Public Policy Instruments to Encourage Construction Innovation: 
Overview of the Brazilian Case

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Introduction
The main objective of this work is to present and to analyse the politics adopted by 
the Brazilian government to promote the technological innovation in the construction 
sector. Knowing a great demand for building construction and in a special way for 
housing, the main investments oriented to the innovation preferably have been 
accomplished in the latter and, for that reason it will be the analysis focus and 
considerations in the present work.
The work is divided in three sections. In the first, it is sought to characterise the 
process of economic and technological development for which the country has been 
passing in the last years with focus for the innovation process in the construction. In 
the second, it focuses the current and more significant government politics that are 
oriented to the technological innovation in the construction, particularly in the 
construction of buildings, trying to show its impact on the whole productive sector. It 
is in this section of the work that one seeks for answering to the questions placed for 
all the countries that participate in this work:

What instruments and approaches are being used by governments to promote 
innovation in this sector?

What works and under what circumstances?
To look for the answers to those questions, it was used data of academic works that 
focus the government politics oriented to innovation and also to valuable information 
gathered directly from persons in charge of several projects in progress- to whom the 
authors would like to thank for the collaboration - and, yet, the supplied information of 
several research and development supporting agencies in the country.
Finally, in the third and last section, the conclusions of the work are presented 
through which one tries to answer to the questions placed by the participating 
countries:

How to strengthen innovation in the construction industry?

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Section 1 - Context

1.1. Technological and economic and Brazilian development.
This first section of the work shows the context in which the technological innovation is happening in Brazilian’s Construction.
Brazil, after a period of great economy growth happened since the beginning of the sixties to the end of the seventies, started a period of great economic instability, high inflation, and literally no economic growth that lasted long during the whole decade of 80, getting to reach the first years of the decade of 90.
That period was characterised by a series of financial difficulties that the State could not honour its commitments and not even to refinance its debt; it also leads to the growing increase of the inflation, and to an expressive recession; and, as result of this two factors, there was a sequence of economic plans that tried to stabilise the economy again.
Among the several proposed plans, in 1994, one was implemented that was able to keep the economy stability until nowadays, at least under the inflationary point of view. However, the great foreign debt and the need of structural reforms in several productive sectors of the country, to begin for the own State, not always easy to accomplish, they still stay as hindering factors that make difficult to plan and forecast for medium and long range. Completing this picture, the government politics that has been establishing the interest rates in very high values, is one more obstacle to be won for the full retaking of the growth.
In spite of all those difficulties, the decade of 90 was also marked by the internationalisation that brought the market opening to the companies and foreign products, contributing in this way, for an expressive change in the national economy because, threatened by foreign competition, all the productive sectors were compelled to modify and to modernise its production relationships, looking for to increase its products competitiveness.
With that, it is being consolidated a new phase of industrial growth oriented to production relationships modernisation, and, the construction industry, that characterised for several authors, for wastes of several natures, for high production costs, and for sustaining and keeping employed disqualified labour, due to the economic and social importance that it represents in the productive group, that could not stop participating of the process of country modernisation because besides being responsible for country modernisation process, is responsible for high percentage of the gross domestic product (GDP), it is intimately related with the countless other activities, that not just the specific of construction. It is within this modernisation process for which the Construction Industry is passing that will be approached in the sequence.
1.2. Construction and technological innovation: recent evolution and current practices

1.2.1. The years of growth and the crisis

Inserted previously in the economic context above described, the construction has passed by different development phases and of government politics. In the beginning of the decade of 60, according to the works of Farah (1988), of FUNDACÃO JOÃO PINHEIRO (1992) and of Vargas (1994), structural changes happened in the whole Brazilian society, with significant repercussions on the Construction industry.

It was in that time that happened the infrastructure implantation to make possible the industrialisation, strengthening the of heavy construction subsector, with great projects in the area of transports, energy, mining, and metallurgy; it happened, in addition, a strong urbanisation process that has led the development of the material and component construction subsectors, particularly, in function of the State intervention, through the Institutes of Welfare, of the People's House Foundation and, in 1964, through the creation of the National Bank of Housing (BNH), that looked for the mass production of housing units.

That period of economy investments and growth continues for decade of 70, beginning to give signs of gradual fall starting from its end, intensifying the recession in the middle of the 80 decade. It is of that period the construction of great housing blocks, marking an important stage of the construction of buildings history in Brazil, mainly because it allowed the introduction of technological innovations heading for the industrialisation. To have an idea, between 1976 and 1982, the housing financial system financed annually, on the average, the construction of almost four hundred thousand new dwelling units. In the beginning of the seventies, motivated by the high demand provided by the release of government resources, the sector of Building Construction was motivated mainly to look for the productivity increase, so that it was possible to produce a great number of housing units in a short period of time.

The introduction of "innovative" constructive systems or "industrialised" systems, based mainly on the pre-fab components, the majority brought of other countries, was answer given by the building companies to the demand. According to Castro (1986), more than 50% of the used technology in those sites were imported and, for its adaptation to the national conditions, investments were required in technological research, carried out by the State as well as the manufacturers, and construction firms. By the end of that period and beginning of the eighties the picture of resources offerings begins to change, marking, then, the beginning of the crisis.

For that time, two factors began to substantially modify the scenery of the construction. By one side it happened the political opening in the country, allowing that government was enforced an action that could made feasible popular dwellings construction; for other side, there was the economic worsening crisis that hindered the obtaining of financial resources, mainly because the used financial system until then was completely compromised.

The need to build more dwellings, given the existing deficit, and the shortage of resources led the search of more intensely construction cost reduction. This last factor has led, consequently, to the need of new constructive technologies adoption that is to say, of technological innovations.
With the aim at solving housing problem, the State triggers an action oriented to the new construction technologies and, for that, promoted several seminars and discussions that involved the whole productive chain. Farah (1988) reminds that counts of that time the experimental sites located in Naramdiba (BA), in 1978, and in Jardim São Paulo (SP), in 1981, in which the technological innovations were tested; those action had the objectives of achieving the sector modernisation; for that, one could meet the objectives of the state action, of low-cost and of large-scale production, to address low-income population.

The experimental sites were created to accomplish an evaluation of the proposed new technologies and, starting from there, to release those that could be used. For that occasion the outstanding role of Financiadora de Estudos e Projetos - FINEP (Financial Support of Studies and Projects), was stressed. FINEP is a public company linked to the Ministry of the Science and Technology - MCT, of the Federal Government, that has as objective to promote the technological development and the innovation in the country, in compliance with the goals and priorities established by the State.

FINEP, that was acting in housing area since 1976, in the research and technological development area had a complementary action in connection with National Bank of the Housing - BNH, and with National Council of Scientific and Technological Development - CNPq, entity also linked to the Ministry of the Science and Technology

One of the actions of FINEP, already in the end of the seventies, resulted in the definition of some research lines, with a priority to support the projects oriented to low income population. Co-operation protocol was signed between FINEP and BNH for information exchange about researches of the area. Basing on the activities developed in this period, in 1978 was approved the Integrated Program of Habitation and Sanitation, through which FINEP supported (together with BNH) several researches of the two chosen areas.

Through that action it was possible to set up an important partnership among FINEP, BNH and IPT (Institute of Technological Researches of the State of Sao Paulo) for the development of an evaluation methodology of new constructive processes, that aimed at the creation of evaluative parameters for the units produced in the experimental sites.

That partnership, in spite of passing per high and low moments, has persisted until current days, as it will be seen further on, because the evaluation of new constructive technologies is not still a subject solved in the ambit of the Construction Industry in Brazil and, new actions with that same objective are still being undertaken.

Unfortunately that government action had a short duration, because, in spite of financial resources still existed for the execution of works with processes and or innovative constructive components and of there being the government’s agents really engaged in the incentive process to the financing of those types of construction and still having had actions as the partnership established with IPT, a more contusing of technological innovation politics never existed in the sense of involving the whole entities in that movement.

The own government was fragmented in relation to that subject, having groups that defended the maintenance of the conventional construction and they only gave room to the innovation when the lack of money for the financing forced the search of lower costs. Thus, the experience of technological innovations introduction ended up by
characterising it as a punctual event, because as soon as the government provided favourable conditions to the use of the innovations stopped, there was a retraction in its use and the whole described process by the companies’ side as well; thus, it was abruptly interrupted with the worsening of the economic crisis, that added to the problems of construction fund of financing administration, they caused the wreckage of the whole financial system of the housing since then.

According to Castro (1986) for the construction industry of material, component, and equipment, the investment in the production amplification oriented to the housing demand, in the following years turn out into idle capacity, mainly due to the countless pathological problems that appeared in the dwelling units, as a consequence of the absence of a adequate technological development.

With the lack of financing, the companies that had the option for the development and use of new technologies were forced to re-do their strategies. The tenuous innovation experiences ended up, and since 1986 the sector has been complaining about the lack of a financing structure for the construction in the country.

1.2.2. The current picture
The current construction configuration begins with the experienced crisis since the end of the seventies, which has provoked expressive changes in the sector.

The great competition resulting from the decrease in the number of works (in 1987 the number of licensed works was of just 47% in relation to for 1980) (IBGE, 1989) has drove the companies to excel for the cost-reduction as the only possibility of maintaining their profitability and staying in the market.

That cost-reduction was sought moreover through the production rationalisation. According to IPT (1987) and (1988), the companies try to obtain productivity gains and to minimise costs and time is through production rationalisation, without disrupting the productive base that characterises the sector. One tries to reduce the waste of time and of material, fighting some of the main conventional construction bottlenecks, such as: lack of articulation among the several design types and between office and site; absence of quality control; bad work conditions as factor of low productivity; site disorganisation, etc.

Although the building companies were concerned with their costs and with the new ways of performance identification so that they could stay competitive in the market, on the State side, only FINEP, besides foment at organisms for essentially academic research, through scholarships, like CNPq, FAPESP - Foundation of Help to the Research of the State of São Paulo and CAPES – Co-ordination for Personnel of Superior Level Improvement Foundation, maintained some action aiming at the development of the construction industry.

In the middle of 1980, FINEP programs were elaborated in the field of the social development. For the housing area were established four researches lines with emphasis for the formation of human resources, as below described:

- production process of the urban space (legislation of the land use; studies on the urban land profit, and on the real state market);
- habitation production process (the construction industry and the construction material industry; technological researches seeking low-cost construction);
- the State, the politics of investments in housing; equipment of collective use;
- dissemination (exchange promotion in researches; creation of informative bulletins; surveying the "state of the art" of the sector).
It was also elaborated the Program of Housing, Sanitation, and Urban Development, with the proposal priority of choosing, in each one of the following subsectors:

- Researches aiming at subsidising the responsible entities performance for politics planning and implementation;
- Case studies and pilot-experience aiming at local problems solution, with special concern to low income population;
- Projects aiming at simplified technologies diffusion for users.

In 1987, a new Program, PROURB - Program of Urban Development - was approved in FINEP; it addressed the areas of Housing and Urban Development. Its research lines were defined from a comprehensive debate with the scientific and technological communities, and with other financing agencies such as: CNPq; Ministry of Housing, Urbanization and Environment; and Federal Savings and Loans (CEF). It is to note that after BNH closure in 1986, CEF was appointed to co-ordinate all activities related to the research linked until then to this bank.

The implementation of those programs were made both in terms of public politics oriented to the housing area, and in the new material and constructive systems development.

In the area of new materials, studies oriented to the use of vegetable fibber were financed (sisal and coconut) and for the use of light weighted aggregate in the construction, developed by the Centre for Researches and Development of Bahia - CEPED - and for the use of fine grained concrete in construction, accomplished by the School of Engineering of São Carlos - EESC/USP.

Concerning constructive systems, it is to mention the outstanding research accomplished by the Foundation Technological Centre of Minas Gerais - CETEC, about the catalogue elaboration of constructive typologies potentially usable in low-cost housing in several areas of the State of Minas Gerais.

In spite of the efforts accomplished by several researchers of the area (notedly in the period of the end of 1989 and the beginning of 1993), through the resources from FINEP, countless difficulties existed to set up a true politics oriented to the Technological Innovation of the section.

Even so, two researches were supported: the first, developed by the Foundation of Technology of the State of Acre - FUNTAC, addressing the search of alternatives of low-cost housing for Amazon Region; and, the second, accomplished by the Latin American Institute - ILAM, of São Paulo, that aiming at designing and building prototypes adapted to the conditions of certain urban areas of the Country.

A more systemic approach from the State happens through the Ministry of Social Action in which was created the National Program of Housing Technology - PRONATH (BRASIL, 1991), linked to the Brazilian Program of Quality and Productivity - PBQP, having as a guidance the technological and managerial modernisation of housing production. In this program, it is acknowledgeable that actions aiming at the sector "technological innovation" is indispensable, and to stress the following:

- to strengthen the productive structure of the sector in respect to its technological and managerial capability;
- to implement politics of labour training that enhances the introduction of technological innovations;
- to motivate the use of new technologies for housing production;
• to strengthen the laboratory and research infrastructure for the technological
development and rendering services;
• to foment the creation of new laboratory units and research groups,
consultanship and technological consultancy;
• to develop courses in technological innovation;
• to develop mechanisms of technology transfer.
Regarding the Technological Innovation Program - PRONATH (BRASIL, 1991) it shows the following central objective: "to enlarge the knowledge range and available technologies in the country, in the design, material manufacturing, and components areas, as well as in the construction, operation, and maintenance of housing construction".
Aiming that, a proposition is done to minimise the current "technological bottlenecks" in the subsector to reach the following goals:
• developing technological innovations in the design, material, component, and constructive systems areas;
• training all the national productive sector for the use of design, production, construction, operation and maintenance new technologies;
• promotion and large scale application of new technologies in housing construction.
In 1992, now in the competence of the Ministry of the Social Well-being, the Program was reformulated in respect to the foreseen actions for the biennium 93/94, becoming less comprehensive and more adapted to the financial reality of the Country. The objectives of "final cost reduction of low-income housing" and of "housing quality improvement" started to prevail over others and the actions to be developed link to the technological innovation, to the use of appropriate technologies of local conditions, and the fight against the construction waste.
From this new definition, several initiatives were adopted in the ambit of the Program, for example, the accomplishment of a "ploy", in Brasília, gathering alternative constructive systems; and still, an Agreement of Co-operation with Italy government, in the year of 1989. Within this agreement was elaborated project of "National System of Technological Development Applied Housing", approved in the year of 1991, whose objective was the financing of equipment for construction materials and components tests, aiming at creating conditions, in national laboratories, of improvement of the quality and productivity of the housing production, especially the one of social interest. The project intended the establishment of ten evaluation centres equipped with equipment and of technical personnel, besides the assemblage of a reference system of technologies at a national level.

Besides that, there was also the popularisation of the Ministry of the Welfare Instruction Normative no. 4, that established general guidelines for systems and constructive components approval in programs administered by the National Secretary of Housing and by the Ministry itself. This document, of great relevance for the sector, was approved by entities such as, the Private Insurance and Capitalisation National Federation Companies - FENASEG; Brazilian Association of the Companies of Real Estate Loans and Savings - ABECIP, and Federal Savings and Loans - CEF and, although it has not been indeed implemented, it generated a
lot of discussions and debates in the construction sector, strengthening the need of such guidelines as well.

It was also created a new Program of government action for this area, named Program of Technology Diffusion for Low-Cost Housing - PROTECH, attached to the General Secretary of the Presidency of the Republic and supported by eight Ministries, among them the one of Social Welfare and the one of Science and Technology.

For a presidential decree of July 1993, it was also created, a new program of government action aiming at technological innovation called Program of Technology Diffusion for Low-Cost Housing - PROTECH, linked to the General Secretary of the Republic Presidency, being its resources originating from the Federal functional properties' alienation (Decree no. 1,036 of 04.01.94).

PROTECH looked for the diffusion of new construction technologies for low-income housing by means of the construction financing of some pilot units, and of the establishment of a diffusion centre from those units. To that group was gave the name of Technological Village. Eight of those villages took part of this program, but only five were concluded at an average of a hundred dwelling units each; ten technologies were selected for each village. A valued aspect of this program was the community's participation and of representative society sections for choosing technologies to be adopted. Many Technological Villages were built in several Brazilian states, such as Parana, Minas Gerais, Bahia, Sao Paulo, among others. Parallely to these initiatives it was promoted by MCT, in April of 1993, through the Brazilian Academy of Sciences - ABC, a wide debate about housing research in the Country. From this debate emerged the normalisation and certification areas as priority subjects, assembling and memory recovering of the accomplished experiences, quality and productivity management in construction, new materials and technologies development, and sector trade formation and training. It also emerged as conclusion, the need to promote sector re-articulation due to the action of multiple institutions over it (FINEP, s/d).

Facing this scenery, it was necessary the implementation of a Housing Technology Program - HABITARE, by FINEP, to plan and to carry out the strategy in this area, especially in respect to the contribution for the public politics formulation, implementation, administration, and evaluation in the field of the science and technology. More information will be provided in the second part of this work; however, one included action to be stressed in this program (by its relevance for the innovation technological process) is a research initially conducted by IPT and now by COBRACOM (Brazilian Committee for Construction, from ABNT--Brazilian Association of Technical Norms) that will make possible minimal norms for innovative construction systems performance evaluation. For that, the Ministry of Sciences and Technology has allotted resources from National Program of Privatisation to FINEP within the "Low-Cost Housing Technology." In the second part of this work more information about this and other government actions in progress that aiming at directly or indirectly to construction modernisation. It is in that part that we will look for answering those questions:

What instruments and approaches are being used by governments to promote innovation in this sector?
What works and under what circumstances?
Section 2 - Public Interventions
This second section discusses the major public interventions which are nowadays contributing to technological innovation in Brazil’s Construction sector, shown in table 1:

- programs to support R&D: FAPESP, CAPES and CNPq actions;
- programs to support advanced practices and experimentation: the HABITARE Program;
- programs to support performance and quality improvement: the QUALIHAB Program, the PBQP-H Program and the Competitiveness Forum of the Civil Construction Industry;
- programs to support taking up of systems and procedures: COBRACON / ABNT actions.

Actions
FAPESP

Objectives
The Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP (State of Sao Paulo’s Research Support Foundation) is one of the greatest Brazil’s technological and scientific financing organism. Its major objective is to finance grants and other activities related to technological and scientific research, local and international interchange, and information in the State of Sao Paulo. It is an autonomous organism.

Annual Resources
FAPESP’s annual budget is of one hundred and sixty thousand million of dollars (1998), and it finances not only actions related to the construction industry, but also academic research programs. The Health sector is the first one, with 21% of the amount of funds, followed by Biology, with 16%, Engineering – 16% (all fields together, among them Construction), Social and Human Sciences – 12%, and Physics – 9%.

Its resources come from the VAT - value-added tax, once 1% of this tax of the State of Sao Paulo is destined to the technological and scientific research.

The construction industry projects are granted about 1% of the total amount of funds, or something like one and a half million of dollars per year (1998).

Means
The FAPESP’s actions related to construction industry projects include the sponsoring of about one hundred and eighty projects, which two thirds are grants (for young scientists and for Master of Science, Doctoral and Post-doctoral studies). The other third relates to research funds for specifics projects, laboratory installation,

6 In reality FAPESP is largest state financial backer in Brazil where similar institutions exist such as in states of Alagoas, Bahia, Ceara, Goias, Maranhao, Mato Grosso do Minas Gerais, Para, Paraiba, Parana, Pernambuco, Piaui, io de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina e Distrito Federal. From its importance is given the focus.
libraries acquisitions, congress’ organisation, congress’ participation, invitations of foreign researchers, book and journal publications, for example.

The construction projects are related to almost all types of studies, focused on building’s and the habitat’s problems, which goes from building economics and architecture, to very technical ones; from studies made in laboratories to those conducted by mean of field or library investigations; from individual projects to integrated ones, involving different groups of different universities or research centres.

Even if the FAPESP normally finances universities or research centres, from the middle of the nineties to now, it is trying to finance also industry projects where the innovation appears as a central subject, mainly for small and medium firms, by mean of the PITE - Inovação Tecnológica em Parceria (Technological Innovation by Partnerships), and PIPE - Inovação Tecnológica em Pequenas Empresas (Technological Innovation on Small Firms) Projects; the former one bases on the partnership between the innovative firm and a research centre, and the latter is the same but oriented specifically to small firms.

**Contribution to innovation**

It is very difficult to objectively estimate FAPESP’s actions for innovation contributions.

The grants accorded to the young scientists (fifty per year) are investments to the future; the results of those granted to master of science (thirty per year), doctoral (thirty-five), and post-doctoral (five) students are more obvious, even if we do not have indicators to measure their impacts. Nevertheless, one can say that the FAPESP system is one of the most effective and efficient of the country, and that it is very selective, with a very rigorous control.

We can therefore make some reflections about the investments directly related to technological projects and also to the promotion of the innovation. Thus, on one hand, if we regard the amount of specific project, normally those with more resources, related to construction, we will easily see that their relative participation in all the granted money are less important than they are in other Engineering fields. In fact, these kind of projects respond to 37% of the financial investments of the Foundation, percentage that decreases to 10% if we regard the Engineering, and to only less then 7% in the construction case.

On the other hand, the number of financed industry’s project based on innovation (PITE and PIPE) is almost zero (according to FAPESP, 1999, only one of the PITE’s Projects are related to construction subjects). We can give two reasons for that: or the idea is not very attractive to “construction” firms or the technical board of the Foundation prefers to finance more “advanced” areas, like electronic, chemistry or new material. We suppose that the first one is the real reason, even if “Construction” is not one of the major research strategic themes defined by the technological and scientific politic of the country.

The conclusion: construction has to elaborate much more these kind of financing sources, and not only look for grants. If it reaches the same medium figures of the Engineering, or 10% of the total of funds, this can represent the increase of three hundred and eighty thousand dollars per year, or more 26%. In the same way, if construction firms, in partnership with the academia, get 1% of the total amount of funds convened to innovation, this will represent some thing like one hundred and thirty six thousand dollars a year, or additional 9%.
It means that the construction industry could earn from *FAPESP* something like two million of dollars per year, or 36% more than it has been granted nowadays. We can also suppose that the contribution to innovation of the total investment would grow up in the same proportion.

2.2 CAPES’s Actions

**Goals**

Coordination for Personnel of Superior Level Improvement Foundation - is a public entity linked to the Ministry of the Education - MEC. Its main objective is in helping MEC (Ministry of Education and Culture) in masters degree politics, coordinating, and stimulating formulation - by means of scholarship awarding, aids and other mechanisms - the formation of human resources highly qualified for the superior degree mastership, the research and, the attainment of the public and private sections professional demand. CAPES also manages a specific program that is of this work interest called PADCT (Scientific and Technological Development Support Program) whose goal is to widen, improve, and consolidate the nation’s scientific and technological competence at university’s ambit, research centres, and private firms; it is done by integrated projects that impact the scientific and technological development. This program results from World Bank fund to Brazilian Government through Ministry of Science and Technology, MCT. FINEP and CNPq also act as PADCT administrators whose aiming are wider than the above mentioned ones.

**Annual Resources**

As we did not have access yet to the data for the specifically granted scholarships for construction area, we can estimate them, by adopting the same percentile of incidence of that area in relation to the total amount by FAPESP, which is of 1%. In fact, it seems that we will not be making any significant mistake, once the relative percentile of Construction Engineering in relation to the total are similar in the two cases: 16.0% on the average in FAPESP (1998) and 16.6%, 15.9% and 18.9% in CAPES, respectively for master, doctorate and post-doctorate (data of 1999 and 2000, until June).

If it is adopted the value of 1%, it will provide the following numbers (average 1999 and 2000): annual number of masters’ scholarship: 88; annual number of doctorate’s: 69; annual number of abroad pos-doctorate’s: 3; total annual of scholarships: 160. Those values correspond to a monthly medium expenditure of USD 76,000 or a little more than nine hundred thousand dollars a year (1999 and 2000).

Besides the scholarship awarding, CAPES also finances part of the Graduate Programs infrastructure (PROAP and PROF) and it also has foment programs. According to the same previous reasoning, the average annual values granted to construction would be of six hundred and seventy thousand dollars.

In the total, we estimate CAPES’ direct annual support to construction as of almost a million and six hundred thousand dollars.

We could not calculate the portion of PADCT resources oriented to construction as well. In the total, the Contract of Loan between the Brazilian Government and the World Bank foresees, for the first stage of PADCT, the amount of USD 310 million, that must be added USD 50 million as a private sector counterpart, leading to a grand total of USD 360 million.

**Means**

The essential mean for innovation contribution for CAPES is through scholarships grants, besides financial support for specifics research projects, laboratory
installation, library acquisitions, congress’ organisation, congress’ participation, invitations of foreign researchers, book and review publications, etc. Besides that, as manager of such programs like PADCT, CAPES also could act indirectly in the financing of companies and specific projects in science and technology. However, it is to highlight that among the PADCT components, just one of them, the so called CDT - Component of Technological Development, that aims to promote the technological development of companies and to increase the investments from the private sector in R&D, through the incentive of partnership formation between academia and productive sector aiming at the improvement of the global performance of the Brazilian innovation system and the diffusion of technology, it do favour the construction.\(^7\)

The PADCT benefits managed by CAPES are limited to the following: resources for human resources training and formation development projects; scholarships in the Country and in the exterior; event-aids and trip both in the Country and in the exterior; resources for equipment and permanent material to laboratories acquisition for sciences and researches schools and centres ; air tickets provision.

**Contribution to innovation**
As in the case of the *FAPESP*'s actions, it is very difficult to estimate in an objective way the contributions to innovation of the *CAPES*s ones, incluindo aquelas provenientes dos recursos do PADCT.

**2.3. The CNPq Actions**

**GOALS**
CNPq, National Council of Scientific and Technological Development, is a foment Foundation to the research linked MCT - Ministry of the Science and Technology. Its mission is to promote the scientific and technological development and to support researches, necessary to the social, economic and cultural progress of the country. To carry on its mission, CNPq accomplishes three basic activities: foment, research suuport, and science and technology information and diffusion. Among them, the two first are of our especially interest.

CNPq also manages a specific program of this work's, Program of Training of Human resources for Strategic Activities - RHAE, whose goal is of improving the conditions of competitiveness of Brazil in the international environment, by means of elevation of the technological capacity in themes selected by its strategic relevance, according to MCT guidelines; its clients are public or private companies, producing of goods and service renders.

\(^7\) The other two components are: 1) CCT or Science and Technology Component that aims at promoting and financing Research and Development/R&D and human resources in areas of national development relevance (Chemistry, Chemical Engineering as QEQ; Geo-Sciences and Mineral Technologies as GTM; Science and Material Engineering as CEMAT; Environmental Sciences as CIAMB; Biotechnology as SBIO; Applied Physics as SFA; 2) CSC or Sectorial Component that consists in promoting and financing activities oriented of services rendering such as supporting to Brazilian sector of R&D reform and improvement process.
Annual Resources

In all its programs, CNPq granted in 1998 a total of 933 scholarships for Civil Engineering, that here represented 2.2% of the total. Once again, adopting the same percentile of incidence of the area of construction in relation to the total adopted by FAPESP, which is of 1%, we reached to the total number of scholarships of 424, and almost two thirds of them are both masters' or doctorate.

In terms of values, the estimated total invested in construction, in 1998, was of three million dollars.

Means

As we said, two of the three basic activities of CNPq interest us here: foment and research support.
Thus, the function foment is the main action developed by CNPq, for promotion of the scientific and technological development of the Country, driven essentially for the formation of human resources and for the support to the accomplishment of researches, through the scholarships grants. The direct support to the research seeks to promote and to stimulate the production of necessary knowledge to the economic and social development of the country, to the confirmation of the cultural identity and the rational and not predatory use of its natural resources.
The foment action is organised in Basic and Special Programs. Basic Programs are those oriented to the planned use of the foment instruments, according to the traditional areas of the knowledge, among them Civil Engineering in general, and the Construction in particular. The Special Programs are those that correspond to the strategic areas and multidisciplinary fields, as well as those of regional features, whose action passes by any knowledge area. They are characterized by the perspective of medium range, for the emphasis in the induction mechanisms, for interinstitutional articulation and for the relevance criteria incorporation, in compliance with government's orientations contained in sectorial and regional politics that require strategic contributions of the science and technology.
Besides that, in Program RHAE’S ambit, CNPq manages specific budget destined to scholarship grants for several modalities (of 3 to 24 months of duration): on-Country and abroad apprenticeship training; to welcome specialist visitor; for industrial technological development; for training in the country and in the exterior.
The percentile of 1998 show however that the supporting modalities, at least in the case of the Civil Engineering, took place mainly through the foment actions through scholarships (66% of the total value) or of "productivity in research scholarships", granted for renowned researchers (25%), than those that support the research, direct, or indirect, through support coming from the external researchers (total of 9%).

Contribution to innovation
On more time, it is very difficult to estimate in an objective way the contributions to innovation from CNPq’s actions.

2.4. The HABITARE Program
Innovation stage:
Major interests: although there are projects to support R&D within HABITARE, there are other lines to support advanced practices, and experiment that deal with systems and procedures.

Annual Resources:
There is a variation of resources year to year. In average it figures something around US$816,000.00. In the last years the invested total resources were: 1996 - US$ 530,000.00; 1997 - US$ 1,055,000.00; 1998 - US$786,000.00; 1999 - US$ 896,000.00. For 2000, the foreseen value is of R$2 million or US$1,111,000.00 (not reimbursable). The resources of the not reimbursable financing come from FNDCT - National Fund of Scientific and Technological Development. FNDCT is managed by Special Secretary of the President.

Objectives:
To contribute, through the support researches it in the area of science and Technology, for the solution of the Brazilian housing problem and for the modernisation of the construction sector, always having in mind the integration with the environmental concerns.
To achieve the general objective were defined the following action lines:
- formation of research co-operative networks;
- dissemination and evaluation of the available knowledge;
- development of new technologies;
- integration with the productive chain;
- stimulation and consolidation of research institutions’ partnerships with companies of the sector;
- administration of the quality and productivity;
- development of the normalisation;
- decrease of the construction environmental impact;
- proposition of urbanisation criteria and infrastructural aspects;
- innovative procedures of housing administration;
- evaluation of public policies;
- post-occupancy evaluation.

MEANS:
"HABITARE" is a FINEP (Studies and Projects Financing) program that is a public company linked to the Ministry of the Science and Technology, responsible for the financing of projects oriented to the technological development of the country.
In this program, based on the action lines presented previously, two basic types of projects exist: the non-reimbursable, from which financial return is not expected, and the ones of applied research, in which it is mandatory to involve the company that will use the technology to be developed or improved, and a financial return from it is expected.
The projects of applied research are of on-line application, that is, they may apply at any time. The required information must make possible FINEP not only to confirm the adherence of the proposals to the operational politics and action lines, but also the financial conditions of the proposing company, the offered warranties, the internal coherence of the proposal in terms of objectives, budget, methodology, deadlines, etc..
The interest rates, lacking periods, and amortisation are defined case-to-case, within of possible institution limits (almost always lower than market values).

There is no previous definition of the technology type to be financed, but it is necessary provide context of its importance for the sector or for the productive chain of the financed action. It is possible to finance projects of quality management and of managerial administration, as well as basic education of the workers' general contents, since in a complement way to a project of technological development.

The non-reimbursable projects are launched by means of public proclamations - each one of them contemplating specific themes - and they are open to the participation of: Research Institutions, non-profit Associations and Technical-scientific Societies - public and private. Companies of the sector can participate since subordinates to the research institutions co-ordination, and offer financial counterpart (that can be financed).

In compliance with the proposed themes in the proclamations, the institutions elaborate projects that, besides the usual presentation of a project of R&D properly said, they should inform the monitoring and evaluation ways of the projects and - what is to highlight - the strategies by which the research results are passed to the productive section.

The criteria for the judgement and choice of the projects to be selected may vary according to the proclamation but they are basically:

- **Performance qualification** - Approach related to the researcher's capacity or of the group, research methodology and institutional infrastructure;

- **Intrinsic Merit of the Project** - Likelihood that the researches will lead to new discoveries or progress inside of the science and of the technology or that has impact in the area or in areas of the science and technology;

- **Usefulness or Relevance of the Research** - it considers the likelihood that the research can contribute to the technological development and solution of social problems;

- **Impact on the Infrastructure of Science and Technology** - Potential that the researches contribute to better understanding or improvement of the quality, distribution or efficiency of the scientific and technological research, education and human resources;

- **Budget** - The consistency of the proposed budget in relation to the Proclamation objectives, to the institutional capacity and the researchers' team;

- **Financial participation** - financial participation of the productive sector in the project;

- **Resulting projects of researches supported by HABITARE.**

**CONTRIBUTION TO INNOVATION**

There is no numeric data about the impact of those actions on the productive sector, and much less of the specific impact over the technological innovation. However, it is possible to verify that the program has indeed contributed to the technological
advancement in the sector constituting not only as one of the small financial sources for the study and development of innovations, but also as a great opportunity of efforts concentration of the government's organs, research institutions, non-government organisations, class entities, and private initiative around that subject. Unfortunately, the reimbursable projects of applied research have not been of a great acceptance from the sector. Nonetheless, its contributions have been more punctual in helping to develop some products and specific processes. It is expected in the next years, with the search of better quality and productivity for the companies, that there will be a larger search of projects in that modality. On the other hand, the non-reimbursable projects have had a good adhesion of the research institutions, and, among their contributions to the innovation outstand the following:

- Clustering of several organs and entities oriented to the innovation in joint projects;
- The program has been working with the consultantship of a co-ordinating group, composed by main entities that act in the area, and in that way it has been allowing an articulation room of those entities for the development of the sector. In that sense, one of the financed projects by the program resorted to a very interesting research strategy for the first time for a continental dimension country, and several scattered research centres, like Brazil: the concentration of several research centres and universities around an only project, optimising the resources and enlarging the research scope and its results in the productive sector.
- Creation of dissemination/information networks on innovation processes and products in the sector
- The concern of the program with its knowledge transfer to the productive sector it has lead to the creation of informal networks of knowledge diffusion among the research centres and the productive sector. Besides that, an information network was created for the sector, formed by several linked nucleus, and centred in an Internet site
- Technological Innovations Financial proposals
- Several projects were financed aiming at both new products development and of the improvement of existing processes and products, some of them with the collaboration of several sector companies, and, consequently, with the immediate diffusion of the researches results.
- Financing for new technologies evaluation
- Evaluation of some advanced experiences of introduction of new constructive systems, that is fundamental for future decision making about the use of those same systems, and, consequently, for its dissemination. Finally, it is to note that the limit of those results is also found in the development of broader government projects and policies, where PBQP-H is an already analysed example of the productive sector itself.

2.5. The QUALIHAB Program

Objectives
The State of Sao Paulo’s Low-Income Housing Quality Program, the so called QUALI'HAB\(^8\), is a Program to support performance and quality improvement, that is being implemented in the State of Sao Paulo to the local supply chain of the building sector. The Program is based on the purchasing power of a common client of these actors, the low-income housing office of the State, CDHU (Companhia de Desenvolvimento Habitacional e Urbano – State of Sao Paulo's Housing and Urban Development Company).

Through the QUALI'HAB Program, the CDHU aims at optimising the quality of housing with regard to products and services that have been made in use in their conception and implementation, from partnerships with the main actors of the sector through agreements. These agreements ponder: the implantation of specific quality program, the maximisation of the rate profit \(x\) cost (direct costs and costs of exploitation), and the satisfaction of the customers.

Although this Program is not meant to encourage the innovation itself, it has caused a very important effect in this way, as we will see below.

**Annual Resources**

The CDHU contracts, on average, forty thousand housing units per year, on three hundred financial operations. Its resources come from the State of Sao Paulo's budget and, especially, from the VAT -value-added tax (up to 95%), once 1% of this tax is destined to the so-called social interest housing. CDHU’s annual budget is about three hundred million of American dollars.

Despite those values, the resources of the QUALI'HAB Program are not so important, as they represent only seven hundred thousand dollars per year, or less than 0.3% of the total budget. We cannot forget that it is not a program oriented to support R&D, not even to support advanced practices and experiments. In fact, the firms have done the most important investments, and it is difficult to estimate correctly the counterpart amount of money they actually have spent. Small firms, that are normally adherent to the Program, uses to say that their external investments to respect all the QUALI'HAB requirements are of about thirty thousands dollars, without taking into consideration the internal costs (the salaries and upgrading skills of the employees that work in the reorganisation process of the firm, and machinery, such as computer soft- and hardware, for instance). If we estimate the number of firms involved in the Program up to now we can figure nearly three hundred, it means that these firms have invested something like nine million of dollars to support performance and quality improvement, or three million dollars per year, since 1998.

**Means**

The QUALI'HAB Program is based on "deals", even if it has a local reach (the State of Sao Paulo represents almost 40% of the Brazilian GDP). A particular characteristic of these agreements is that they have been negotiated by the CDHU with the different acting unions. For instance, after a negotiation period, the general contractors’ unions, that are the most affected agent up to now, set up an agreement with the CDHU in order to create a quality assurance system that has been included in the CDHU’s procurement processes since July 1998. This system is based on the ISO 9000 Standards and it includes the concept of "level of qualification".

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\(^8\) QUALI is a contraction of quality, and HAB, of housing.
It is easy to understand the CDHU power as a client that is able to improve quality and innovation in all the supply chain of the local housing providers sector. It is to note that Brazil has just passed by a very particular moment, with a low inflation and an important economical growth; from this context, paradigms have been changed, and the barriers that regulate the competitiveness in many sectors, including the building construction have been gradually removed.

We note some of these new features concerning the economic and commercial measurements, through: the new requirement demonstration on behalf of customers, public and private, that express themselves further in terms of quality, reduction of delays, and demand of services, among them innovation; the tendency of decreasing prices of the housing units; the opening of markets to the international competition.

The lack of financial resources and the deep crisis in the housing financing system, that have affected the private market as well, are also new important constraints, now connected to the financial dimension of the environmental concerns.

It says that intervening changes in the Brazilian real estate market dragged a growth with no precedent in the competition among firms. Indeed, two third of the State of Sao Paulo general contractors building sector considered the "competition" as their most prominent problem in 1997 preceding other one as interest rates, matching with problems linked to the manpower or suppliers.

It is in this context that it is necessary to understand CDHU actions: the financial power of the State, that collects funds thanks to a specific legislation, combined with a strong competitive environment, that has driven all actors of the sector to react and to accept a new logic of efficiency, ruled by the quality management and assurance principles, and by the search of innovation.

In spite of its comfortable position in this process, the CDHU did not want to impose rules. Instead of that, and this is one of the most prominent features of the QUALIHAB Program, it has made the decision to conceive and to put in work a program based on “deals”. About what were they concerned? In some words, they consist of commitments negotiated with the employers' different actor unions, witch have fixed two main points: 1) a set of “technical referential" requirements, adapted to each case, based on concepts and tools of the quality management and assurance principles which CDHU progressively requires in the procurement phase of its contracts, and 2) deadlines to answer them, on a horizon of a short period of time (in the particular case of the general contractor’s agreement, it took from January 1998 to January 2000 to accomplish).

Indeed, the CDHU understood well that the only way to get some concrete and positive results is to contract in an efficient manner the distinct actors of the sector, represented by their unions. To recover the delay in relation to the technical capacity, organisational ability, and bound to the management, the partnership public housing “buyers” x private actors has imposed itself.

What were and are still interests of the pace for industrial, engineering firms and contractors in this setting? Very simple: in a context of strong competition it means to achieve advantages in the procurement phase of the CDHU operations. Besides that, even though the rule of the "less saying" valid remainder, all those that have been “certified” by the Program are make savings. For example, general contractors do not need any longer to proceed to the quality controls anymore while using certified products by QUALIHAB, provided that they are already qualified.

The State purchasing power connected to private sector partners' expertise, weakness, and needs has led to a common goal: housing quality; this quality is
perceived on its multiple features: architectural, constructive, environmental, performative, innovative, etc.

Going deeply in the details of the Program organisation, we could say that the QUALIHAB Program’s negotiations with diversified union has begun in 1994. In all the cases it has conducted to progressive processes, with gradual deadlines, that foresee a period of two and a half or three years for their complete implementations. The Program is organised in two committees: "Material, Components and Systems" and "CAE – Construction, Architecture & Engineering." The unions that take part on the first one are those that represent producers of: steel for reinforced concrete, cement, lime, prefabricated products, ceramic products, tubes and components in plastic, industrialised sealers, electric components, for instance. The committee "CAE" is more heterogeneous, and it has included, among others, unions that represent general contractors, architects, engineers, construction managers, laboratories, topographic services, and foundation subcontractors firms.

Up to now, almost twenty different agreements have been signed in both committees together, and all of them are based on the principles above shown. So, every actor's technological and financial limits has been respected.

For instance, in the "materials, components, and systems" agreements, the technical clauses were based on the objectives and principles of product certification. Before requiring that only certified products should be employed on CDHU's projects, the Program has foreseen some intermediate levels, based on the idea of the progressive quality control of production lines. It has also foreseen the implementation of new standards and codes, adapted to Brazilian reality.

For its time, most of the agreements of the "CAE" committee are based on the objectives and principles of the ISO 9000 Standards, as the QUALIHAB Qualification System for General Contractor (QUALIHAB-GC) does. Going deeper in the presentation of this System, we could say that, in an agreement signed in November 1996 between the CDHU and the two general contractors' union, the QUALIHAB-GC as a gradual process (with its series of partial deadlines) has had a foreseen period of three years for its complete implementation. The System has reached its first upper level “A” in January 2000.

The QUALIHAB-GC System has four levels of achievements and according to them the quality management system of the firms is evaluated and ranked in a progressive and continuous way. It has also another particular point: the qualifications are made only by third-parties audits carried out by accredited external independent auditing service organisations. It consists itself of eleven requirements that are related to some of the twenty chapters of the paragraph 4 of the ISO 9001 Standards. It can be considered as a preparatory model to the certification ISO 9002.

The most important principles of the QUALIHAB-GC are (Cardoso (1997) and Cardoso et al. (2000)):

- the step-by-step progression, that allows general contractors adjusting themselves to the accorded requirements, offering them the necessary time to self development, while creating the educational conditions that induce them to progress in the improvement of their quality management system;
- the proactive characteristic, that aims to create an environment that leads firms to a certain degree of qualification;
• the fact that the assignment of a qualification is a privilege of the Assignment Commission of an accredited organisation which is composed of representatives of the general contractors and the customers (CDHU and the civil society);
• the guarantee of anonymity of the firm until the end of the evaluation process and the use of the transparency principles, the independence of those whom accord the qualifications and the collective decisions process adopted in this case.

We should say that a French successful experience in adapting the ISO 9000 Quality Management Systems requirements to the Building reality has inspired the Brazilian system: the QUALIBAT System (SYCODÉS (1996/97); ARCHAMBAULT (1995)).

In conclusion, from January 2000, to participate on the CDHU’s procurements, general contractors should have the level qualification “A”, the highest one. There are now, in the middle of 2000, almost two hundred and fifty firms qualified by QUALIHAB-GC, among which more then one hundred on level “A”.

The Figure 1 tries to illustrate the majors ideas related to the agreements celebrated between CDHU and the actors' unions, taking the General Contractor’s one as an example.

**Contribution to innovation**

Since 1998, the QUALIHAB Qualification System for General Contractors has been adopted by almost two hundred and fifty general contractors, and is deeply changing their relationship with their suppliers, with a very important "up-stream" effect in the building sector; the "down-stream" effect, touching the relationships between general contractors and their clients, is also an unanswerable fact.

More than this, other actors of the supply chain are also concerned with this movement. For instance, architects and engineering firms have just begun in the same way, proposing a progressive system similar to the general contractors’ one. Construction managers and foundation subcontractors firms have already their progressive systems, which have qualified almost thirty-five firms of both types (mainly foundations ones).

Industrialists are also implementing quality principles and tools in their production lines; new standards and codes have been developed; the technical capacity of the laboratories have been stimulated as well, among other actions.

Not only the CDHU’s projects, but also many others all over the country, including in the private sector, have been affected in a positive way by all these actions. More than that, customer’s needs are now more respected than they used to be before.

Nevertheless, its is not easy to estimate the contributions of the QUALIHAB Program to innovation. It is undeniable that it has changed at the same time the way companies understand “quality”, such as CDHU and the most important actors of the building sector. The firms’ internal and external processes, and their relationships are changing, since new procedures have been created, new technologies can now be tested in a much more “controlled” environment due to the right of anonymity, and so on.

In conclusion: the QUALIHAB Program is a very important driving force to all the actors, acting as a motor of innovation, that now begins to spread all over the country, by means of the national Program PBQP-H, as we will see below.
Figure 1 – The interaction between the actors of the supply chain of the housing construction sector and the CDHU, consolidated by means of an agreement. Example for the General Contractors case (QUALIHAB-GC).

2.6. The PBQP-H Program

Objectives
Like the QUALIHAB Program, the Programa Brasileiro da Qualidade e Produtividade do Habitat – PBQP-H (Brazilian Quality and Productivity Habitat Program) aims to improve quality and innovation of the social housing sector. The major differences between QUALIHAB are: 1) it is a national program, dealing with national projects, looking for national solutions for the commons problems found in the supply chain, all over the country; 2) it understands housing in a border way, with the sense of habitat, and deals with the implementation of services other than housing units themselves, as streets and roads, utility networks (for water, electricity, etc.), etc.; 3) it has as one of its central points the search for innovation. Almost all of the major actors of the sector are concerned, looking for the optimisation of the quality of housing and its environment with regard to products and services applied in their conception and execution.

It has been created in 1998, as an evolution of de “building” subjects relate to the Programa Brasileiro da Qualidade e Produtividade – PBQP (created in 1992), and is nowadays one of the Programs of the Secretaria Especial de Desenvolvimento
**Urbano - SEDU** (the State Secretary of Urban Development, directly related to the President of Brazil), that is in charge of its co-ordination. The underlying principles of the purchasing power of the State and of the partnerships with the main actors of the sector have been also adopted here. Nevertheless, we do not have now an unique client like the CDHU, but a set of them, in the three levels of the Brazilian State field of action: municipal, regional (each of the 27 Brazilians states), and federal ones. The most important of them is the Caixa Econômica Federal - CEF, a Federal Bank of Savings and Loans, with the annual budget of more than 2.2 billions of dollars, that has financed two hundred and eighty thousand new houses in 1999.

The *PBQP-H Program* has been created in December 1998, and its major objective is to "give support to the Brazilian effort toward modernisation of the housing construction sector, trying to increase the competitiveness of its products and services, stimulating projects that could increase quality and productivity of the sector". (www.pbqp-h.gov.br)

It has some additional objectives:

- to stimulate the relationship among the actors of the supply chain;
- to promote the international relationship among South-America’s countries;
- to collect and to make available information about de Program itself;
- to stimulate the quality assurance of material, components, and systems;
- to stimulate the quality assurance of construction, architectural, and engineering services;
- to promote actions to increase the level of qualification of the manpower, from the trades to the directors of the firms;
- to promote the creation and the diffusion of standards and codes;
- to fight the non respect of the Codes;
- to support the innovation;
- to promote the managerial capacity of the public organisms that are in charge of the social housing sector, in all the government’s levels (municipal, regional and federal).

**Annual Resources**

The *SEDU* does not construct housing itself; as we have just seen above, *CEF* has an annual budget of 2.2 billion of dollars. One can consider that a part of this amount is invested in innovation, by means of some “experimental” operations, where an innovation is carried on a controlled monitoring.

For its time, the resources of the *PBQP-H Program* are of about five hundred thousand dollars per year. As it is in *QUALIHAB Program*, *SEDU* is not oriented to support R&D, nor to support advanced practices and experiments. In fact, the firms are induced to do the most important investments and, in spite of the similarity of both programs, as the *PBQP-H Program* has just begun, we can not forecast its effects yet, as we did with *QUALIHAB*.

**Means**
The *PBQP-H Program* is also based on "deals", negotiated by the public “buyer” in each city or region with the different local actor’s unions, in function of the local characteristics of the supply chain, level of technical and economical development, for example.

In fact, the Program is based on the action of each “regional co-ordination”, all of them co-ordinated by the central structure, in Brasilia, the capital of the country. Sixteen of the twenty-seven Brazilian’s states are already members of the *PBQP-H*. Even if they have their “local” focus, the local agreements should respect some national rules defined by the national union of the concerned actors, in a process co-ordinated by the *PBQP-H Program* staff.

We can use here the same technical, social, and economical aspects that we have used to explain the “success” of the *QUALIHAB Program*. It is to justify the intended effect to be caused by the *PBQP-H Program* on the supply chain, which is being progressively attempted to spread to all the country, in a negotiated and co-ordinated process. It is to note the particular moment of the economy where many factors could explain, such as: the new constraints that influence the competitive stakes of the building sector, the new requirement demonstration on behalf of customers, mainly public ones; the lack of financial resources; the growth of the competition among firms.

Once again, in spite of their comfortable position in this process, *SEDU, CEF*, and the local public “buyers” involved in housing projects did not want to impose rules. On the contrary, and taking advantage of *CDHU*’s good experience, they are taking once again the decision to conceive and to put in work a program based on agreements. We have already at least three States where the local “buyers” are very involved with the Program, and where many local “agreements” have already been signed: Rio de Janeiro, Bahia and Pará (in the south-eastern, north-eastern and north regions, respectively).

The main difference of to the *PBQP-H*’s agreements concluded between the local public and private “buyers” of Low Income Housing sector and the actors’ unions, by report to the *QUALIHAB*’s ones, is that in this case the local goals and delays are defined depending on the local conditions (a diagnostic phase will demonstrate this), even if the “requirements” are the same all over the country.

The interests of the pace for industrialists, engineering firms, and contractors that are reacting in a positive way to the ideas of the Program are exactly the same as they are at the *QUALIHAB* case: to take advantages in the procurement phase, but now in another scale, as all the country is concerned. It means that a general contractor qualified at level “B” in Rio de Janeiro is eligible to participate of the procurements phases at level “B” in the State of Pará, and *vice-versa*.

The organisation of the *PBQP-H Program* has some similarities with *QUALIHAB Program*. Besides being based in the “local” structure and adopting the same dual structure of the *QUALIHAB Program*, based on both committees, "Materials, Components and Systems" and "CAE – Construction, Architecture & Engineering". Due to its federal scope, the National Forum of the Industry of Materials and Distributors is managing the first committee and the National Federation of General Contractors the second one.

*PBQP-H Program* is composed of twelve Projects. Each one of the twelve Projects is trusted to a manager, and has particular objectives and goals to achieve. Among them, one would like to highlight seven: the “PBQP-H Qualification System for General Contractors”; the Project “Regional Program”; the “Co-operation Project with France”; the Project “Support to the Use of Alternatives Materials and Systems”; the
Project “National System of Technical Approval”; the Project “National Goal of the Housing Sector”; and the Project “Improvement of the Technical Normalisation”.

The “PBQP-H Qualification System for General Contractors – SiQ-GC” is very similar to the QUALIHAB Qualification System for General Contractors – QUALIHAB-GC. It is closer to ISO 9002 standards and keeps the central idea of four progressive levels of qualification.

The Project “Regional Program” is promoting an international relationship between Brazil and the southern countries of South-America (Argentina, Chile, Paraguay and Uruguay), working with themes related to quality and productivity of housing (habitat), where the innovation appears as one of the central subjects. In March 2000, a Regional Forum has been created in the fifth meeting of the group, in Buenos Aires. The major objectives of the Forum are: integration of qualification process, in all its levels; stimulation the chain of supply development; development common norms and codes; development of common mechanisms of technical approval; stimulation of forms of co-operation with other economic blocs, like ALCA or EU. Consequently, the innovation is directly related to the Forum’s concerns.

At its time, the co-operation Project with France, supported by the Inter-American Development Bank, is one of the most important concerning to innovation. The French partner is CSTB – Centre Scientifique et Technique du Bâtiment, the most important French building research institution. Thanks to this Project, Brazil has had five technical missions in 1999 dealing with subjects such as quality management, innovation in construction, and site organisation. In 2000, three exchange programs in France of members of the PBQP-H staff have already took place (with eleven participants up to now), and other two are scheduled to the second semester.

The Project “Support to the Use of Alternatives Materials and Systems” has been developed between 1998 and 1999, to offer housing “buyers” and in particular a technical way of evaluate performance of the innovation solutions proposed by the actors of the sector in operations financed by this bank. To understand the importance of this Project, one should say that there are inadequacies in the Brazilian standards, and the consequences are not only the difficulties of evaluating ordinary solutions, but also mainly to innovative ones. The Project has created a direction that aims to evaluate these innovation solutions, reducing the involved risks. It is a “prototype” of a Technical Approval System.

At its time, the Project “National System of Technical Approval”, that is not yet in progress, will allow the development of an “integral” Technical Approval System, in accordance with international rules, mainly with those of the South-America’s countries. It will be a very important tool for innovation.

The last two projects - “National Goal of the Housing Sector” and “Improvement of the Technical Normalisation” – are very closely related. In fact, the National Goal of the Housing Sector, the rate of conformity with the national standards of the majors products that are used in housing construction, is expected to grow up to 90%, from 1998 to 2002. It seems to be a simple task or even the obvious for somebody from a developed country; however it is a great challenge that should be overcome by the less developed and poorly structured ones, like Brazil. In fact, Brazil does not even have all the necessary standards, many industry products do not follow existing ones, and the required justice system is not so effective to enforce customers’ rights, for example. Attaining the fixed goal, and, at the same time, developing the

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9 The amount of money accorded by the Inter-American Development Bank to the CSTB – Centre Scientifique et Technique du Bâtiment has not been considered in this document (Annual Resources).
standards is one of the most important aspects of the PBQP-H Program, and many actions have been done in this way, since 1998. The engaged actors of the supply chain expect to reach the goal in the scheduled date.

**Contribution to innovation**

Since 1998, the PBQP-H Program is trying to organise the actions that are been carried out all over the country concerning quality, productivity, and innovation in housing construction. Many things have already been done, and many other still lag. As PBQP-H is trying to make use of the successful experiences conducted all over the country, where QUALIHAB seems to be the most important, and if we look at the actions already implemented, we can say that its impact on innovation will be very important.

For instance, we estimate that, from July to December 2000, up to one hundred general contractors’ firms will be certified by the PBQP-H’s SiQ-GC. This will deeply change their relationships with their suppliers, with a very important "up-stream" nation-wide effect in the sector.

Industrialists are already progressing in the search of standardisation and compliance with the accorded codes. The Project “National Goal of the Housing Sector” is working very well, with a reasonable reduction of codes non-compliance Laboratories capabilities seem to be one of the major problems of this process, as they cannot for the moment respond to the entire necessity of experiments, and tests that have to be conducted. Important investments should be done by the sector to overcome this weakness of the production chain.

We can also expect that architectural and engineering firms will begin to participate of this movement in the next months.

The international experiences have also been important, concerning Brazilian’s neighbours and France, thanks to the Regional Program and to the technical co-operation Project.

It's is not easy to estimate the future contributions of the PBQP-H Program to innovation. Nevertheless, as in the QUALIHAB Program, it is undeniable that it has already begun to change the way the major actors of the building sector think “quality”. The internal process of the firms and the external ones, related to the relationship between them and to the way they take in consideration customers’ necessities, are beginning to change; new procedures have already been created, new technologies can now be tested in a much more “controlled” environment, and so on.

In conclusion: the PBQP-H Program is also a very important driving force to all the actors in the sense of the innovation of products and processes. Its major characteristic, that means the great passport for its success, is the partnership between the public and the private forces involved in housing construction (namely habitat).

**2.7. The Competitiveness Forum of the Civil Construction Industry**

**Objectives**

The Competitiveness Forum of the Civil Construction Industry is another federal project that is related to the improvement of the supply chain of the sector. As its name suggests, it is a forum, where the major actors of the sector, co-ordinated by
the Development, Industry, and External Commerce Ministry (Ministério do Desenvolvimento, Indústria e Comércio Exterior – MDIC), are put together to identify problems related to their relationships and also internal ones, in the way of solving them, to grow up the competitive capacity of the sector (MDIC (2000a), (2000b) and (2000c)).

The Forum has also other objectives, related to generation and income of employment, to regional development, to innovation promotion, and to external commerce promotion.

The Construction Industry is one of the twelve forums that have been organised, and it has been created in May 2000.

Annual Resources
In this case, we can not talk about investments, as the Forum has just been created.

Means
After a first phase, when a diagnostic has been done and the strategic plan of actions established, we can suppose that, from the moment that all the actors of the supply chain are trying to improve their competitive capacity, promoting innovation will be one of the ways of doing this.

Nevertheless, up to now, it is not clear by mean of which actions this innovations will happen, but we can suppose that organisms like the FINEP, the financial backer organism will finance them.

Contribution to innovation
There is no direct contribution up to now. The only product is a diagnostic of the sector, and a strategic plan of actions, with objectives and goals, defined in function of the identified problems.

2.8. The COBRACON / ABNT Actions: Technical norms for evaluation of innovative constructive systems for habitations

Objectives
The objective is the elaboration of norms for performance evaluation of new material, components and housing construction systems.

Addressing all the stages of the productive process - from the initial research - allowing a larger flexibility and a better adaptation to its development - going through processes and products improvement until ease acceptance and adoption of new technologies.

Annual Resources
The total cost of the project, expected to be developed in 18 months involves resources around USD 80,000.00, that would lead to an annual average of USD 53,000.00.

Means
The project is being developed by the Brazilian Association of Technical Norms (ABNT) - non-profit civil entity. ABNT is, in Brazil, the association oriented to Technical Norms elaboration in several areas whenever necessary. The association works by means of committees that are established in connection with each productive sector. In the case of construction, the committee in charge is COBRACOM - Brazilian Committee of Construction - that elaborates the norms for the sector.

For that specific work COBRACOM is receiving financial support from Federal Savings and Loans (CEF) - the Brazilian government bank that has financial lines for dwelling construction oriented to low-income population - together with other government institution, FINEP - Financial Backer of Projects and Researches. The project has already began (January of 2000) and within 18 months its intended to accomplish those norms elaboration.

**Contribution to innovation**

One of the problematic aspects for the use of new technologies is the absence of norms for approval new ones in the country. The financial agents, and even the government institutions, and NGOs feel insecure on financing constructions with innovations, due to doubts in relation to their performance. When ready, it is intended that those norms be a safe tool in which the government’s financial backers, NGOs, or private entrepreneurs could base on, bringing a positive impact in the productive chain in the sense of facilitating the adoption of technological innovations in the sector.

**Section 3 - Effectiveness of Public Interventions**

In the second part of this work we presented the current and more significant government politics oriented to the technological innovation in construction, particularly in the building constructions, that we have synthesised in Table 1, in order to show their contributions to the sector. It was in this part of the work that we tried to answer to the subjects:

*What instruments and approaches are being used by governments to promote innovation in this sector?*

*What works and under what circumstances?*

Data from that table show an annual investment from the State of USD 8.15 million, mainly being invested in human resources formation (75%), that is not meant as an investment in technological innovation.

On the other hand, in this third and last section, the conclusions of the work are presented through which we will try to answer to the last question placed by the participating countries:

*How to strengthen innovation in the construction industry?*

Before passing through the answers, it is appropriate to say that, besides the government programs, although timid, they have been providing conditions for the technological evolution of the sector, there also are the initiatives from the private sector. Many authors that have been studying the productive chain behaviour involved with the construction of buildings, among them, PICCHI (1993), CARDOSO (1993 and 1996) and Barros (1996), they have identified a series of another factors, belonging to the market, favourable to the technological development and the innovation implementation in the construction sector such as:
increasing demand from consumers that come from: country democratisation, establishment of PROCON's (public institutions for the consumer's defence, CONsumer PROtectio), and the new code of the consumer's defence, that prioritises consumers’ rights from to the market point of view;

influence of the sectors of heavy construction manufacturing industry - to face the crisis some companies from heavy construction decided to operate in the building sector carrying influences and procedures from a part of the industry that always had better organisational and technological procedures;

more demanding workpower - with the widespread democratisation of the country, and the increase of labour rights from the constitution of 1988, labour become more demanding by itself, in relation to its safety and to the construction procedures.

It is to mention the sector of construction material and components that has been presenting a growth not only qualitative, but also quantitative since the sixties, and have been modernising in a very consistent way ever since.

During the last decades it has been possible to find a great increase of the number of products on-site manufactured. The basic materials such as sand, cement, lime, for example, they are giving place to the industrialised mortar. The own mortar coatings are giving place to polymeric products, of faster application and more performance.

Even though the Brazilian construction productivity remains low (McKinsey, 1998) and if material losses in works are still significant (Agopyan et al. 1998), evolutions have happened in that sense. The movement towards quality management systems implementation in companies, moreover in construction firms is a reality.

From a general point of view, the numbers from the sector continue thoroughly favourable towards its modernisation. The housing deficit of the country remains high (5.5 million dwellings to be built and 8.5 million dwellings demanding urgent reforms). The participation of the construction industry on GDP has kept an average of 6% of the total, constituting one of the highest as a single economy section. Besides that, if it is considered all the construction macro-complex (comprising material and components), that participation jumps to almost 15% of GDP (FIESP, 1999).

More than 60% of the national gross investment is done by construction while machinery and equipment come to 25%; the residue is stock. Chaining Index sets Construction Sector ranking as fourth in the Brazilian Economy. Back chaining index is the main effect for this performance; it provides USD 27 billions; for the forward chaining this number is USD 2.8 billions. The private sector has the first place in the back chaining; that is why construction sector is called the “economy locomotive” (de Oliveira & Cardoso, 1999).

It is also remarkable the direct and indirect employment participation in numbers. In 1989 the industry has employed 3.9 million people, representing 6.9% of the labour occupied in the country and 26.3% of the employment in industrial activities, according to the data of the Brazilian of Geography Institute and Statistics (IBGE, 1989). For each direct employment in the sector, is considered the generation of 2.68 indirect employment, and therefore, involving more than ten million people.

It is important to remind, that Brazilian construction is one of the sector less dependent of importing products, that means, according to the government's effort in the search of a credit in the trade balance, an aspect thoroughly favourable to its development.
However there are factors that have been hindering the innovation process, among them the following:

- difficult to forecast the future market behaviour;
- great number of taxes and other social contributions for each registered worker, that has been motivating the workers’ precarious and informal hiring and to the growth of the subcontractors not only for increasing the productivity and quality of the work process, but as a form for defrauding the labour laws, and for cost-reduction;
- great trade rotactativity that hinders the training;
- backward vision of some sector’s managers, who do not see innovation introduction as an investment, but a cost-increase, and do not notice the technological innovation as a strategy for the profit increase;
- little capitalisation of the sector with the existence of a great number of companies with small capital, and therefore, with difficulties in making investments.

We do not have all data to estimate the level of innovation and the R&D investments in the sector. On the other hand, although the sector has many problems to resolve and the level of these investments is lower than it should be, the environment is favourable to innovation.
Table 1: Main public Brazilian intervention synopsis of technological innovation support in the field of construction in progress in July 2000, described in section two of this work.

<table>
<thead>
<tr>
<th>Innovation Stage</th>
<th>Name</th>
<th>Resources to Construction</th>
<th>Objectives</th>
<th>Means</th>
<th>Contribution to Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs to support R&amp;D</td>
<td>FAPESP</td>
<td>One and a half million of dollars per year.</td>
<td>To finance grants and other activities related to technological and scientific research, local and international exchange and information in the State of Sao Paulo.</td>
<td>The sponsoring of about one hundred and eighty projects, which two thirds are grants. The other third concerns research funds for specific projects, laboratory installation, book acquisitions, congress’ organisation, congress’ participation, welcome of foreign researchers, book and review publications, etc.</td>
<td>It is very difficult to estimate in an objective way the contributions to innovation of the FAPESP’s actions. The grants accorded in 1998 were: from the young scientists – fifty; to master of science studies - thirty; to doctoral studies - thirty-five; to post-doctoral studies – five. The FAPESP system is one of the most efficient and effective of the country, and it is very selective, with a very rigorous control. 60 other research projects (1998) for specifics projects, laboratory installation, book acquisitions, congress’ organisation, congress’ participation, welcome of foreign researchers, book and review publications, etc.</td>
</tr>
<tr>
<td>CAPES</td>
<td>One million and six hundred thousand dollars a year (estimation excluding special programs such as PADCT).</td>
<td>Highly qualified human resources formation for the mastership in superior degree, the research and the attainment of the professional demand of the public and private sectors.</td>
<td>Grant of scholarships and graduate programs infrastructural support.</td>
<td>It is very difficult to estimate in an objective way the contributions to innovation of the CAPES’s actions.</td>
<td></td>
</tr>
<tr>
<td>CNPq</td>
<td>Three million dollars a year (estimated).</td>
<td>To promote the scientific and technological development and to support researches, necessary to the social, economic and cultural progress of the country.</td>
<td>Development of three basic activities: foment (grant of scholarships; 91% of the budget), research support, and science and technology information and diffusion.</td>
<td>It is very difficult to estimate in an objective way the contributions to innovation of the CNPq actions.</td>
<td></td>
</tr>
</tbody>
</table>
| Programs to support advanced practices and experimentation | HABITARE | Eight hundred thousand dollars | To contribute, through the support researches it in the area of science and technology, for the solution of the Brazilian housing problem and for the construction modernisation, always having in mind the connection with environmental concerns. | Financial support for companies’ proposals for technological development. | - Clustering of several organisations and entities oriented the innovation in common projects.  
- Creation of diffusion/information networks about innovation in the sector.  
- Financing proposals for technological innovations.  
- Financing for new technologies evaluation. |
| Programs to support performance and quality improvement | The QUALIHAB Program | Seven hundred thousands dollars per year. | To optimise the quality of housing with regard to products and services employees in their conception and execution, from partnerships with the main actors of the sector established through agreements. |  | - Three hundred firms have already implement their Quality System, mainly general contractors.  
- A very important "up-stream" effect, effect in the building sector; the "down-stream" effect, touching the relationships between general contractors and their clients. |
| | The PBQP-H Program | Five hundred thousands dollars per year. | To give support to the Brazilian effort of modernisation of the housing construction sector, trying to increase the competitiveness of its products and services, stimulating projects that could increase quality and productivity of the sector. | Based on "agreements". | - Three states with agreements already signed.  
- Integration with countries of the south of South-America.  
- The SiQ-C System.  
- The Project "National Goal of the Housing Sector".  
- The technical co-operation Project with France. |
| | The Competitiveness Forum of the Civil Construction Industry | Nothing up to now. | The improvement of the supply chain of the sector, and also the generation of employment and incomes, the regional development, to the promotion innovation and the promotion of the external commerce. | Based on an initial and a strategic plan of actions, with objectives and goals, defined in function of the problems identified. | - The diagnostic, the plan of action, the objectives and the goals. |
| Programs to support taking up of | COBRACON / | Fifty thousand dollars | Elaboration of norms for evaluating housing new Multidisciplinary research team co-ordinated by | To make easy the adoption of new technologies as soon as guidelines are |
| systems and procedures | ABNT | materials, components and construction systems. | COBRACON with financial support of CEF and FINEP. | offered for its safe use. |
Therefore, to motivate the innovation in Brazilian construction, and thinking of the actions that may continue to be conducted for or with the support or articulation of the State, these actions would be oriented to:

- the incentive to new products and processes research and development, allotting an amount of resources in R&D to the sector in compliance with its economic and social importance;
- human resources formation in all education levels;
- the increasing State and its institutions’ induction action as buyer (purchasing power);
- incentive to technological competence development, and to local and regional producers, both with environment protection;
- incentive to better integration of productive chain with co-ordinated modernisation actions in progress;
- nation wide incentive to technological co-operation actions between research institutions and companies by means of co-operative networks as well as abroad mainly with at South portion of South America;
- companies refinement aiming at competitiveness and innovating capability increasing, including financial appeasement for R&D investments;
- better capability and valorisation for research institutions and universities, both working together with private sector;
- better laboratory capability of the country, both from public side, linked to the research institutes and universities, or from private sector;
- technical normalisation refining, with emphasis for the norms oriented to performance, still incipient in Brazil;
- incentive to the certification of traditional products and processes;
- development of new products and processes technical approval mechanisms;
- make public the tested and approved innovations, that can reach the less privileged layers of the population, that by itself build three forth of the housing production of the country, through the self-help-construction10;
- valorisation of consumers’ protection mechanisms and the increase their understandings in relation to their rights;
- the warranty of an efficient and effective judiciary functioning system.

For we have shown in the work, the Brazilian State has been promoting important actions in that sense, but there is a lot to be done. One percent of its investments in a sector that responds for, at least, 6% of GDP are very a little.

On the other hand, it is not the State by itself to promote the construction industry innovation and not even to be the main agent of the process. The roles and responsibilities have to be shared with:

10 This production is estimated around 800,000 new dwellings a year.
• the private companies (makers, manufacturers, designers, managers, dealers, etc.), by themselves have been promoting concrete and integrated action, they should improve their understanding about the meaning of innovation, of its strategic role, and of the benefits that it provides, by investing more on its development; we don’t have data, but the percentage of the sectorial gross revenue invested by them in R&D is, certainly, very low; Would we distinguish manufacturers from others? Do they reasonably invest in R&D?

• Do the financial agents and the insurance companies should more and more motivate the use of innovative solutions that accrue technical and economic benefits, with performance warranty; why not the constitution of a performative insurance system that do incentive and do value the innovations of assured performance?;

• the research institutes and the universities more and more should look for innovation as a clear and tangible goal, by integrating with the productive sector, without losing of view consumer’s interest and the society’s in general;

• the society and the consumers, that they should enforce the State, its institutions, and the companies, charging their rights and valorising innovative initiatives that bring them benefits.

Although all those difficulties exist, the Brazilian picture is quite promising, above all for the development sense that presents, more than for the absolute numbers by itself, that are still low, and a lot of far of the desirable.

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