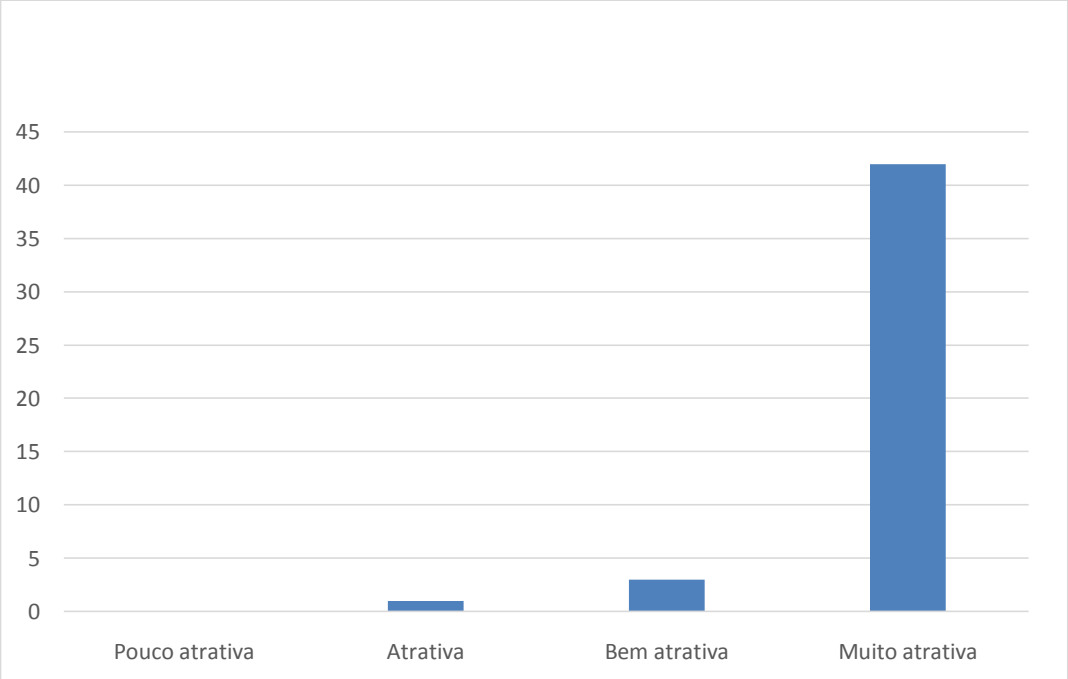
Figure 7:- Graph 2 (Interface View).



Source: Authors (2022).

Graph 3 of Figure 8 was asked about the gamification system, how attractive the rewards functionality is to the user. As a result 42 people responded as very attractive and another 4 as attractive overall.

Figure 8:- Graph 3 (Opinion on the gamification system and rewards).



Source: Authors (2022).

Final Considerations

The life cycle of solid waste management requires caution from its manufacture in quality control when product, to its handling and disposal for common collection. As a factor, the presence of solid waste in urban areas is still very significant, because the way disposal is carried out lacks good methods to avoid impacts on public health and especially the environment, given the various external factors that have contributed negatively to persistent global problems such as atmospheric, in urban, water and visual soils, mainly.

The application will assist in the proposal of organizing the collection points scattered throughout the city of Manaus, mapping, providing better routes for the common collection and offer users a better convenience when separating their waste, consequently performing the disposal consciously at the exact points and times, greatly reducing the chances of animal or human manipulation, after disposal in the trash cans and collection points.

The low cost tools have facilitated the development in the prototype of the application, with the help or even partnership of companies the cost and time of implementation would decrease significantly. Through the results the gamification included in the application proved to be a differential and attractive potential for its popularity, making it a more interesting option for users. As a complement the rewards granted on the platform positively influence awareness, in addition to the growth of accesses to be able to keep the platform well updated, enabling better user support.

References:-

1. ANDRION, R. **Shopee advances in Brazil with "gamification" and coupons that attract consumers**. Canaltech, 30. Aug. 2021. Available in: <https://canaltech.com.br/negocios/shopee-avanca-no-brasil-com-gamificacao-e-cupons-que-atraem-consumidores-194261/>. Access: 26 Sep. 2022.
2. BALDISSERA, O. **What is gamification and how it increases engagement**. Post PUCPR Digital, 5 Apr 2021. Available from: <https://posdigital.pucpr.br/blog/gamificacao-engajamento>. Access: 26 Sep. 2022.
3. **Brazil is the 4th country in the world that generates the most plastic waste**. WWF, March 4. 2022. Available from: <https://www.wwf.org.br/?70222/Brasil-e-o-4-pais-do-mundo-que-mais-gera-lixo-plastico>. Access: 26 Sep. 2022.

4. **Characterization and Classification of Solid Waste**. VR, March 22. 2018. Available in: <https://www.verdeghaia.com.br/blog-caracterizacao-e-classificacao-dos-residuos-solidos/>. Access: 27 Sep. 2022.
5. COSTA, J. **APIs: Everything about what API is, examples and importance!**. Zenvia, Sao Paulo, Jan. 27. 2022. Available in: <https://www.zenvia.com/blog/apis-entenda-o-que-sao-e-como-funcionam/>. Accessed: 26 Oct. 2022.
6. SON, J; BIRTH, F. **THE ENVIRONMENTAL IMPACTS OF SOLID WASTE**. ENCYCLOPEDIA BIOOSFERA, Centro Científico Conhecer – Jandaia-GO, Rio Grande do Norte, v. 18, n.38, p. 219, 30 Dec. 2021. Available in: <http://www.conhecer.org.br/enciclop/2021D/os%20impactos.pdf>. Accessed: 21 Oct. 2022.
7. FREITAS, J. **Gamification combined with the use of mobile technologies (smartphones and tablets) and QR Code as a facilitating strategy for learning the contents of genetics**. 2020. Available in: <https://repositorio.ufpe.br/handle/123456789/35504>. Access: 26 Sep. 2022.
8. JUNIOR, H **. Mobile Application Development**. Analecta, v. 4, n. 4, p. 606, Nov. 2018. ISSN 2448-0096 607. Available from: <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjc3s3mqdj6AhWwQ7gEHRTBCjYQFnoECAcQAQ&url=https%3A%2F%2Fseer.uniacademia.edu.br%2Findex.php%2FANL%2Farticle%2Fdownload%2F1797%2F1142&usg=AOvVaw2HjsGF6T1tdoGNMbiZlNm4>. Accessed: 11 Oct. 2022.
9. MOREIRA, E. **Gamification as a technological tool for talent retention.** TD, 30 Apr. 2022 . Available from: <https://transformacaodigital.com/recursos-humanos/a-gamificacao-como-ferramenta-tecnologica-para-retencao-de-talentos/>. Access: 26 Sep. 2022.
10. **REtorio Management 2013-2020**. Semulsp (Manaus),p. 4, Nov. 2020. Available in: <https://semulsp.manaus.am.gov.br/wp-content/uploads/2020/12/Relatorio-Semulsp-2013-a-2020-parcial.pdf>. Accessed: 30 Aug. 2022.
11. **Solid waste: what it is, legislation about it and how to properly target and treat**. VGR, Aug. 27. 2020. Available in: <https://www.vgresiduos.com.br/blog/residuos-solidos-o-que-sao-legislacao-a-respeito-e-como-destinar-e-tratar-corretamente/>. Access: 27 Sep. 2022.
12. **Learn the main consequences of incorrect garbage disposal**. Environmental Dynamics, São Paulo, Jan. 18. 2018. Available in: <https://www.dinamicambiental.com.br/blog/meio-ambiente/saiba-principais-consequencias-descarte-incorreto-lixo/>. Accessed: 30 Aug. 2022.
13. SZIGETHY, L; ANTENOR, S**. Municipal solid waste in Brazil: technological, political and economic challenges.** IPEA, Rio de Janeiro, 7 Sep. 2020. Available in: <https://www.ipea.gov.br/cts/en/topics/217-residuos-solidos-urbanos-no-brasil-desafios-tecnologicos-politicos-e-economicos>. Accessed: 31 Aug. 2022.
14. TRECENTI, J. **HOW TO USE GOOGLE MAPS APIS TO FIND WHAT YOU WANT!**. Mundo API, São Paulo, May 29. 2017. Available in: <https://mundoapi.com.br/materias/google-maps-api-2/>. Accessed: 26 Oct. 2022.
15. VILAS BOAS, J; TEIXEIRA, M; DAMACENO, E; BRANCHER, J. **GamAPI - An API for Gamification**. Informatics in education: theory & practice, Porto Alegre, v. 20, n. 1, p. 73, Jan/Apr. 2017. DOI: 10.22456/1982-1654.69917. Available in: <https://seer.ufrgs.br/index.php/InfEducTeoriaPratica/article/view/69917>. Accessed: 21 Oct. 2022.