

Technological opportunities for adobe bricks produced with aquatic macrophytes for Palmas [Tocantins], Brazil

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Abstract

Technological innovation is the successful introduction of technological change in the society. The productive chain of Civil Construction industry plays an important role in the economy and in social development. However, beyond causing negative impact in the environment, the main product of its chain is resulted of a complex production process which involves a great number of agents, making it difficult any technological change in the process. The adobe produced with aquatic plants is a new technology, gotten from a traditional material. This work presents the ideas and results of a thesis, which was intended to analyze the variable of influence on technological innovation process in the city of Palmas [state of Tocantins], Brazil, and verify the competitive advantages of the introduction of the adobe produced with aquatic macrophytes in Civil Construction. Politician/normative, strategical and operational dimensions necessary to the technological insertion had been evaluated, concluding to be the positive the conditions for the process.

Keywords

technological innovation, adobe bricks, aquatic macrophytes, civil construction, regional development.

Introduction

This list of global discussions regarding the development crisis, the concept of sustainable development has its origin in the debate launched in Stockholm in 1972, consolidated 20 years later in Rio de Janeiro (GUIMARÃES, 1998, apud VIANA et al.). In 1987, the World Commission on environment and development (BRUNDTLAND, 1987) defined “sustainable development is one that is able to meet the needs of current generations without compromising the ability of future generations to meet their own needs”.

According to Guimarães (1998, apud VIANA et al.), assert that human beings are at the Centre and the reason in the development process means to advocate a new style of development that is environmentally sustainable in the access and use of natural resources and conservation of biodiversity; socially sustainable in reducing poverty and social inequalities and promoter of Justice and equity; culturally sustainable conservation of the system of values, practices and symbols of identity. Technical improvement to tailor the use of natural resources the specificity of each territory constitutes one of the pillars of the promotion of sustainable development.

Designed to works as the capital of Tocantins State, Palmas city appears on the national scene in constant dynamism and in continuous growth. The capital has received numerous incentives to emphasize its qualities of geographical and political centre of the border of the country's economic expansion, bringing together the conditions to make the practice of sustainable development because of the current discourse, between the various social actors, on the importance of the same come to constitute an “ecological capital of Brazil”.

In the year of 2001 on the shores of the city of Palmas, Luís Eduardo Magalhães Hydroelectric power plant, also called Lajeado hydroelectric power plant, was concluded by Investco S.A. After the formation of the Lake, the population was facing the occurrence of aquatic macrophytes in coastland areas of backwaters (IRENAEUS, 2005) and together with the public authorities and the company responsible, it starts intense discussions about your withdrawal and disposal, considering the difficulties imposed by the excessive growth of the species and its risks for environmental and water quality of Lake function itself.

Generally, the construction constitutes one of the productive chains with greatest potential for generation of impacts. It makes necessary investments in technological innovations that foster the adoption of a new development model.

Adobe brick produced with aquatic macrophytes is a different technology, improved from a material long used in various civilizations. It can be produced with raw materials and local labor, it allows the disposal of surplus, its manufacturing energy spends are almost null and it produces good aesthetic and hygrothermal results. Thus, it can appear like a suitable material to societies with sustainability goals. It was developed by Obede Borges Faria, in 2002, during his doctoral studies.

Considered an innovation, the brick proposed is an alternative to materials traditionally used, as ceramic brick. However, the process of technological innovation involves further discussions about the challenges of building a society where the knowledge is the prime mover of cultural, social and economic achievements. Without them, the country opens up essential tools to plan for the future, determine priorities, assess and correct the course of development in science and technology.

The general context that guides the construction of this work pertains to the insertion of science, technology and innovation in construction schedule of the country and, in parallel, their responsibility to turn it into an ally to any society with sustainable goals. For that to occur, it must be investigated the conditions under which we can enjoy every potential for social advancement, economic and cultural development that science and technology can offer.

In order to built the work, two strands of analysis have been delineated. The first one refers to the process of technological innovation within the context of public policy and increment toolbar. The second deals with the technology of adobe brick produced with aquatic macrophytes and their potential, for both user and environmental. The data interaction checks institutional political conditions for the material to constitute an innovation in the city of Palmas.

The emphasis on technology is given initially due to conventional construction use of materials and components highly harmful and aggressive to the environment, as the cement (overused and misused), constructive elements of fibre cement (cement-asbestos), among others. These materials are pollutants in origin, in their production process and also later (after use in construction), producing large volume of waste. According to Resende (1995, apud FARIA), the rubble is caused by waste of materials during delivery, which can vary between 30% and almost 90% of the total mass.

Among all techniques of raw earth use, the choice for the technology of adobe brick produced with aquatic macrophytes is justified by the fact that several technological opportunities have been found on it: owner of regional raw materials, it can generate jobs and income; it meets users seeking for construction alternatives (unconventional materials); it responds well to climatic criteria, one of the primary requirements of Palmas; it mitigates the problem faced by hydroelectric plants, with eutrophication of its reservoirs.

The subject involves a great number of issues that could justify it (management of macrophytes, construction waste, deficit housing stock, quality and comfort of the building). However, the main justification to the achievement of the research is the fact that for a technology to be developed, produced in considerable scale and applied to meet the expectations of society, and may finally be considered an "innovation", it is required the prior research of determining factors for its implementation as an alternative material in construction.

In Brazil, the technological opportunities generated by the production of knowledge have fallen short of possibilities. For this reason, it was essential to research innovation cycle, learning about their obstacles and potential and the reasons that often make knowledge coming up within the limits of the laboratories and thus remains stagnant.

The general goal of the thesis research was to highlight the key factors to be assessed when it comes to notice how conducive an environment is to promote an innovation (successful introduction of technological change). In this case, specifically, the adobe technology produced with aquatic macrophytes, in the Civil construction sector in Palmas. The specific objectives were:

- (i) Theoretical analysis on technological innovation in national scenario and in Palmas area, the influence variables and its unfolding in the productive sector civil construction. It would be the construction in Brazil an industry open to technological change? With this specific objective can be verified a great diversity of actors involved and the efficiency of innovation focused tools.

- (ii) Identification and verification of technological opportunities of adobe technology produced with aquatic macrophytes, targeting your deployment in Palmas, Tocantins.
- (iii) Proposals for actions to be undertaken through public policies to improve the process of Technological innovation in Palmas.

Methodology

The whole research was developed into two parts: one, theoretical nature, structured from the research of conceptual and regulatory milestones. And the second part, that seeks to establish relations among the variables checked, area of study and the technology inside your local perspective. These two parts were subdivided in seven stages.

The stage 1 was built of the bibliographic search covering the theoretical and necessary for the elucidation and conceptual understanding of the subject. After the definition of the term "technological innovation", puts in thematic national, its trajectory and the scope of discussions, including in the area of Civil Construction. In addition, sets out the main actors involved in the process between politics/strategic and operational, regulatory, and delimits the topics that guided the analysis, when related to the study area.

In Stage 2, also theoretical, are dealt with specific aspects of adobe technology produced with Aquatic Macrophytes. Initially, for contextualization, is made a brief approach about buildings raw earth (characteristics and key techniques) and also on the macrophytes waterfowl, which are explained in that consist of his decision and the reasons appearance.

Then the work focuses on the proposed technology since the research that the originated by its intrinsic characteristics. At this time, terminating this the first part of the survey, it deals with the potential of material for the city of Palmas, within the concept of "technological opportunities" and here are defined the headings fact-finding that guided the analysis and real product competitive advantages.

The city of Palmas is the scope of an evaluation in Stage 3, which features geographic aspects of the area and describes briefly how and when the flooding which gave rise to the Lake, cradle of Aquatic Macrophytes. The creation of the State and city building, consolidating social and cultural aspects, are also outlined in this part of the research.

The Stage 4 investigates the conditions for innovation, in general, in State and in local scenario. It is verified that there is no legislation relevant, except in the definition of the Councils, and the presence of some local programs to encourage the innovative entrepreneurs. The educational infrastructure is object in parallel, and placed in check because of its under-performance in the production system. It was intended here the understanding of the local environment for the innovative process.

In Stage 5 the main focus is back again to adobe technology produced with macrophytes. The goal now was to verify whether the technological opportunities, previously identified, are in fact liable they are exploited. The topics have different approaches, between aspects social and cultural, economic and physical. However, both tend to matters of technical feasibility of technology. The variables to be evaluated are classified in external, internal and entrepreneurial. The last one was not covered in the study.

The Stage 6 works with results, expressed in terms of valuation tables, each one of the variables. The classification of items between favorable, neutral and unfavourable, allowed

the understanding about the environment deficit for innovation, as well as the limitations on the technology implementation adobe produced with macrophytes.

In order to respond to specific objectives, the last stage, Stage 7, brings several recommendations, based on the information obtained in the analysis of the variables. First, it covers the various aspects of innovation and, subsequently, it is made a proposal on how maximize the competitive advantages adobe produced with aquatic macrophytes.

Results and Discussions

Analysis of technological innovation

In the course of the work, the multiple variables inherent in the process of Technological innovation were approached, one by one, seeking to establish relations with the region setting of palms and their conditions under innovative design. In order to systematize the perceived potential and alert for the main obstacles in the system, the variables described were classified in the following tables¹.

The valuation of the variables for the innovation was made at three levels: “favourable”, when the conditions are beneficial and clearly point to the sustained technological development; “neutral”, when the factors are not differentiators – although they can be incremented-for the promotion of Innovation-based development; and “unfavourable”, because its assessment diagnosed complex disabilities and appropriate public policies are needed.

External conditions for innovation

Table 1. Institutional political Conditions for technological innovation in Palmas:external variables.

VARIABLES			EVALUATION
EXTERNAL	State regulation	Posture	
		Existence of actions	
	Institutions, Programs and Lender Agencies	Local programs	
		Lenders	
	Educational and Research System	Professional training	
		Knowledge production	
		Relationship with production systems	

In national technological scenario still in training, the city of Palmas inserts itself in a marginal way. This fact is noticeable by the local institutional politics setting.

When it was examined its external conditions for innovation, we realize that the State limits on speech the intention to foster local properties for the technological development of the region. The programs have their research priorities in areas related to environmental, health, agriculture and education. For new industries and new materials, there is just an incubator of enterprises and a serie of tax incentives to those who settle in the State.

¹ Tables 1 and 2.

The predominance of public policies relating to innovation reach, in most of the time, the scale of research activities. This fact reveals a communication gap between the local innovation systems, starting with limitations on the identification of technological needs and, therefore, demands for the definition of priorities that require research and development activities.

Consolidating the State conduct, local programs proclaim its main lines of action, the expansion and consolidation of the National Science, technology and innovation system. However, they do not define areas of strategic action to promote technological innovation in companies and the S, T & I for social development. The large breadth among priorities of training programs and incentive sectors reveals the decoupling the topics of interest and local needs in the region.

Until now, therefore, the available resources to achieve the goals through this type of action, although they can be used as a learning process, there should be sufficient to capture, in the appropriate level, the needs the region's technology and promote the efforts mobilization of all variables involved.

In the education system, it lacks a management entity and the practical application of scholarly work is reduced, related to the complexity of contracts between the parties and the absence of appropriate channels for interaction among companies. These factors set out in the State of Tocantins the stagnation of the cooperation process between educational or research institutions and the productive sector.

In addition to the disability still eminent between technology management and inefficient interaction among the players, there is also a forceful regional disparity, given by the spatial concentration of scientific labor competence in the South and Southeast regions of the country. The North, in that context, points with significant disadvantages, always at the rear of the investments, knowledge production and, as a result, technological performance.

Internal conditions for innovation

Table 2. Institutional political Conditions for technological innovation in Palmas: internal variables

VARIABLES			EVALUATION
INTERNAL	Social and Cultural Environment	User agreement	
		Environmental concernment	
	Economical Environment	Companies with similar technologies	
		Sector resistance	
		Similarity with existing technologies	
	Physical Environment	Climatic conditions	
		Availability of raw material	

During the research, the vectors considered as technological opportunities of adobe technology produced with aquatic macrophytes, to be used in the city of Palmas, were evaluated considering social, cultural, economic and physical aspects.

A survey applied in the stage 5 allowed the perception about the existence of a specific demand (potential users), or the possibility of opening a new market segment. Composed of

people who believe to be positive the use of constructive alternatives distinct from conventional, dominant, this slice does not declassifies adobe by prejudice. In contrast, most of them demonstrate affection and nostalgia for buildings executed in that traditional way.

These people, surprisingly, are not defined by their family income or purchasing power, but by the degree of knowledge and everyday aspirations. The increasing dissemination of environmental issues on social atmosphere has brought changes, still slow and gradual, in awareness of the population. The results showed that the concern environmental is already beginning to integrate the social capital, although with little (or any) influence on both individual and collective actions.

Given this scenario, it can be concluded that adobe produced with aquatic macrophytes' characteristics in favor of this nascent awareness are competitive advantages in comparison to other materials.

However, this attribute needs to be exploited to become a thruster, both in purchasing incentives such as the dissemination of technology. When it comes to differentials, other technological opportunities to be assigned as competitive advantages are related to the comfort hydrothermal that can be offered to the user. Local climatic conditions may be a facilitator in the process of absorption of the brick, since the majority of Palmas' population makes criticism of the remarkable warmth of the city and its impact on dwellings.

On the other hand, when it comes to the economical environment, Civil Construction chain's conditions for technological development are complex. Brazilian industry feeds other profile questions to be discussed on the environment for innovations. Delayed and conservative, its setting leads to the following question: incentive policies for technological developments do not cover construction due to its consolidated profile (institutional resistance), or the industry conformation discourages possible initiatives focused on the introduction of actions aiming at innovations in chain?

The diversity of actors involved is one of the most fundamental problematic. In construction, the elements involved with the system range from the designers/suppliers, specifiers, to professionals performers, users and incorporators. In this way, the innovative process must necessarily be achieved and mobilize the whole range of stakeholders that will integrate it. And, in this case, although the industry exists in a coordinated manner, the goals of each one of your agents are well-differentiated, what often causes disruptions in the innovation cycle.

The users, for example, depending on your search, purchasing power and cost appropriateness to their housing needs. Otherwise, the incorporators aim building the greatest number of units, in the shortest space, acquiring the biggest profits. The performers, in turn, when believe they have qualified the labor, resist to the changes, believing that can cause possible delays in the results and preferring not to incur in risks.

The great institutional resistance of the sector, both on the national scene as in reality of industry in the region of Palmas demand from all means of promoting development based on innovation, new outbreaks of analysis and alternative proposition. It is essential to the discussion, broad and participatory, both in the productive sector, political and academic environment, about the possibilities of enrichment and strengthening the chain.

The construction, in this context, is a limiting factor for innovation. The constitution described above, in addition to numerous firms (homebuilders and pottery) working with similar technologies, sets up the main obstacles of diagnose.

In this respect, the issue of innovation requires special attention and the risks of failure are considerably larger. Thus, the meticulous planning and technical support, in the case of an enterprise, are crucial questions.

For the manufacture of material, other variables suggest impediments. Firstly, the instability of the life cycle of plants, raw materials essential to the adobe brick, requires investment in new research and adaptations of the technology to the local sphere. As the species studied at risk of being extinct, substitute of equal or greater efficiency must be discovered, that also contribute to the reduction of surplus biomass. Secondly, the intensity of rainfall between the months of January and March, can also be an obstacle to use technology. As this is sensible to water, its effectiveness and durability can be compromised.

In General, none of the negative aspects for the implementation and successful dissemination of adobe with macrophytes are damage definite or irreparable. However, they require specific studies, individually, in search of solutions to solve (or bypass) the problems diagnosed.

Recommendations for the case of Palmas

Technological innovation in Palmas: proposals for external variables

The definition of the role of the different political and institutional actors involved in the process of technological management in Palmas reveals two groups of agents: those attached to the State (public sector), establishing standards and developing actions in order to define and strengthen priorities; and those linked to the strategic environment that are entrepreneurs, institutes of education and entrepreneurial stimulus, associations and lenders agents.

The State certainly is an important vector in technological management through mechanisms for identifying local priorities for science, technology and innovation. However, by taking on the regulation and control of goals, often faces with two institutional problems.

Firstly regarding to the irregular distribution of scientific and technical skills in the country. Secondly, if it is taken as a reference to technological problems in the context of the process of development, the formulation and implementation in Tocantins policy still addresses the issues very wide, not treating the sectorial development and technology locally. Thus, makes also difficult the delineation of specific actions from strategic staff.

Therefore, before the decisions, it is suggested that the municipal plans/state related to science and technology include the following, with respect the instruments:

- (i) Support for the implementation in the region of a nucleus of technological management shared that lays the foundations for local authorities in the Organization a platform for identifying difficulties/opportunities various technological chains. As priority actions, the establishment of methodologies for collection and organization of local indicators to notice local skills and the selection and identification of good practices of technology management models, adapted to specific conditions;
- (ii) Provision of an information system and communication to increase the interaction among the agents and the dissemination of local needs priority interventions;
- (iii) Incentives aimed at attracting human resources committed to activities of science and technology and the increment.training of existing ones.

In the strategic environment, in terms of institutions, programs and promotion agencies:

- (i) Regional meetings conducted by the entities to discussion and dissemination of local opportunities to technological development;
- (ii) Sectoral support activities, enabling the construction and operation of networks or the provision of services in the areas of information, management of science and technology (including prospecting processes and planning, as well as monitoring and evaluation) and maintenance programs;
- (iii) Encouraging projects that include the sectoral priorities of local chains, as well as the demand for intellectual property (patents and trademarks) and social technologies;
- (iv) Definition of policies for the development of relations between the entities and institutions of higher education and research by encouraging when offering traineeships, holding of fairs, and establishment of agreements;

For the Educational System, some interventions are essential for the stimulation of its acuteness in the regional technological development:

- (i) Institutional self-knowledge and the own philosophy/policy definition for business relations. The diagnosis of conditions (institutional infrastructure, human resources, the existence of initiatives and goals) to contribute with the productive sector allows the appropriateness of the unit, within their specific features, for the elaboration of goals;
- (ii) Training of relations managers or a institutional business council to coordinate and seek for alternatives to stimulate their interaction with society;
- (iii) Stimulus to promote business fairs in institutions; internships/jobs and traineeships promotion; program of alumni tracking; University extension projects; provision of services; search to order or contract; business incubators; Junior companies; provision of an academic research database.

A proposal for the adobe brick produced with aquatic macrophytes

In the specific case of adobe technology produced with Aquatic Macrophytes for Palms, two issues, in addition to its competitive advantages, are be addressed in defining key proposals: ease of acquisition and absorption (tendency to appropriate technology) and obstacles for the process of innovation in the construction sector. The highlight of them, within a possible process of technological innovation, induced the consideration of the possibility:

The formation of a cooperative of production of buildings using the technology. In addition to the benefits for both environmental and users of the buildings, the cooperative could contribute with the generation of direct and indirect jobs, in addition of providing opportunity – qualification and work – to a considerable number of construction professionals and/or interested person in become a member, through a joint venture owned by collectively and democratically managed. According to recommendations of SEBRAE (2000), to organize a cooperative, which is sought is to improve the economical situation of certain group of individuals, minimizing problems or satisfying common needs that exceed the capacity of each individual meet alone. The means of production are collectives.

In the cooperative, part of the vectors of the constructive chain components would be organized in the same way and have the same goal of producing adobe buildings with macrophytes. Thus, the potential user would seek it the satisfaction of their wishes regarding

their dwellings. The various sectors of production system could democratically articulated, increasing the chances of a good performance of the company and extending opportunities for various types of professionals, with the most varied specialties, or even to be trained. Departments as the production, research and development, implementation, sales, and marketing and projects define actions and strategies to solve each of the stages of formation, stabilization and consolidation of the company.

Moreover, a firm like that, participatory and with more extensive horizons, would force majeure in the acquisition of financial incentives and higher maturity to seek continuously for the help of innovation strategic actors.

Within other complementary possibilities, the technology could be adopted by the State in the construction of public facilities (schools, jobs of health) or housing programs operated by State/Hall. The adoption by these means could boost the introduction and successful marketing material. The governmental instruments could promote the production of material on an industrial scale and same, empowering the future resident to use the system in self-help.

Final Considerations

In the process of Technological Innovation of Civil Construction, knowledge plays an important role. However, it is not enough for it to be created, it needs to be downloaded and subsequently disseminated. Furthermore, the results on each of these three phases are directly proportional to motivations of the environment in which the process occurs.

The internal market and its dynamic condition generated new demands of economic policies, expectations and social participation that foster motivations for change and a new context covering topics such as environmental protection and social responsibility of companies.

As a result of new visions regarding development, own society, composed of potential consumers, are now considering values before not pointed, mostly, as determinative in the acquisition of goods and services.

Also the responsibility in innovation process shows itself not fit only in the context of enterprise. The construction company should not be the single agent the structuring actions aimed at introducing new technologies, but must seek strategic agents – supported on strand policy/regulatory innovation system – the motivations that make efficient its initiatives, in order to respond to the demands of society.

Discussions are fundamental to the consolidation of national innovation system, which must broadcast political leverage and application of knowledge, both within the company, as in the environment of its insertion. Moreover, the choices should be oriented in such a way that enable direct public policy of science and technology according to specific mechanisms of control to each region and consistent values to a sustainable development in the long term.

In the broad spectrum of development, it is essential to meet the challenges to be overcome as social and regional inequality in training and dissemination of knowledge, extension and quality of education, compromise the activities of science, technology and innovation as sustainable development staff, as well as the commitment of construction companies in the appropriation of knowledge, to promote technological innovations of value not only economical, but also social.

In this sense, the necessary linkage between the instruments is one of the largest challenges within the profusion of elements of influence on several fields the innovative process. Anchor the technological development of a region This set still demand, and greater efforts, and investments features of public authorities and institutions, the effective participation of society and the productive sector, and greater coordination between the actions in the different process balls, in the construction of local technology management with satisfactory performance.

This survey allowed a great learning about the topic. The diversity of agents that mobilizes the technological innovation process is not yet discussed in the country on a large scale and realized that, especially in construction, the literature on technological innovations is very scarce.

However, the possibilities are many and should be explored. In the case of adobe produced with Aquatic Macrophytes, proved a material with great potential. There are many qualities in the context of sustainability.

The work also revealed a higher eminence of developments research, both from the material itself, as for the process of innovation in the construction industry. In view of the importance of knowing better equipment and the process of innovation in jail, some themes can be proposed as prospect for future research, for example: other species of macrophytes for the material, study on the forms of production and the indexes that can be achieved; research on the origins of Brazilian construction chain barriers to innovation Technology, among others.

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