



P4TREE TECHNOLOGY APPLICATION AT THE BELO HORIZONTE CARNIVAL

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ABSTRACT: The Brazilian Carnival is considered one of the best known tourist products internationally, and is responsible for the movement and composition of flows of people, motivation for travel, generation of income and jobs, changes in supply and demand and changes in consumption habits. The events surrounding the carnival also have social, cultural, economic, political and environmental impacts on the host cities. These impacts deserve attention, along with efforts to reduce the more negative ones. The Belo Horizonte Tourism Office - Belotur, an organization linked to the Belo Horizonte City Hall, in partnership with the Department of Chemistry of the Federal University of Minas Gerais – UFMG introduced measures for the “P4Tree Technology Application at Belo Horizonte Carnival”. P4Tree is a technology developed at UFMG that consists of in the formulation of a tablet capable of holding the phosphorus element in contact with waste. This material is manipulated in the laboratory and transformed into fertilizer for use in various crops. This is because phosphorus is a fundamental nutrient for the development of any living being. The project was tested at the Belo Horizonte Carnival in 2018 and based on the results, it was replicated at the 2019 Carnival. It consisted of the application of P4Tree technology in 100 chemical toilets around the stage dedicated to the family and children’s programming of the Carnival, in the central region of Belo Horizonte, with high flow and movement of people. The toilets supplied and installed by Belotur were labeled with the project’s visual identity, and were later equipped by the team of students from the UFMG Chemistry Department with P4Tree tablets in the tanks. The tablets were left in the toilets until the end of each day, before suction of the waste by the company responsible for cleaning the toilets. The P4Tree material collected was properly packaged and transferred to the University Laboratory where it was handled and made into fertilizer. This fertilizer was used/tested on five different crops at the Belo Horizonte Zoobotany Foundation, including Ipê, a tree symbol of Belo Horizonte. Tests were conducted to compare with traditional fertilizer used by the Zoobotany Foundation. The proposal is to use the seedlings of these crops to replant other areas of the city. Actions to promote the use of technology that enables the sustainability to be incorporated at one of the biggest urban events in Belo Horizonte. Due to the visibility and results achieved, it can be replicated at events with different characteristics. Interdisciplinary combination relevant to the sector, considering events as one of the main links in the tourism production chain.

KEYWORDS: Carnival; Sustainability; Technology

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INTRODUCTION

The junction of carnival and science may seem unlikely, but proof that this is possible is the P4Tree project, a partnership between Belo Horizonte Tourism Office - Belotur (Belo Horizonte City Hall) and the Department of Chemistry of the Federal University of Minas Gerais, which was conducted for the second time in Minas Gerais. Following a pilot operation in 2018, the technology, called P4Tree, capable of absorbing the phosphorus micronutrient (available in phosphate form) present in urine and turning it into fertilizer, was placed in chemical toilets during the 2019 Belo Horizonte Carnival.

In 2018, P4Tree was placed in six toilets during the four days of the carnival. The repercussions and results were so positive that in 2019, the project was extended to 100 chemical toilets - including toilets for people with special needs - which were set up at strategic points of the Belo Horizonte carnival with a high flow of people. The action, which is part of the 'Sustainability and Innovation' axis of the Belo Horizonte Carnival, was given special visual identification, as well as a team to guide the carnival goers, informing them about the technology and the aims of the project.

The action involved placing 200g sachets of P4Tree material in the chemical toilets identified. When it comes into contact with urine, the collector filters and separates the phosphorus from the other elements present in the tank. To avoid loss of material, the toilets of the project are in fixed locations. The sachets are installed about one hour before the start of the program for each day, and at the end of each program, each night, the material is removed. Once the event has finished the samples are taken to the University Laboratory, where they are disinfected.

After collection, the material transformed into fertilizer is used through a partnership with the Belo Horizonte Zoobotany and Municipal Parks Foundation. It is applied to new Ipê crops, for example, which will be replanted in the city's gardens and parks.

The use of P4Tree material at the Belo Horizonte Carnival shows a path that it outside the norm: it is possible to design collaborative projects between universities and public agencies, which generate benefits for both parties, quickly and efficiently. Individual efforts are needed from representatives of the institutions of interest in the partnership to make it happen, applying the many technologies that Brazilian public universities can offer. Partnerships of this type are not always easy to maintain, due to the bureaucracy surrounding the public bodies and the high expectations of the corporate environment in new technologies.

RESEARCH PROBLEM AND RELEVANCE

Phosphorus deficiency is an environmental issue, according to Matheus (2014), Mahowald (2008) and Elser (2007). The search for new sources and ways to recover this element is crucial for our experience. This project therefore seeks to reconcile responses and results for the following research problems: a) reuse of phosphorus; b) identification of the most cost-effective fertilizers; and c) establishment of a method that reduces the impact of the chemical toilets used during the Belo Horizonte Carnival.

These are issues that arose out of research projects implemented at UFMG and which, due to their importance and relevance to the interest of Belotur, have become the object of a practical implementation at the Belo Horizonte Carnival.

Phosphorus is a crucial chemical element for the cultivation of basically any plant, is part of the group of essential macronutrients in fertilizers, together with potassium and nitrogen, also known as the combination NPK: nitrogen (N), phosphorus (P) and potassium (K) (Mumbach et al, 2016) . A lack of phosphorus in fertilizers and soil causes premature death of the plants, low development, and problems with uptake of nutrients and minerals present in the soil, as well as problems in the process of photosynthesis, according to Kanashiro (2007).

Most of the phosphorus used worldwide comes from extractive mining (Santos, 2008), but this reality may change with the decline in quality based on increased demand, prompting the search for other sources of this nutrient. Another issue linked to this theme is the environmental imbalance caused by incorrect disposal or the lack of proper treatment of phosphorus thrown into sanitary and industrial wastewater. Added to this is the fact that various aspects of our diet and our disposal of food and waste are rich in phosphorus that is not reused.

Within this scenario, the possibility considered of using the phosphorus present in the human urine of the phosphorus element was investigated. These factors motivated the development and application of P4Tree technology at the Belo Horizonte Carnival, with one of the main actions being the installation of chemical toilets throughout the city to meet the demand of carnival goers and hygiene care of the city.

By aligning the technology developed by the Department of Chemistry of UFMG with the Belo Horizonte Carnival, one of the most representative events of Brazilian culture, which is growing and evolving each year in Belo Horizonte, this has become an important project for the 2020 event.

The application of P4Tree at the Belo Horizonte Carni-



val combines the interest in minimizing the impacts of the event in the city with innovative technological solutions aimed at incorporating sustainability actions into the planning, organization and operation of the event, in which such actions are becoming increasingly important.

Effect triggered by the growth of the events sector, which motivates tourist flows (Getz, 1998; Crompton and McKay, 1997) and by the economic, social and environmental impacts resulting from the increasing number, diversity and popularity of festivals, shows, and concerts in urban centers (Crompton and McKay, 1997; Getz, 1997; Gursoy, Kim and Uysal, 2004). In the case of Brazil, the emphasis on the occupation of public spaces, which are used as event venues, within a perspective of marketing of places, intrinsically linked to the development of urban tourism and, more recently, social changes (Picard and Robinson, 2006).

The organization of events for a locality is also positive for government bodies and companies, since it promotes and improve the local image and generates taxes and income at municipal, state and federal levels. Allen, McDonald and William (2003) question the negative consequences that failures in this organization can cause in terms of media and structure, transforming positive impacts into negative ones, such as those of an environmental nature.

Touristic events can, therefore, be understood as the planning, execution and systematic marketing of tourist resources in a given period of time (Getz and Wicks, 1993), having become one of the most important links in the sector, and sometimes assimilated as the application of a technique or specialization in the way of organizing an activity in the tourism sector (Getz, 2008). It is also a motivation used as an important tool in the destination marketing plan (Richie, 1997).

These are elements that motivate entrepreneurs, producers and event organizers to assess the environmental impacts in their local or regional contexts, and in order to minimize the negative results and maximize the positive ones, especially from the perspective of future projections, in which implementing sustainable measures and actions, such as the application of P4Tree at the Belo Horizonte Carnival, play a prominent role in the organization and hosting of events.

METHODOLOGY

The relationship between UFMG and Belotur began at the second International Business Fair (FINIT), which took place in 2017. Students of the master's and doctorate courses in technological innovation of UFMG, and members of Belotur's Committee for Tourism Policies and Innovation, expressed interest in for-

ming a partnership and learned about the P4Tree technology, with a view to possibly using the material at events. Seeing the potential of the material for the tourism sector, meetings were scheduled to outline joint strategies for its application, and the Belo Horizonte Carnival was the chosen event.

The P4Tree technology involves various materials developed at UFMG. Its surface has the capacity to absorb phosphorus in the wastewater with which it comes into contact. The material is mostly composed of materials and minerals already used in agriculture, such as soil correctors or in the addition of specific minerals for deficient soils. These have mixtures with specific proportions, and are treated in a laboratory to give them the properties of capture and adsorption of phosphorus.

After contact with the P4Tree material, the urine still needs to be disposed of in the sewage, but its phosphorus content is now lower, and less harmful to the environment (when not treated properly). After various manufacturing and synthesis processes, the material is shaped into a tablet, which can be deposited in special containers or in chemical toilets.

This material can be placed inside a chemical toilet using a kind of bag or covering with holes in it, enabling direct contact with the effluent, forming a kind of "sachet", but with the opposite effect: instead of diffusing the contents outwards, like a teabag, the sachet captures the phosphorus inside it.

The P4Tree implementation project at the Belo Horizonte Carnival in 2019 was carried out through a partnership agreement between Belotur and UFMG. The technology was and is still developed at the laboratories of the UFMG Department of Chemistry, using public resources in the research and intellectual protection stages. Thus, the Federal University of Minas Gerais is now the legal holder of the technology, and it is currently in the licensing process for partner companies of the project in which the technology is developed. A "Test Authorization Agreement (Termo de Autorização de Teste) was then created, to formalize the use of an UFMG technology in a public space in order to test the technology, not only in terms of its technical aspects, but also looking at user behavior.

Before the start of the action, students of the Department of Chemistry at UFMG took part in a selection and training process, to act as promoters at the Carnival 2019. There were a total of 56 applications from those interested in taking part, including postdoctorate, doctorate, postgraduate and undergraduate students. The promoters took part in raising awareness, and providing guidance and information.

The project consisted of the implementation of P4Tree material in 100 chemical toilets, duly labeled with adhesive signs, and mapped by Belotur. A sa-



chet containing 400 grams of P4Tree material, processed and developed at UFMG, was placed in each chemical toilet. The mass in the sachet was considered to be the amount needed to capture all the phosphorus from the urine if it reached the maximum in the tank by the end of the day, i.e. around 220 liters of waste per toilet.

At least one person was available for every five toilets. They wore P4Tree branding t-shirts and were responsible for distributing stickers, informing users of the benefits of the project and how the tablets would be used, and gathering information on user's behavior.

The sachets were placed in the toilets by hand, using protrusions inside the toilet, on the surface of the bowl, to "tie" the sachet so that it remained hanging in the bowl without touching the bottom. This would ensure that the material came into contact with all the deposited waste. The sachets were placed about an hour before the start of the carnival block in which the toilets were installed.

The progress and implementation during the Carnival period was shared between Belotur and UFMG, from monitoring the placement of the chemical toilets to the recovery of the material.

Once the material had been collected and treated, it was transformed, at the UFMG laboratory, into fertilizer which is currently being tested at the Botanical Garden of the Belo Horizonte Municipal Parks and Zoobotany Foundation. Creating a test environment for P4Tree materials is crucial to understanding its potential as a fertilizer. If we find that P4Tree has the potential to fertilize seedlings of the Botanical Garden, then a plan may be developed to replace fertilizer currently purchased by the Foundation for its garden and parks in Belo Horizonte with P4Tree.

This testing stage consists of taking the material removed from the chemical toilets in the form of fertilizers, for use on various corps/species in the Botanical Garden (at least five with fast or slow growth, requiring more, or less phosphorus respectively). The proposal is to use the P4Tree material to fertilize Ipê trees, for example, which would later be planted around the city of Belo Horizonte. Crop fertilization begins shortly after material is removed from the toilets.

RESULTS

The application of P4Tree at the Belo Horizonte Carnival not only brought recognition for an initiative developed within the academic environment, but was also an action with application at one of the largest public urban events in the country. Advantage was taken of the knowledge of the UFMG academic community to propose a project that, developed jointly, reached spontaneous national media and generated results for the teams who had taken part in the design, organiza-

tion and execution of the project.

The project also raised awareness about the correct use of chemical toilets at the Carnival, preventing the city from becoming an open-air toilet. It promoted care of the city's patrimony, and of the resources invested in toilets, urban cleanliness, and understanding the importance of phosphorus in our lives, as well as the scarcity of this resource in the environment. All this was thanks to the involvement of carnival goers in the actions developed through this project. With the toilets signaled, and with the students working to raise awareness, explaining the objectives of the project, carnival goers were more open to collaborate in urban cleaning, proper use, and correct destination of the residues generated in the chemical toilets during the period. Through the project, producers, stage management staff, Belotur employees, the Urban Cleaning Superintendency, UFMG students, locals and visitors (carnival goers who took part in the research, raising awareness and using the toilets) learn more about the implications of sustainability applied at events, and become agents of for raising awareness and multipliers of good practices on other fronts of action.

The results of the project were positive, especially in terms of spontaneous media data with national repercussions. In addition to the results obtained through this partnership with academic environment, increasing projects associated with Carnival and seeking new areas in which the event can be connected with the city. Thus, the common interest between Belotur and UFMG in replicating and expanding the project in 2019 materialized in the form of a proposal to carry out tests for the Carnival, within a framework of Sustainability of the planning of the Committees for Tourism Policies and Innovation of Belotur.

The execution of this project represented less than 0.5% of the total budget of the Belo Horizonte Carnival 2019, and it was the only special project developed for the event that featured spontaneous national media. The return and results of the project demonstrate an excellent cost-benefit, generating in Belotur its execution in 2018 and 2019 and its inclusion in the planning for the Carnival 2020 as a permanent project. This result was achieved through a cost-benefit comparison of this initiative, as sometimes sustainability actions are considered high cost, which was not the case here, in view of its low percentage in the overall cost of the event.

The main impact of this experience has been the collaboration between a public entity and an educational institution, through the execution of a project aimed at the city in which the most relevant result was focused on reducing the impacts of a large event, especially from a perspective of sustainability combined with innovation.

Besides producing 45 kg of fertilizer for the Botanical Garden, the project also distributed over 4,600 flyers



during the period of the event and had impacts on social networks and media vehicles, creating a significant impact on the Carnival 2019 in terms of raising awareness among carnival goers, in the interaction between those involved in the project, in the conducting of tests in two areas, and in expanding the sustainability actions of the event, seeking to add this theme to the future planning of the carnival and promoting a balance of economic, social and environmental impacts resulting from the event.

PRACTICAL IMPLICATIONS AND CONCLUSIONS

One of the main links in the tourism production chain is the events sector, which continues to be one of the fastest growing sectors the country. A study conducted with more than 2,700 companies in the sector, by Sebrae Nacional and the Brazilian Association of Event Companies (ABEOC, 2014) found that the sector had a turnover of R\$209.2 billion in 2013, representing 4.32% of Brazilian GDP for the period. Earlier surveys from 2002 reported \$37 billion.

Throughout the year, there are numerous events held all around the country. All of them depend on logistics and infrastructure, including food and beverages, and the provision of toilet facilities, such as chemical toilets. These events also manage the movement and flow of large numbers of people.

Elements that are the basis for testing and using technologies such as the P4Tree project, thus configuring the scope and replicability possibilities of the Belo Horizonte Carnival 2019 project. The P4Tree experience can be used to inspire events, whether public or private, indoors or outdoors, to use technologies, methods, and tools such as P4Tree in sustainability actions aimed at reducing environmental impacts.

It is difficult to find similar projects that have brought together two areas as distinct as tourism and chemistry in the way the P4Tree project does. The elements described throughout this proposal explain how this experience articulates the knowledge of two or more disciplines and/or fields of knowledge. Thus, contributing to the recovery of phosphorus, an element that is declining in its natural form, was one of the objectives that motivated the development of this action, by using extraction from the urine of carnival goers (every 25 thousand liters as a source of extraction), it is possible to transform the waste in the laboratory, extracting the phosphorus and collecting around 45 kg of fertilizer.

This experience can be considered innovative in several aspects: 1) in the form of collaboration between a public entity and an educational institution; 2) in the prac-

tical application in the real world, of technology developed within the academic environment, at one of the largest events in the country; 3) in the technology itself, which is considered an innovative technology; and 4) in the destination given to the collected material.

The relationship between the public university and the business sector is not always an easy one. The bureaucracy of public bodies, and the high expectations of the corporate environment in new technologies can make this relationship even more fraught. The use of P4Tree material in the 2019 Belo Horizonte Carnival, organized by Belotur, contradicts this, demonstrating that it is possible to create a collaborative project that can benefit both parties, quickly and efficiently. Particularly because it was applied in 2018 and replicated in 2019. Individual efforts are needed from the representatives of the institutions of interest, in order to make these partnership. This applies to the numerous technologies that Brazilian public universities can offer.

The practical aspects, costs and learning obtained from the technology testing in the real world, outside of UFMG or any research center, are important and should be promoted, as they provide valuable information for technological development, both from the technical and business aspects perspective.

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