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Green Virtual Enterprise Breeding Environment: A Proposal of Web Platform Model for a Circular Economy

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Abstract. This paper aims to present a proposal for a Green Virtual Breeding Environment (GVBE) grounded in Circular Economy to create Green Virtual Enterprises (GVE) for the deployment of green solutions for products and services. Through the life cycle of the products, in which, a product, for one organization is discarded and for another, input for new products. New solutions will be developed jointly by the GVBE component actors. Entitled as Reciclica GVBE it contributes to the management of residues focused on sustainability in an economically viable way. It will also contribute, with the population, organizations, and researchers to have a clearer view of the processes that involve waste management, which will allow for better citizen participation, greater responsibility on the part of companies, and new research on the subject.

Keywords: Green Virtual Breeding Environment, Green Virtual Enterprise, Circular Economy, Industrial Ecology, Collaborative Network.

1 Introduction

Over the last few decades, the concept of development has involved a large number and variety of conceptions and values, with new references for individual and collective rights, to balance the relations between humans and nature, however it still exists major debates on the nature of sustainable development, the necessary changes, the tools, actors and the benefits of the proposed changes. It is possible to affirm that there is a relative global consensus that the desired sustainable development must harmonize the mutual influences, between nature and society, and guide actions to promote harmony between human beings, humanity, and nature and overcoming challenges.

From the premise that development cannot exist if natural resources deteriorate, nor can nature be protected if economic growth does not consider impacts on environmental destruction. We can disagree of the need for capital reproduction about

the tendency of the scarcity of natural resources, and perhaps start looking for an alternative development model that integrates social and economic interests, beyond the limits of nature, and which necessarily demand a transformation of society and human relations with the environment to avoid a growing crisis, and even a possible collapse in the future [1] [2] [3] [4] [5]. In this sense and based on two main pillars: the use of resources and the awareness of their limits, the Brundtland Report [6] solidifies an approach that assumes that natural resources are not inexhaustible and that it is not possible to continue with economic growth without considering the variables environment and society, defending the preservation of environmental and cultural resources for future generations, respecting diversity and promoting the reduction of social inequalities.

There is a relative global consensus on environmental limitations and the urgent need for changes in the society thinking, for a desired sustainable development, with a focus on aspects and phenomena with a global scope, leading to the intensification of studies on environmental issues, as well as the regulation of industrial activity and its effects, and the establishment of relevant milestones and their results on sustainability, especially within the scope of the United Nations (UN), with the elaboration of objective and practical measures for the implementation of sustainable development to materialize and systematize conduct that will be followed by society. In this sense, the construction of the 2030 agenda for Sustainable Development, considering extreme poverty as the greatest global challenge and as an indispensable requirement for the effective achievement of sustainable development [7].

UN component countries have promulgated the 2030 agenda, in which they present 17 objectives for the sustainable development of the planet, among which: 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all; 9. Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation; 11. Sustainable cities and communities; 12. Ensure sustainable production and consumption patterns and 17. Develop partnerships and means of implementation [8]. To achieve these goals, actions will be needed that will disrupt how activities are being carried out and provide a new look at the world, including economic activities to promote sustainable development.

The Johannesburg Declaration [8] establishes that sustainable development is based on three pillars: economic development, social development, and environmental protection, thus reflecting the true scope of the theme, the definition is the result of the recognition that social and economic relations Economic conditions are so complex that sustainable development must be studied with a multidisciplinary focus, comprising economic, cultural, social structure and resource use aspects, among others.

Thus, the circular economy as a theory and resulting practices can present solutions to problems in this theme [9] [10], allied to the Green Virtual Enterprise Breeding Environment (GVBE) [11] [12] [10] [13] [14], whose concepts will be appropriately addressed in the course of this work. After all, GVBE and its Green Virtual Companies (GVE) represent promising aspects to address the sustainable challenges of production, logistics, and consumption towards the circular economy [14]. Therefore, this article proposes a GVBE based on the Circular Economy to create GVE for the development of green solutions for products or services. In an

innovative perspective of developing technological tools, with alignment, not only for solving green problems but also for economic and social development [15].

Therefore, the research questions that guide this work are: 1. Development of new technologies in products and services by GVEs, through recycling or reuse of discarded materials; 2. Exchanges of materials between organizations that joined in GVBE; 3. Employment and income generation. This work is structured in addition to this introduction, follows with theoretical reviews about GVBE and Circular Economy, then presents the results with the presentation of Reciclica GVBE to finalize with a conclusion and suggestion for future work.

2 Green Virtual Breeding Environment (GVBE)

Collaborative networks consist of a variety of entities, such as organizations, people, govern, autonomous, geographically distributed and heterogeneous in terms of environment, culture, social capital, and objectives, but which collaborate to achieve common or compatible objectives [16]. Collaborative networks have different configurations, topologies, types, sizes, activities developed, and characteristics of the actors that compose them. They can be based on contracts, supply chains, or less formal or more dynamic forms of collaboration, such as virtual enterprise [17]. There are many different forms of such associations, including, strategic alliances, partner networks, industrial clusters, collaborations in research and development, collaborative manufacturing, complex co-production arrangements [18].

The collaboration process needs to mature over time and involves sharing information, resources, and responsibilities, risks, resources, results and rewards between partners, to plan, implement and jointly evaluate a program of activities for a common goal, either to solve a problem or to present an image of joint identity [20].

A collaborative network model is the Virtual Breeding Environment (VBE), which is characterized as a long-term strategic alliance between organizations, which provides an adequate environment for the rapid formation of goal-oriented networks, such as virtual companies, aiming at specific business opportunities [16]. VBEs are also known as a source or support networks, designed to offer the necessary conditions (for example, people, financier, social, infrastructure and organizational) to support the fast and fluid configuration of virtual companies [22]. Also known as a platform, it is a stationary group of organizational entities, although not static, that has developed a preparation to help in the case of a specific task or customer demand [21].

Green Virtual Business Creation Environments (GVBEs), can be understood as long-term strategic alliances of green companies and support institutions, designed to offer the conditions to support the fast configuration of Green Virtual Enterprises (GVE). The GVBEs, grounded in traditional bases of set up a suitable environment for the establishment of collaboration agreements, mutual operating principles, interoperable infrastructures, ontologies, and common trust, among others, to prepare its members to take part in potential GVEs, that will be settled when a business opportunity appears or it is identified by a member of the GVBE who acts as a broker

[11]. GVBEs aim to offer the necessary conditions (people, financier, social, infrastructure, and organizational) to promote and efficiently establish work and sharing common principles to create sustainable value in a shared and collaborative way [14].

The difference between VBEs and GVBEs is that in these, the collaboration aims to create economies of scale in a recycling strategy and shared sustainable engineering efficiency. As a result, GVBEs seek to offer their members, the market and society a model of sustainable industrial development, characterized by economic growth combined with a low environmental impact compared to other traditional models of industrial development [11].

The Green Virtual Enterprise (GVE) emerges from the GVBE, which is characterized as a business model of tenable manufacturing and logistics network focused on offering, delivering, and retrieving green products, under a life cycle thinking, supported by its source network [12]. In this sense, the GVBE is in line with the principles defended by the circular economy, besides, it enables an environment favorable to innovation, exchanges, industry, and trade in developed products and services, bringing together the various actors that are related to this environment. In section 3, the circular economy can be better understood.

3 Circular Economy

The circular economy (CE) involves a wide field of knowledge and performance, a review presented 114 definitions for the term and based on the concepts studied, the following understanding was formulated, the circular economy is an economic system that replaces the notion of "end of life" for reducing, reusing alternative goods and services, recycling and recovering materials in production, distribution and consumption processes. It operates at the micro (products, companies, consumers), meso (ecosystems) and macro (city, region, nation) levels, to achieve sustainable development while creating environmental quality, prosperity and social equity, for the benefit of current and future generations, being supported by new business models and responsible consumers [9].

The perspective of the life cycle of materials or products is thinking from the production to disposal and involves: a) prevention with the generation of waste by reducing consumption and new business models and value generation; b) the minimal use of materials and, preferably, materials of easy reincorporation in the production processes and fast and safe absorption by natural ecosystems (as is the case with biodegradable materials) and c) the end of life stage with adequate management of the materials in the post-consumption by directing them to a processing and reincorporation network in some production process or as an input for the generation of energy. To act with this perspective, the CE is based on the performance economy [23], Biomimetics [24], Cradle to Cradle design [25], and Industrial Ecology [26].

The performance economy has as pillars the extension of the product life cycle through more durable products and waste prevention, it also addresses the importance of selling services and not products to produce wealth and economy with less physical resources through value-added business as its core value [23]. Biomimetics has nature

as a model, measure, and mentor, understanding that the more human processes are like natural cycles, the greater the chances of being effective [24].

The Cradle to Cradle design has as its central idea that resources are managed in a circular logic of creation and reuse, each cycle passage becomes a new 'cradle' for a given material creating a flow of “technical metabolism” of materials industrial [25]. Finally, Industrial Ecology is an interdisciplinary field of science that proposes a radical overhaul of the business model and intersectoral collaboration [26], with a view to sustainable economic development. It involves the exchange of resources between companies in a mutually beneficial way, closing their production cycles through the reuse or entry of the residues of one in the production process of the other, generating a “symbiosis”.

The application of CE in waste management in a life cycle perspective depends on the interaction of local public authorities, final consumers, and the private sector [27], especially the industry that absorbs materials again in its processes, closing the cycle in an approach Industrial Ecology [28]. This requires communication and technology tools capable of fostering and making feasible [29], which is the purpose of the platform presented here, which is under development and whose pilot project will be applied in the city of Florianópolis, Santa Catarina.

The principles of CE are appropriate in the proposal presented in section 4 of this paper, which contributes to the more sustainable management of waste in Brazil. Through GVBE companies can connect to develop new product and service technologies, considering the performance savings, Cradle to Cradle design, and biomimetics to obtain increasingly durable products, avoiding waste, facilitating the reuse, and biodegradation when the disposal is unavoidable. In turn, concerning existing waste, Industrial Ecology takes the collaborative network character of the proposal forward, enabling symbiosis between the organizations that joined in GVBE, in which the disposal of a material may be the raw material for the production process of another organization.

4 Reciclica GVBE

Considering the principles of Circular Economy presented in section 3, Reciclica GVBE will be aimed at facilitating the reuse or reuse of discarded materials, using the end-of-life manufacturing approach to recover goods, parts, subassemblies or scrap, and shared resources for your direct use (reuse), repair, renovation, remanufacture, recycle or safe disposal [13], whereby one can make more efficient use of complementary skills or essential competencies of people and organizations, who will be called actors. The name Reciclica comes from the Portuguese words “reciclar” and “ciclo”, the first meaning recycle, about the formation of new products from discarded materials, while the second meaning cycle, about the cyclical characteristic from of the circular economy. The name also contains the acronym CE (rECiclica) of circular economy and in Portuguese, it is pronounced in feminine, in honor of women and nature (also pronounced in the feminine in Portuguese), since both have vital cycles.

As shown in figure 1A, the GVBE was planned considering its useful life from its creation, which involves policy procedures, standards, vision, mission and values, criteria for selecting organizations and people that meet the readiness and preparation requirements [30] to compose this environment for emerging virtual companies. The operation stage involves governance of the GVBE, as well as conflict resolution, coordination of activities, infrastructure, and technology. The evolution phase is the growing stage of the GVBE with the formation of an increasing number of GVE, consolidating the model, finally, the dissolution stage is the phase in which the GVBE fulfilled its objectives or was transformed and does not support the maintenance of this model as expected.

According to figure 1B, the GVEs that arise from their creation environment bring together actors who share the same objective, the broker of a GVE can be represented by the GVBE administrator or by any actor who has identified the opportunity, to characterized and elaborated preliminary planning, in which it will be foreseen from the objectives of the GVE until the products or services that will be made, going through the search and selection of partners [19] among the members of the GVBE, so that together they can prepare plans more detailed, remaining to operate at GVE until its dissolution, the results of which will be partly distributed among the participants and partly returned to GVBE [31], for platform maintenance and growth.

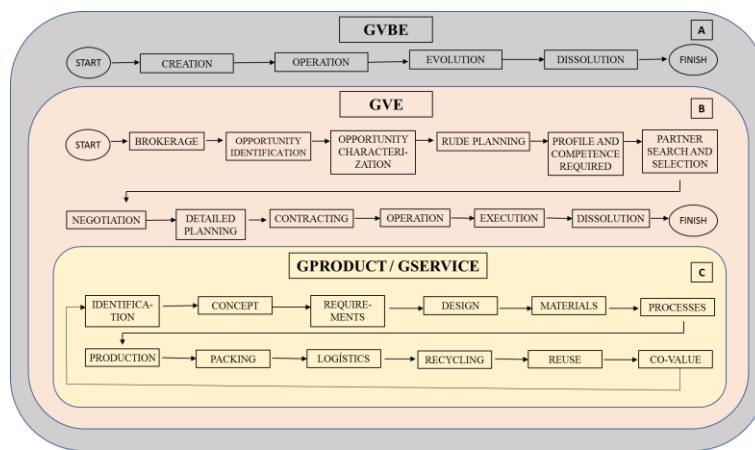


Fig. 1. Recíclica GVBE concept structure life cycle.

The green product or service developed by GVE (fig. 1C) will consider the policies, rules, and regulations that govern all platform participants, to improve production processes that lead to minimizing impacts on the environment, in the meantime, new products or services are developed to meet the needs of consumers, in this sense, the waste resulting from the productive processes of any one of the GVBE actors may serve as input to the productive processes of another, as well as an opportunity for the formation of GVE to jointly develop new products based on new uses of waste in a continuous process of innovation, therefore, both producers and consumers may be present at GVBE, whose production process will be based on recycling, reuse, and co-value.

Therefore, the GVBE administrator or any actor, exercising the broker role, may see a problem or an opportunity that will require collective action, both in the external

environment and in the GVBE, such as reusing packaging, recycling metals, plastic, glass, product design for use or new use after the end of its useful life. Considering the problem or opportunity and from the GVBE the actors will be gathered in GVEs from the registered profile, considering their skills and abilities, from an analysis of complementarity made by the manager or the broker, together they will develop the best solutions in Economics Circular. Besides, it will also be possible to share logistics and services, carry out trade, donate materials, loans, and use other resources among the platform's participants.

For a better understanding of the specificities of Reciclica GVBE, we briefly contextualize the normative scenario of Brazil, the country where the platform is under development. In this country there is a low propensity for the formation of collaborative networks, data show that less than 8% of innovations in the industry were promoted in cooperation between the years 2006 and 2017, showing limits to the joint performance of the actors, such as the lack of an environment that favors collaboration.

In 2010, the National Solid Waste Policy (PNRS) was instituted, which favors materials management focused on sustainability and the Circular Economy. According to scientific works that demonstrate the role of the State in promoting collaborative networks between organizations [32]. Through this legislation, the principle of shared responsibility among manufacturers, traders, consumers, and public agents for the life cycle of products was established to “minimize the volume of solid waste and waste generated, as well as to reduce the impacts caused to human health and environmental quality”. The PNRS has a decentralizing character and it is up to the municipalities to implement a selective collection system, to elaborate a diagnosis of the situation of solid waste generated in their territory, as well as mechanisms for the creation of business, employment and income sources, through the valuation of materials through reuse or recycling, the reality of which shows many cities allocating urban waste to open-air dumps, and recyclable material collectors seeking to obtain some income from this waste.

Therefore, it is necessary to seek for alternative means to promote a more ecological environment, through the development of new technologies in products and services, through recycling or reuse of discarded materials, facilitating the exchange of materials between organizations and generating jobs and income.

The GVBE Reciclical was planned with the support of the World Wide Web, through an electronic website, whose modules enable: a) registration of actors; b) sharing products and services in a structured manner as well as selecting and finding products and services; c) conversation module; d) contractual instruments; e) means of financial transactions; and f) logistics [33]. Reference value information for the material, geographical distance between the participants, the ranking of materials most available by geographic areas, as well as other information will be included.

As a reference for the values of the materials, which are waste for some organizations and raw material for others, the tabulation of the Business Commitment for Recycling (CEMPRE), one of the main non-profit associations dedicated to the promotion of recycling in Brazil, will be used. The geographic distance information will be obtained by the geolocation feature. As transactions occur through the GVBE,

a ranking of materials will be obtained, which can guide the creation of new businesses aimed at prolonging or closing production cycles.

Finally, other information will be presented, such as suitable disposal points and forms of disposal obtained from information from the entity responsible for collection. In the case of special wastes (electronics, batteries, tires, among others) that manufacturers must reverse logistics according to PNRS, the proposal is that the platform can promote intelligent methods of return and reuse of these materials assisting in compliance with legislation.

Other accessories services presented on the platform will be examples of initiatives focused on sustainability, CE and Industrial Ecology (IE) principles and good practices, public and private funding notices for projects aimed at sustainable development, legislation, carbon footprint calculator (for companies and people) and information about the responsible team. Such information will have educational content and will be transmitted interactively, with the help of videos and texts, using a simplified and creative language.

5 Conclusions and Further Research

The purpose of this article was to present a GVBE proposal grounded in the Circular Economy to create Green Virtual Enterprises (GVE) for the development of green solutions for products and services called Reciclica. The purpose of the platform is to contribute to waste management geared towards sustainability in an economically viable way, what, in the current model, is an expense for public agencies, in GVBE is a business opportunity.

Besides, Reciclica GVBE will help the population, organizations, and researchers to have a clearer view of the processes that involve waste management, which would allow for better citizen participation, greater responsibility on the part of companies, and new research on the subject.

Brazil is one of the most unequal countries in the world, in addition to preserving such exuberant and fundamental biomes, the use, and recovery of waste can represent a source of dignity, income, inclusion and, consequently, development. Sustainable development, especially in the case of emerging economies, must commit to improving the quality of life of people through productive inclusion, in this sense, even networks that have a global reach that develop in a virtual environment should preferably be able to contribute to improving the local context in which they are established.

The Reciclica GVBE, although intended for a global and scalable network, also promotes waste management geared towards sustainability at the local level, with information on conscious consumption and adequate waste disposal by the population. It also seeks to support an intersectoral collaboration system in the city, an action that collaborates with the surroundings but also facilitates transactions all over the world in the format of the CE and through the IE. Since CE is an area of interdisciplinary knowledge that proposes a radical reformulation of consumption habits and the business model with a focus on networking, it often needs encouragement to establish itself effectively. Therefore, the importance of the

Reciclical GVBE platform to adopt a local-global approach, in harmony with SDGs 11 and 17 simultaneously.

Further research is needed to develop protocols for assessing the readiness of organizations to join the GVBE and preparedness for the formation of GVEs, as well as improving the governance of Reciclica GVBE.

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