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THE IMPORTANCE OF THE LAB MAKER, LIVING LAB MS FOR THE PROTOTYPING OF BUSINESS SOLUTIONS IN MATO GROSSO DO SUL

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ABSTRACT
This work aims to demonstrate the relevance of the Lab Maker, of the Living Lab MS, as a space for innovation, to support micro and small companies in Mato Grosso do Sul, Brazil. We adopted the exploratory method combined with the case study. The results indicate that in Mato Grosso do Sul, the Lab Maker has been a way to enhance the results of micro and small entrepreneurs who have in the Lab Maker space for prototyping solutions to problems related to the production of goods and services. From the illustration of the cases presented, it is evident that without the support of the Lab Maker, from Living Lab MS, small business owners would not have been able to solve their problems and increase the productivity of their businesses.

Keywords: Open Innovation. Sebrae-MS. Mato Grosso do Sul. Prototyping.

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INTRODUCTION

This work aims to demonstrate the relevance of the Lab Maker, of the Living Lab MS as a space for innovation, to support micro and small enterprises (MSEs), in the state of Mato Grosso do Sul, Brazil.

To achieve the proposed objective, we adopted the exploratory method, combined with a case study, to illustrate the arguments debated.

The work is structured in five parts. The first is intended for the theoretical framework. In the second part, the historical aspects and fundamentals of prototyping are raised. In the third part, an overview of the creation of the Lab Maker of Living Lab MS is presented. By way of illustration, in the fourth part, some prototyping services to MSEs in Mato Grosso do Sul, whose problems were solved thanks to the performance of the Lab Maker, were presented. Finally, some final considerations regarding the content dealt with are presented.

We hope that the work can bring the topic of prototyping to the debate, as well as demonstrate the importance of open spaces for disruptive innovation to support micro and small entrepreneurs.

THEORETICAL FRAMEWORK

Living labs are innovation environments that promote co-creation between various actors, including citizens, governments, and companies. This collaborative innovation model is part of a broader paradigm, known as *Open Innovation 2.0*, which emphasizes the openness and interactivity of innovative processes. *Open Innovation 2.0* represents an evolution of the previous concept of open innovation, emphasizing participation in a more dynamic innovation ecosystem. In it, knowledge flows not only from the inside to the outside of organizations but also from a continuous interaction with the external environment. This translates into an organization's ability to adapt and innovate quickly in response to changing user needs and wants.

The European Network of Living Labs (ENoLL) plays a key role in the formation of a network that connects several *living labs* in Europe, enabling the sharing of experiences and best practices. It was created in 2006 to promote the development of *living labs* in Europe. The initiative comes as a response to the growing demand for innovations that are not only technological but also socially relevant. The interaction between different

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stakeholders in real test environments contributes to the validation of ideas and services, allowing for real-time adjustments.

The *living labs* approach has expanded to several regions outside Europe, including Brazil. This movement reflects the growing awareness of the importance of collaborative innovation in social and economic development. In Brazil, several initiatives have explored the concept of *living labs*, applying it to sectors such as health, urban mobility, and information technology. Collaboration between academia, government, and the private sector has proven essential to the success of these projects.

From the established theoretical foundation, the Living Lab MS was structured as a dynamic and collaborative space, designed to integrate different *stakeholders*, such as universities, government, the private sector, and the local community, in an environment where innovation is fostered. The central idea is that the solutions developed are adapted specifically to the challenges and opportunities present in the state of Mato Grosso do Sul.

The Lab Maker plays a crucial role in this process, as it is an environment that promotes direct experimentation and co-creation. In it, participants have at their disposal tools and technologies that allow them to transform ideas into tangible prototypes. The Lab Maker methodology encourages creativity and practice, allowing those involved to test and refine their solutions in real-time, incorporating feedback and adjusting proposals according to local needs.

In addition, Prototype acts as an essential step in validating concepts. Prototyping allows theories and ideas to be visualized and experimented with, making it easier to identify failures and enhance successes. This phase is essential to ensure that the projects are viable and effective, taking into account the socioeconomic, cultural, and environmental particularities of Mato Grosso do Sul.

Through this hands-on, interactive approach, Living Lab MS not only tailors innovations to the local reality but also strengthens the capacity building of its community. Participants are involved in a continuous learning process, which encourages the exchange of knowledge and the implementation of sustainable and impactful solutions in the territory.

In summary, the integration of Lab Maker and Prototype within Living Lab MS represents a significant move towards collaborative innovation, preparing the region to address its challenges effectively and creatively. This model not only meets local demands

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but can also serve as a reference for other regions that seek innovative solutions adapted to their realities.

This development responds to the need for an innovation environment that takes into account the specificity of the context of Mato Grosso do Sul, highlighting the importance of practice and collaboration in the process of creating and implementing solutions.

From this theoretical base, the dynamic basis of Living Lab MS was structured for the adaptation of the reality of Mato Grosso do Sul, through Lab Maker and Prototyping.

HISTORICAL ASPECTS AND FUNDAMENTALS OF PROTOTYPING

When we investigate the origin of prototyping, it is possible to see that it is an integral part of human evolution. We can identify it in the process of construction of the pyramids in Egypt, applying the technique of overlapping the blocks, as pointed out by Volpato2; as well as the construction of the Sputnik satellite, by the former Soviet Union, in 19573; the construction of the prototype of a combustion-powered car, in 1886, by Karl Benz; among many other creative processes in the industry of products, processes, and services.

But, after all, what is prototyping and how has it been applied in the various means of production today? In our understanding, prototyping is the testing of a product, process, or service. In this context, we can understand it, for example, when the automobile industry launches a new car. Before the new car reaches the stores for the final consumer, a series of tests were carried out through "prototypes", which are the cars produced to test performance, safety, economy, and other infinities of requirements that make up the car. This is the strategy adopted by the industry to detect possible failures in one of the components or even several of them so that the product is made available as perfectly as possible so that it can meet the demands of the end consumer and even the safety, quality, and sustainability standards that guide the sector.

Other forms of prototyping can also be found in the launch of processes and services, such as a new product marketing portal. Thus, in a hypothetical situation, a food company that intends to launch a new dish may provide a prototyping period, in which consumers will be able to give their opinion, through a previously structured questionnaire, on what would be the improvements of the new dish, such as aspects of flavor,

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appearance, delivery time and other information that the supplier may require to make the product acceptable to the final consumer.

Of course, these are costly processes that involve large investments in research and development (R&D), supported notably by large companies.

However, the scientific and technological development achieved in recent decades has resulted in new forms of prototyping, especially those practiced in disruptive environments, such as *living labs*.

Among the various ways of working on open innovation in these environments, we highlight rapid prototyping (PR), a more accessible way for micro and small entrepreneurs-innovators.

The rapid prototyping process can be classified into four principles: fusion, removal, forming, and addition.

The melting process consists of casting materials, whether permanent or temporary and metal, plastic, etc. can be used. In the removal process, the technique is basically to remove the excess to reach the ideal shape of the prototyped product, such as grinding and turning, electrochemistry, and machining, among other forms. Forming is the technique of reaching a final geometric shape, through deformation, as in the cases of sheets, rolling, powder metallurgy, etc. Finally, prototyping by addition is that in which one material is added to another to reach a final product. Examples are welding, brazing, and gluing, among others.

THE STRUCTURE OF A PROTOTYPING LABORATORY

The prototyping structure can be **structured** in the Lab Maker model, which at first can be structured in an extra plant (Lean Lab Maker) and, later, according to the development of projects, evolve into a Lab Maker model, along the lines endorsed by FabFoundation3, represented in Brazil by the FabLab Brazil Institute4.

According to these references, the process of implementing a lean Lab Maker can be distributed in nine sequential steps: Step 1: the creation of a Lean Lab Layout; Stage 2: implementation of the physical structure according to the layout; Step 3: Creation of complete laboratory layout; Step 4: specifications of equipment necessary for the operation of the laboratory; Stage 5: training of the technical staff; Step 6: definition of processes for operation and use of the Lab Maker; Stage 7: Opening of public notice to attract companies; Step 8: Creation of the Lab Maker operations manual; Step 9: monitoring of the selected companies.

From this methodological framework, the Lab Maker of Lilving Lab MS, of the Support Service for Micro and Small Enterprises of Mato Grosso do Sul (SEBRAE/MS), was developed, which is detailed in the following topic.

THE CREATION OF THE LIVING LAB MAKER AT SEBRAE/MS

SEBRAE/MS's Living Lab MS was created in 2016, with the initial purpose of serving startups in Mato Grosso do Sul. However, demands were emerging, mainly coming from digital entrepreneurs, micro and small entrepreneurs (MSEs) with demands for complex physical modeling devices, making it essential to expand services, which resulted in the construction of the Prototyping Laboratory (LAB MAKER) in the Fab Lab standard.

Fab Lab (fabrication laboratory) is a platform for rapid prototyping of physical objects and is part of a worldwide network of laboratories. Unlike a large factory that works based on large-scale production, a Fab Lab is a center for personalized production or small-scale production, an activity that should not conflict with its other equally important activities, which are: educational and research function and social commitment with local impact.

It is grouped as a set of professional-grade but low-cost numerically controlled machines. Examples are: a laser cutting machine capable of producing 2D and 3D structures, a vinyl cutting machine that manufactures antennas and flexible circuits, a high-resolution milling machine to manufacture printed circuits and molds, and another larger milling machine to create large parts. There are also multiple electronic components, as well as associated programming tools that are open, low-cost, and efficient microcontrollers. Other more advanced components, such as 3D printers, can also equip them.

Although the machines are a major attraction, the main feature is their openness. Unlike traditional rapid prototyping laboratories found in companies, universities, and certain specialized centers, Fab Labs are open to everyone, without distinction of practice, diploma, project, or purpose of use. It is part of a collaborative work movement on the internet, where mechanisms of exchange (peer-to-peer), cooperation, interdisciplinarity, sharing, learning through practice, bottom-up, and community innovations are encouraged.

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The "network" dimension is inscribed in its essence for several reasons. First, because they follow the internet. Secondly, they facilitate openness, connection between people and organizations, exchanges, and crossovers between the members who use it. In addition, the standard kit of numerical control machines common to the different Fab Labs allows the replication of processes developed in any laboratory, regardless of its location. Once the object is prototyped and the processes are tested, the project can easily be replicated by others in the network.

This openness is the key to success and popularity, facilitating encounters, chances, and the development of innovative methods for the crossing of competence. This space is open to all and accessible (low fees or even free access) favors the reduction of barriers to innovation and the constitution of a fertile ground for innovation.

In this way, he contributes to refining the project, estimating its feasibility, and, if the intention is to develop a series or product, being able to present potential investors with a first functional model, which can then be reworked in different specialized centers. Therefore, they are part of the product life cycle, as their flexibility and accessibility make them true platforms and reduce barriers to innovation. Lab Maker brings solutions to business demands. Given this and seeking to provide the best technological and infrastructure solutions for the management of Sebrae and customer service, the implementation of Lab Maker is necessary.

With the vision of already meeting some existing demands, the proposal was created to divide the laboratory facility into two phases: the first, to develop a lean laboratory within the Living Lab and the second, the improve the lean laboratory into a complete laboratory, being built in the new building attached to the Living Lab. Living Lab could start in a minimal and agile way to carry out some work without a high impact of time and resources on the current one. The second phase would run in parallel with the first, and when the complete laboratory is completed, the laboratory would meet all the criteria of a Fab Lab.

To ensure efficiency and technical compliance in the implementation of this laboratory, it is necessary to hire a company specialized in the development of Fab Labs, taking into account that this type of laboratory requires internationally regulated rules and specifications. It is expected as a result that this hiring will contribute to the development of a Lean Lab Maker and later a Lab Maker, both within the parameters of the Fab Lab

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concept, allowing the development of prototyping projects within the environments that enable the generation of business and learning.

It was identified that the Fab Lab Brazil Institute (IFLB) is the one that best fits the mentioned profile. As a result, it is expected that this hiring will contribute to the development of a Lean Lab Maker and later a Lab Maker, both within the parameters of the Fab Lab concept, allowing the development of prototyping projects within environments that enable the generation of business and learning5.

Instituto Lab Maker Brasil was founded on January 25, 2019, and is the institution that promotes the concept of Fab Lab and Maker culture in Brazil, provides support to present and future Fab Labs, facilitates and supports the growth of the international Fab Labs network, as well as the development of maker spaces and projects. As actions to this end, the Institute:

- It promotes meetings, events, and forums with open discussions on issues of interest to the Fab Lab community in the country;
- Produces audiovisual content, texts, infographics, and other media, and broadcasts them through analog and digital channels to promote the maker culture and Fab Labs;
- Provides consultancy in the implementation of new Fab Labs as well as the development of good practices in existing ones;
- Develop methodologies to facilitate the exchange of information and projects between the Fab Lab community in the country and the world;
- Introduces and encourages good practices in Brazilian Fab Labs by the principles of the international network and encourages the international network to recognize practices that make sense to Brazilian Fab Labs;
- It proposes to the Fab Labs to follow the FabCharter purposefully;
- Provides consultancy for the implementation of "Academy" courses, such as "FabAcademany", and "How to Grow (almost) anything", among others;
- Develop the mapping of Brazilian Fab Labs;
- Encourages research and production of financial resources in the Fab Labs ecosystem, through partnerships between individuals and companies;
- It carries out programs and training related to the multiplication and expansion of the maker culture in different sectors of the economy and society.

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RESULTS OF THE LAB MAKER'S PERFORMANCE

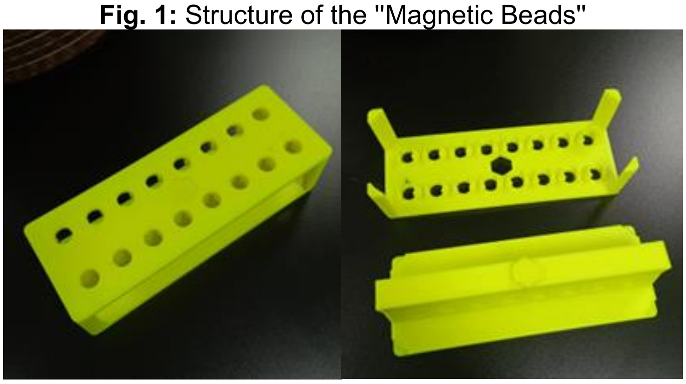
CASE 1 - PROTOTYPING APPLIED TO VETERINARY MEDICINE

The first case deals with a demand from the area of Veterinary Medicine, in which a doctor seeks LivingLab MS to build a solution that replaces a traditional refrigerated centrifuge. For this, the product needs to deliver efficiency and agility in the process of separating DNA and RNA, blood genetic components. It uses a 3D printer to assemble the desired equipment, thus obtaining a low-cost solution.

The client brings this demand seeking to take the solution to a new animal laboratory clinic, where a refrigerated centrifuge, which is usually used, has a high cost. To solve this problem, the doctor performs a solution called "magnetic beads" at the LivingLab laboratory, which facilitates the extraction of nucleic acids (DNA and RNA). The technique enhances the waiting time, since in a traditional centric, the waiting time is 2 to 3 hours.

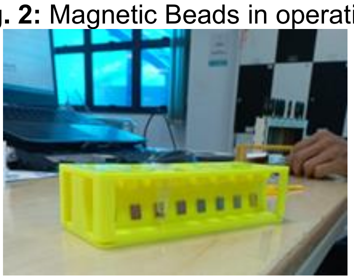
New centrifuge feather (*fig. 1 and 2*), the time is reduced to a maximum of 5 minutes.

Fig. 1: Structure of the "Magnetic Beads"



In this way, it allows for a greater availability of laboratory results in less time. In addition, beads use safe and low-cost agents, while the traditional extraction of these components uses chemical agents that are harmful to health, such as chloroform and acids.

Fig. 2: Magnetic Beads in operation



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The "Magnetic Beads" are produced using 3D printers from the laboratory in Mato Grosso do Sul. They were assembled with spaces to aggregate the neodymium magnets that separate the blood components, and with spaces to place the samples, which when positioned, come into contact with the magnet, causing this separation.

CASE 2- PROTOTYPING IMITATING CHEESE

In this project, a cheese producer comes to the laboratory and develops a solution that avoids the waste of products, which spoil during the demonstration to customers when they are felt and removed from refrigeration. Therefore, the manufacturer decided to assemble a prototype of the cheese in the Living Lab Laboratory, created with materials that resemble the original pieces.

In the laboratory, the producer develops a mold made on 3D machines (*fig. 3*)

Fig. 3: 3D mold with the acetate

Inside this mold place an acetate to correctly unmold the product to be poured (*fig. 4*).

Fig. 4: Two-component silicone already unmolded

The input used to assemble the piece that simulates the cheese is the Bicomponent Silicone in white, which has the texture and weight equivalent to the original piece (*fig. 5*).

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Fig. 5: Product validation

After drying the product, it is removed from the mold and vacuum packed in the same packaging as the cheeses manufactured, obtaining a prototype with the same appearance as the original cheese (*fig. 6*).

Fig. 6: Prototype of the finished cheese.

According to the manufacturer, the project prevented an average of 2 pieces of cheese from being wasted per week, saving a total of almost 100 pieces annually.

CASE 3- PROTOTYPING OF SUPPORT FOR MOLES

The project is aimed at solving a problem for those who are physically disabled and have to wear sweatshirts (axillary or Canadian model).

When the user arrives somewhere, it can be at work, bars, or restaurants, in general, he has no place to accommodate his sweatshirt, which generates discomfort for the user and even embarrassment. If it is in a restaurant, the attendant usually offers to store the moles in the porta-moles, which are usually at the entrance. However, this is an embarrassing and impractical situation, as it limits the movements of the disabled person

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since when trying to move to talk to a friend at another table or to go to the bathroom, he will have to call the attendant or the *waiter* to pick up his moles.

On the other hand, if he chooses to place the moles standing next to the table, they end up falling or disturbing other people who move in the environment. A similar situation is routine in the work environment of most people with disabilities, as illustrated in the following figures.

In Figure 7, we have the sweatshirts of a disabled woman weakly leaning against a table. As the surfaces are smooth (both on the table and the softies), they end up giving way and falling, which is why the unforeseen events shown in the following figures 8 and 9 occur.

Fig. 7 – position of the moles in a closed environment.

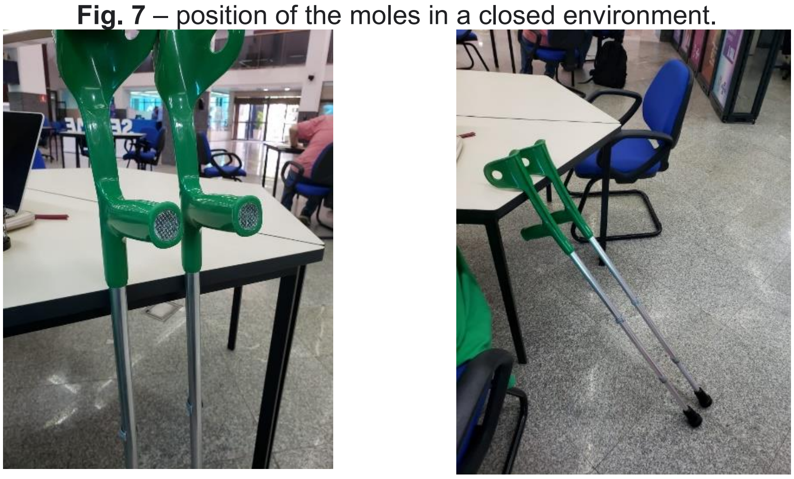

Fig. 8 – Consequences that arise from this positioning.

In Figure 8, we have a person passing by and tripping over the muletas, which makes the situation uncomfortable for both of them making noise and bothering people, especially, the two involved in the situation.

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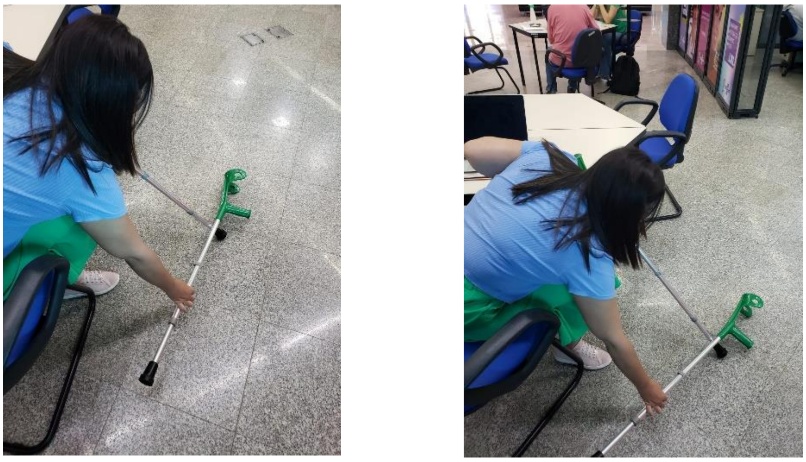
Fig. 9 – A moleta slips and falls on its own and the disabled person needs to bend down to be able to recover the moleta.



As shown in Figure 9, sweatshirts can slip easily and fall on their own, leading the disabled person to an uncomfortable situation, to say the least. She needs to bend down and retrieve her moleta by herself, in case no one is nearby or offers to help her.

The situation is repeated in other situations, as is the case of Figure 10, in which a supermarket stocker leaves his crutches unbalanced in a cart next to it, otherwise, they can easily slip across the surface and cause discomfort to the stocker, as well as cause accidents for customers who transit through the market's fruit and vegetable sector.

Fig. 10 – a stocker at a supermarket leaves his sweaters precariously accommodated in a cart next to his work

The ideal situation would be for the sweaters to remain safely accommodated vertically next to the table, as shown in Figure 11. Therefore, we have a problem to be

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solved, and so far we still do not have the perception of the manufacturers of moletas. This is an opportunity for inclusive innovation.

Fig. 11 – the ideal position for the sweaters in a work environment, however, without the claws it will fall easily.

In applied research carried out at the Living Lab MS, in the Maker Laboratory, the solution was the development of support for fixing the muletas, as shown in Figure 12.

Fig. 12 – conception of the model of support of moles with a view to prototyping.

From the model proposed by Maker Engineering, it was possible to prototype the solution found, as shown in Figure 13.

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Fig. 13 – a prototype of the muletas support being assembled after printing on a 3D printer, from the Maker Laboratory

After prototyping, the project moves on to the next stages, in which the final goal will be production and commercialization.

FINAL CONSIDERATIONS

As demonstrated in this work, the Lab Maker of Living Lab MS has contributed greatly to producing solutions, often inaccessible to micro and small entrepreneurs in Mato Grosso do Sul. It is important to emphasize that the services provided by Lab Maker are financed with their resources, in which entrepreneurs receive guidance from competent professionals from the Living Lab MS and SEBRAE-MS staff, and also from renowned consultants, working in a first-world infrastructure, located on the premises of SEBRAE-MS, in Campo Grande, Mato Grosso do Sul, Brazil.

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