

Housing the Poor and the Sustainability Context in Brazil: A Study of the Brazilian Building Sector Challenges for the Future

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The green wave of sustainability is getting bigger everyday and as consumers' awareness is increasing so are their demands for socio-environmental responsibility. That is the scenario the Brazilian building sector, one of the world's biggest polluters, must face in order to continue developing. The expected investment for the next 4 years in this sector is more than US\$ 165 billion in order to deal with the over \$6 million housing units deficit and the growing demand due to the 2014 World Cup and 2016 Olympic games. This paper aims to present the Brazilian building sector situation towards the sustainability context and the challenges it must face to succeed. Workforce qualification, partnerships among actors, search for continuous innovation and competition, a performance-based legal and regulation framework and constant investments are the main challenges – and tools – to overcome the obstacles towards the sustainability goal.

Keywords: Brazil, housing, sustainability.

Introduction and Methodology

The impact the adoption of performance-based procurement in public housing policy has on innovation and sustainability in the construction sector in Brazil is analyzed. This article's objective is to present the Brazilian building sector situation regarding the sustainability context. The methodology was mainly based on a prospective study (PCC 2003). This prospective study was made in 2003 based on a ten-year period and interviewed 70 specialists representing all actors participating in the construction sector and present in 4 out of 5 Brazilian regions, although most concentrated in São Paulo. Other articles, news and studies produced in Brazil and abroad were used to support the analysis of all critical success factors (CSF) and its expectations in the future. Also notable are Sao Paulo's Industry Federation's (FIESP) study for the next 12 year-period of the Brazilian Building sector and the Agenda 21 for Sustainable Construction in Developing Countries.

Sustainability and sustainable development are treated as the same in this paper and according to the definition of "*Our Common Future*" (UN Documents): "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Table 1 presents a brief timeline of the sustainability evolution internationally and nationally. Brazil was always late in implementing actions towards sustainability, but since the last decade of the 20th century it is possible to note the efforts of all

Brazilian groups – universities, private sector, government, civil society – in order to make Brazil a leading country on the path to real sustainable development.

Table 1

Timeline (Seiffert 2007, Sousa n.d.)

Time	International	Brazil
The 1960's	Questioning the current production model (Club of Rome 1968).	
The 1970's	Scientific publications that present the actual situation and the future consequences of modern industrial society pollution (report Limits of Growth of Club of Rome published in 1972); Several international meetings (organized by UN, NGOs as WWF and governments); UN creates its Environment Program (UNEP) in 1972.	Participate the Stockholm conference in 1972, but with the position that "nothing could harm economic growth"; Create Special Environment Secretariat in 1973; First social movements for environmental causes.
The 1980's	Obligation of Environmental Impact Reports (first in the USA in 1970's and during 1980's in several countries); Environment Management Models (first was Responsible Action Program of Canadian Chemical Industries Association in 1984); UN Conference on the Environment in 1983, also called Brundtland Commission, presents the first definition of sustainable development (Our Common Future in 1987).	Law 6938/81 creates the National Environmental System and National Environmental Council (1981); 1988 Brazilian Constitution has a specific chapter on Environment; Create Brazilian Institute for the Environment and Natural Resources (1989) unifying all former institutes and secretariats; Participate in UN Environment Conference in 1987 (UN Documents).
The 1990's	Montreal Protocol of 1987 (Ozone cover protection); Basilea Convention in 1992 (transportation of hazardous materials); Berlin Mandate 1995 (about green house gases emission) and Kyoto Protocol in 1997; Unced-92/Rio-92/ECO-92 where Agenda 21 and ISSO 14000 and 14001 were presented;	Decree 99274/90 to effectively implement the 1981 Environmental Law; Unced-92/Rio-92 stimulates series of actions in order to improve environmental protection; Unced-92 propose creation of Agenda 21; Create the Environmental Crimes Law in 1998; After several name and status changes, in 1999, it is determined the name Ministry of Environment to the Special Environment Secretariat.
21st century	UN Conference on Environment and Development (Rio+10) in 2002; IPCC report in 2007 with alarming information on Climate Change; COP-16 with post-Kyoto discussion and a Green Fund creation.	Society, private sector, government and universities' efforts to effectively incorporate sustainability aspects in their practices; Strengthen of environmental associations, councils and organizations; Sectional mobilization towards sustainability.

The first section presents the competitive situation of the Brazilian building sector. Using a study (PCC 2003) the construction value chain's critical success factors (CSF) are defined. Furthermore, through documented research in technical books, papers and the news the situation of each critical success factor as well as the expectations identified in the prospective study are analyzed.

At the end of this section it will be possible to identify the main challenges the Brazilian construction value chain must face, such as:

- Qualify the workforce in order to improve productivity;
- Develop managerial skills that enable companies to fully understand customers' needs and find alternatives to satisfy them;
- Define strategies that stimulate the private and public sectors to truly commit to improving quality, efficiency and productivity in order to achieve sustainability;
- Promote competition and innovation in the sector, through new contracting methods, performance-based normalization and elimination of bureaucracy.

The second section presents the impact the building sector has on the three components of sustainability: economy, society and environment. Through this presentation it will be possible to assure the strategic importance of this sector to Brazil, due to: the labor positions generated each year, the wealth generated and distributed or even the level of the usage and disposal of natural resources. At the end of this section it will be clear the strategic position of this sector to Brazil that represents 5% of national GDP and 20% of industry's value creation, consumes from 40% to 75% of all natural resources, despite water and energy, is one of the biggest employers in the country and has the expectation of billions of dollars already planned to be invested and more than 2 trillion dollars and 10 million people needed to effectively reduce the housing deficit and solve the inadequate housing problem until 2022.

The third and last section aims to unify what was built on the two previous sections and will present the main challenges this sector will face in a globalized context, competitive and pressured by society to be social-environmentally responsible. Through the main actions defined in the Agenda 21 for Developing Countries by CIB, besides the expectations identified in the prospective study and the planned investments suggested by FIESP's study, each actor's responsibility will be identified in this value chain towards this transition to a low carbon, less environmental impacts and social development economy.

An Analysis of the Sector's Competitive Situation

Before the role the building sector has on Brazilian society and what trends are expected for the coming years is discussed, an assessment of the internal environment of this value chain is presented. This assessment was part of a prospective study (PCC 2003) that identified the critical success factors of the sector and each factor situation on that moment and the expectation of its future situation on three different scenarios – the continuity scenario, the optimistic scenario and the pessimist scenario. After assessing 88 indicators of the construction value chain, 19 critical success factors were chosen “according to its importance related to the indicators, possibility of comparable analysis between the factors, consistency and complexity to quantify, assess and compare the indicators” (PCC 2003). The critical success factors (CSF) are divided in three groups (access to housing, quality of housing product and technology and management) and are related to five performance indicators category of the construction value chain: competition, efficiency, quality, equity and sustainability.

Background to Critical Success Factors

Some of the CSF presented in this group relate to macroeconomic variables (that transcend the building sector) and are already a target of public policies (created after 2003, the year the studied was published) such as financial offer that had several governmental programs.

One of these programs that will be referred to in this article is the Programa Minha Casa Minha Vida (PMCMV) whose first version – from 2007 to 2010 – had the target of building one million housing units, the vast majority concentrated in families with an income of minimum wage (95% of the housing deficit is concentrated in this group), and its second version – from 2011 to 2014 – aims the construction of two million units. Brazilian minimum wage is actually 309 dollars, with an exchange rate of US\$ 1 = R\$ 1,65. This exchange rate was used in all values in this paper.

Another important regulation mark is the law 11.888 from June 24th 2009 that determines technical assistance to poor families to build their houses must be free. The objective with this law is to give more support to self-construction in order to guarantee a minimum quality level of these kinds of projects as well as aiming to minimize the great problem of inadequate housing that affects more than 15 million units (IPEA 2007).

On institutional matters, because of political instability and economic crisis during the beginning of the “re-democratization” process (from 1985 to 1992), state intervention on popular housing production was interrupted and restarted during Fernando Henrique Cardoso’s terms (FHC, from 1995-1998 and 1999-2002) when economics and politics became more stable. FHC government had two main contributions to the housing policy: the creation of programs that finance the houses to the end-user not the building companies (changing a policy that was practiced since 1960’s with the Banco Nacional da Habitação – BNH) and the consolidation of a housing deficit definition that was made with the work of Fundação João Pinheiro that developed a methodology and quantified for the first time this deficit.

Finally, Luiz Inácio Lula da Silva’s term (Lula, from 2003 to 2006 and from 2007 to 2010) also had two important institutional contributions: the continuity of the programs created by FHC, converting the Special Secretariat of Urban Development of the Presidency of Republic (Sedu/PR) into the Ministry of Cities (MCidades), increasing the resources destined to the housing programs and resuming stopped works. The other contribution was the openness of the process of developing public housing policies to all stakeholders through the Conference of the Cities and the creation of the Council of the Cities, making this process more transparent and democratic (Triana Filho 2006). The matter of land availability and adequate infrastructure also had a sensible investment rise during Lula’s term through the Programa de Aceleração de Crescimento (PAC) that centralized all existing initiatives and created new ones to support an economic and social growth, providing universal access to electricity, sanitation service, clean water, and others. Besides that, there are city level actions responsible for the urban land legislation, in order to balance the matter of land availability to popular housing, such as the application of progressive taxes in houses considered empty

Access to Housing

Regarding access to housing, it can be observed that the major improvements were achieved during FHC and Lula terms, with the former more notably responsible for the political and economic stability and the latter notably recognized by continuing and expanding the previous projects, besides democratizing these programs and benefitting more people. However, there is still an obstacle to overcome, mainly the issue of land availability that needs more attention and action of the State, in all its levels, in order to guarantee that the land use accomplish the house social role and not just an asset capitalization option (Santana 2009).

Table 2

Critical Success Factors – Access to Housing (PCC 2003)

Critical Success Factor	Definition	Performance Indicator category*				
		Eq	Q	Ef	C	S
	Access to Housing					
Accessibility	Incapacity of the productive chain to provide access to quality houses to all people that need it, notably because of the distance between the price of the houses and the consumer's income, specially the low income population.	X				
Financing Offer	Lack of resources for public and private financing, associated to the high cost of the actual financing options – mainly due to the high interest rates – what makes the access to this financing more difficult and leads to a high default rate.	X				
Land Availability	Lack of lands and adequate urban infrastructure to housing production, leading to a disproportional land price in determined urban areas better served by infrastructure and services.	X				
Informal Production	High incidence of informal production, due to the low accessibility to the formal market and the public housing programs. Informal production leads to high cost to dwellers and results in bad house quality, besides contributing to the degradation of social and environmental conditions.	X	X			X
Self-construction Support	State and private sector's low capacity of supporting self-construction, what would be an adequate alternative.	X	X			X
Regulation and Coordination Capacity	Low political and institutional regulation and coordination capacity, especially because of the inexistence of a housing policy with targets and long-term strategies, effective investments and institutional articulation to avoid function's superposition and to improve housing management efficiency.	X		X		
Housing Deficit	Necessity of solving the Brazilian housing deficit, estimated in 6.6 million units, and related to the factors presented above.	X				

* Eq = equity; Q = quality; Ef = efficiency; C = competition; S = sustainability.

Quality of Housing

As well as in the previous group, the Quality of Housing already has actions developed to work on the problems identified in the research and to modify some of its expectations. According to the research analysis, the actual housing quality is, “satisfactory in the high pattern, medium in the medium pattern and unsatisfactory in the low pattern. The trend to the future is of improvement; the quality will go respectively to fully satisfactory/ satisfactory in the high and

medium patterns and regular in the popular pattern. The best-assessed requirement is structural safety and the worst is environmental efficiency. On the other hand, this last one is the one that seems to have higher improvement in the future” (PCC 2003).

As it happens in the other two groups, the critical factors for quality don’t work independently, that is, there is a strong interdependency among these factors. Therefore, a weakness in one factor is enough to compromise the excellence of the offered product. It is possible to identify in the institutional context a commitment on the search for quality, on the regulations made by the Associação Brasileira de Normas Técnicas (ABNT) or on the efforts of the governmental operators, like Caixa Econômica Federal (CAIXA), in supporting and demanding approval of all innovative building solutions in the Programa Brasileiro de Produtividade e Qualidade do Habitat (PBQP-H).

The PBQP-H was created in 1998, as part of the Brazilian commitment in the Conference Habitat II of 1996, with the general goal to “elevate the level of quality and productivity in the building sector, through the creation and implementation of mechanisms of technological and managerial modernization, contributing to the expansion of house offer, especially the low-income population,” according to the information of its website (PBQP 2009). Through a wide network, made by public and private agents, and constant dialogue among all stakeholders, this program aims to use purchasing power as a tool to promote continuous quality improvement of housing products offered to market. Although it has already had improvements with its more than 2,300 active participants, there is still a lot to do in order to make the assessment and approval process of innovative solutions faster and to incorporate in the programs’ directions ways to enhance the ability of participants to search, understand and fulfill the end-user’s needs (Carvalho n.d.).

The partnership between PBQP-H and CAIXA, the main operator of federal public policies, demands all building companies to be certified in the PBQP-H strengthens this strategy of using the State’s purchasing power as a stimulus to the commitment of private actors in the search for quality and continuous improvement. Besides the certification demand, CAIXA also uses the SINAT’s approval of new technologies, considered innovative, to approve the financing of housing projects by the bank.

As for ABNT’s actions and its normalization of the building sector, the expectation identified in the prospective study is “of improvement, even the continuity scenario and in the pessimist scenario it doesn’t get worse. There is a perception that formal normalization will improve, due to the sector’s modernization and to legal demands. The main obstacle is the effective application of these norms” (PCC 2003).

A great step towards this normalization improvement was the edition of NBR 15757 (edited in 2008 and planned to be effective in November 2010), the first Brazilian norm that determines a minimum performance of buildings not specification of its components, although it makes reference to several previous norms that determines specifications. This norm raised discussions about its applicability all over the building sector, its impact on the market and the difficulty building companies are facing to accomplish this norm – that will be mandatory, including in the PMCMV operated by CAIXA – reflecting another fundamental point of improvement towards

product quality: the workforce qualifications from the project design until the end of construction and delivery to the end-users. This norm, made for buildings of 5 floors or less, clearly focused on the end-users' expectations, is an important milestone in the difference between prescriptive norms – base of all Brazilian norms – and performance norms. Even after ten years of discussion, including debates before and after its publications in 2008, there is an expectation that its liability will be postponed because the sector is still not sure about its capability to comply with the norm.

These discussions around NBR 15575 show the opportunity to strengthen all existing actions towards quality improvement and the search for building material compliance to quality standards that is the case of PBPQ-H. It also shows the importance of the project phase of buildings, including the project of building useful lifetime, the performance needed to fulfill end-user's expectations and, therefore, the procurement method used to select the builder of a building.

Focus on the end-user is essential to achieve quality and its lack is notable in the popular building projects, reflecting the production model established after the Military Coup of 1964, that Bonduki (2000) defines as central-developing, characterized for: “1. authoritarianism; 2. management centralization; 3. lack of users and society participation in any level; 4. disrespect to the environment and to cultural heritage with modernity myth predominance in a logic of urban transformation without commitment to the environment and cultural values; 5. disarticulation of sectional policies; 6. prioritization of individual transportation; 7. preference for great buildings, sometimes unnecessary, directing public investments to building companies to the detriment of social investments and; 8. prioritization, in the housing financing, of high income classes”.

According to Bonduki, (2000) the central-developing model lasted until 1993, when “dozens of bad quality and bad location houses were financed and built by suspect companies and people who could afford them didn't want to live there and those who would accept living there couldn't afford it. In the end, lots of these units were left unfinished or empty.”

Corroborating Bonduki's definition, Leite et al. (2006) studying building of the Programa de Arrendamento Residencial (PAR) operated by CAIXA stated that:

“Following the development of the studied building, it is possible to say that the client that most influences the requirements of the building project is CAIXA. These requirements, on the PAR's buildings so far, don't come from a systematic process starting in the end-user, but from guidelines of the program developed by the Ministry of Cities and by technical specifications made by CAIXA's technicians. Identify the requirements of the end-user is essential to minimize conflicts and enhance the product value to this end-clients, once they might become the future owners of the building. According to Whelton and Ballard (2002), to generate more value to end-user and investor it is necessary that the responsible for conception and projecting the building learn about the building requirements in a critic and collective manner. This way, in order to create more value to (actual and prospective) end-users of PAR must participate in the design of the building. One first step on this end-users' requirement management is to collect their opinion during the PDP [Product Development Plan].”

Medvedovski et al. (2006) also studying PAR, found results that show there are problems in maintenance of the buildings, in building management – especially in the relation between the building managing company and the dwellers – and in the houses’ characteristics that are changed by its own users because they don’t satisfy all their needs. This need of intervention not only might harm the building structure, safety and integrity but also shows a clear deficiency in fulfilling the user’s needs and expectations (Table 3).

Table 3

Critical Success Factors – Quality of Housing (PCC 2003)

Critical Success Factor	Definition	Performance Indicator category*				
		Eq	Q	Ef	C	S
Quality of Housing						
Quality of Housing Project	The intermediate and final housing products still have serious quality problems, represented by the low performance in certain requirements and by the high rate of pathologies observed in the houses.		X			
Technical Normalization	Need to expand, adequate and refresh all the ABNT technical norms applied to the construction sector. It is also needed that the normalization be focused on performance and not on prescription, as it is still common, in order to stimulate technical improvement.		X			
Organizational and Institutional Support to Quality	Need to expand the actual actions dedicated to improve the quality of the value chain and its products, such as: use of State and private sector purchase power to fight non-compliance, certification schemes, expansion of laboratorial and technological support net, disseminate quality programs, as Brazilian Program of Productivity and Quality in the Habitat (PBQP-H).		X			
Knowing Customers’ Needs	Need to define what a quality house is and need to know deeper, through market research, the real needs of end-users, such as type of products, prices, financing options...		X		X	
Material and Components Compliance	Need to adequate materials and components to the existing technical norms.		X			

* Eq = equity; Q = quality; Ef = efficiency; C = competition; S = sustainability.

After explaining the central-developing model, Bonduki (2000) presents a proposal – still developing in practice – of a model he calls environmental-participative and whose characteristics are: “1. decentralized and democratic management, emphasizing the role of local power and in the sectional articulation; 2. creation of institutional channels for popular participation, as urban management councils, housing forums and the citizens participation on the definition of governmental priorities, with participative budget and following of budget execution; 3. inversion of priorities in order to guarantee access to housing and the city; 4. partnership between governments and NGOs to develop programs and projects, through the support of self-management or co-management in habitat production and wealth and job creation; 5. search of ways to lower the cost of housing production, through new ways of management, production and funding direct to the end-user and the recognition of the real city, through land regularization and urbanization of spontaneously occupied areas; 6. find a balance between environmental protection and urban projects implementation, housing production and recover of preserving areas already occupied; 7. reuse of urban disposals, by recycling, aiming

environmental preservation and it's reuse in public programs and; 8. prioritize collective transportation and traffic safety”.

This model, more compatible with the idea of sustainable development than the previous one, is still not a reality all over the country and it's not only an organization's responsibility to implement it. It is, as it can be observed in the model's characteristics, a city plan and not just a housing plan, being the participation and integration of several fundamental actors. This current moment can be called a fundamental moment of transition from the first model, focused on prescriptions to be followed, by the second model, focused on value creation according of the performance of what was bought, that is, focused on the end-user satisfaction.

Technology and Management

Regarding the Technology and Management group, the majority of the factors refer to internal issues of the sector, that is, issues the companies have more power of action and where there are greater challenges. The expectations raised by the research show, in all scenarios, a wait for improvements, however, in some items such as productivity, as stressed in the research, “even in the optimistic scenario, the average Brazilian productivity still isn't 50% of the American average productivity” (PCC 2003).

Table 4

Technology and management (PCC 2003)

Critical Success Factor	Definition	Performance Indicator*				
		Eq	Q	Ef	C	S
Technology and Management						
Project	Need to improve the housing project, that means incorporate the following practice on the companies' project-design routine: modular coordination and compatibility among all subsystems; standardization of dimensions and constructive details; use more pre-manufactured components and systems; integrate the product to the production project (project to produce), coordinate all steps of production focusing on the end-user needs; use computing technology that improves productivity and avoid waste and error.		X	X	X	
Management	Need to improve the whole management of building production, disseminating across companies to proactively coordinate, plan, do and check in order to optimize the use of resources and assure quality in processes and products.		X	X	X	

Barriers to Technological Development	Need to implement actions to combat the barriers to technological development and productivity improvement, such as: expand access to equipment, diversify suppliers of materials (actually very concentrated); lower taxes on pre-manufactured products; contracting models that stimulate productivity; review the labor legislation aiming to reduce informality and improve its qualifications; modernize the local building codes that are old and prescriptive instead of performance-based, in order to stimulate innovation.			X	X	
Productivity	Need to enhance productivity related to project management and technological development discussed above.			X	X	
Waste and losses	Need to reduce waste and losses that are mainly related to management and technological development.			X		X
Cost of construction	Need to reduce cost of construction that depends on the supply market behavior, as discussed above, and to the workforce costs that depend on the evolution of real wages and productivity.			X	X	
Research	Need to expand technological research as fundamental support to technological improvement and to enhance productivity that needs more public and private resources to research, besides a stronger integration among private sector, universities and research centers.		X	X		X

* Eq = equity; Q = quality; Ef = efficiency; C = competition; S = sustainability.

The improvement of management process, from project to production and delivery of buildings, must take in consideration the needs of end-users, their participation must be sought in order to avoid delay in delivery due to changes in projects and higher costs due to these changes or even because the buildings, once they do not satisfy users' needs, must be frequently modified (Guerra et al. 2009).

Again, we'll make reference to the norm NBR 15575 – that didn't exist by the time of the prospective study base of this article because it also impacts on this group of factors. Once focusing on minimum performance and no longer on specifications to be followed, it will demand a managerial focus change and the way companies deal with the project phase, and all involved with it, inside the whole construction process. The huge public investments in popular housing heated the construction market and along with the NBR 15575 made for building of 5 floors or less (that is practically all popular building projects) and CAIXA's demands for companies to participate the PBPQ-H, among others, will be a strong stimulus for improvement in the quality of management and projects in this sector.

Productivity improvement is related to workforce qualification, what has already been identified as a strong obstacle to the development of the productive chain, with the focus on performance and not on prescriptions, the demand for architects, engineers and specialists in all items of NBR 15575, such as lighting and acoustic comfort (one polemic item of the norm) will increase.

Partnerships between universities and companies, that according to the prospective study depend more on political will than economic issues, is an important point to be sought for both universities and companies, once this is a good win-win relation during this managerial focus transition period.

Sustainability, although not explicitly pointed out in the study's answers, appears as an important issue for the future expected by the respondents on project improvements due to the integration of systems and subsystems to avoid waste, on the improvement of workforce qualification to enhance productivity, or on the trend of growth in "components made to save water and energy, systems of remote consume measurement, systems of intelligent components, systems of solar energy generation, materials aimed to sustainable constructions and material DIY (do it yourself)" (PCC 2003).

The prospective study of the building sector and the combat of barriers to technological development aims to stimulate innovation, that is, the continuous development of new process, projects and solutions that satisfy user's needs in a more economic and better way than the actual options. Innovation development, through a procurement system that supports competition in the sector (fighting the existing oligopolies), through contracting alternatives that stimulate productivity and performance – as stressed in the research – and through the combat of workforce made by stronger control or by economic tools to stimulate workforce formalization. This will all enhance competition in the Brazilian construction sector. From the analysis of this prospective study data, actions must be proposed, discussed and implemented in order to enable the whole construction productive chain to compete in a new context that quickly appears, globalized and pressured by socio-environmental responsibility.

The Building Sector's Eco-Socio-Environmental Role in Brazil

The building sector is one of the world's biggest employers and at the same time one that causes greatest impacts on the environment. This situation puts this sector in a strategic position anywhere in the planet, because to provide society the infrastructure to its development it is necessary to build roads and ports to plants and housing buildings. Throughout this large value chain of production, millions of people are employed and billions of reais (or dollars) are invested. An example is the Programa Minha Casa Minha Vida (PMCMV) that has more than 18 billion dollars of investments to build one million houses. The challenge of the sector continues, because for the 2011-2014 period, the second Programa de Aceleração do Crescimento investments in the building sector exceed 168 billion dollars, besides the investments in other construction areas – such as the transport and energy infrastructure. Only the second version of PMCMV, with the goal of building two million houses, is valued at more than 43 billion dollars.

It is evident that the construction sector has for at least four years guaranteed investments that will keep the sector employed, producing and, consequently, polluting. The Brazilian Council for Sustainable Construction estimates that from 40% to 75% of all natural resources extracted in the planet, despite water and energy consumption, are used in the building sector (CBCS 2009). Besides all this environmental weight, another prominent role this sector has is socially. In terms of employment generation, the building sector is one of Brazilian biggest employers with more than two million formal employments registered until November 2010 (MTE 2010) and with a

growing trend in job posts generations (Table 5). It is worth of note the great jump in job generation of this sector, both in relative or absolute terms, after PAC was launched (including PMCMV), heating the sector and reinforcing the weight of public housing programs. Despite the great growth of formal jobs in this sector, informality is still a serious problem, achieving in certain areas 50% of all sector's workforce. Its impact transcends the matter of product/service quality or cost reduction, for instance, getting in areas such as social justice and development, because in the absence of a correct labor regulation there will be no stimulus to respect basic rights and workers' safety, increasing accident rates and labor diseases, for instance (Reporter Brazil 2010).

Table 5

Amount of formal employment generated (Caged – MTE year)

Period	Construction Sector (CS)	All sectors	% CS
Jan a Dec/04	50.763	1.523.276	3%
Jan a Dec/05	85.053	1.253.981	7%
Jan a Dec/06	85.796	1.228.686	7%
Jan a Dec/07	176.755	1.617.392	11%
Jan a Dec/08	197.868	1.452.204	14%
Jan a Dec/09	177.185	995.110	18%
Jan a Apr/10	166.112	962.327	17%

Not only the amount of job generated has increased, wages and quality of life in the sector also have improved, as shown in a research by the Brazilian Council of Construction Industry (CBIC) (Tendenciasmercado 2010). This schooling rise took to an initial wage raise, from US\$ 395,00 in 2003 to US\$ 535,00 in 2010, a 35% real growth, higher than the respective period inflation. This wage raise generates a clear economic impact, raising workers' available income; one can consume more and promote the expected economic growth. Just as an example, in 2008 according to the Brazilian Institute of Geography and Statistics (IBGE) data, more than 23 billion dollars were spent with payroll in the building sector, with more than 15 billion dollars (65%) destined to the wages of workers.

Table 6

Workers' schooling evolution (CBIC, 2010)

Schooling	2002	2010
1 year study or less	8%	5%
8 years of study or less	37%	20%
11 years of study or less	36%	48%
More than 11 years	19%	27%

The economic importance of the building sector is not limited to the number of jobs generated or the wealth distributed, the investments and production of this sector represents approximately

5% of Brazil's GDP and according to the Industry Federation of São Paulo (FIESP) projections, the investments and production needed until 2022 represent almost 6% of Brazilian GDP.

This investment estimation of over 2 trillion dollars until 2022 is higher than the effective investment. In 2009 the investment was 79 billion dollars, but still below the needed investment according to FIESP in order to solve the problem of inadequate housing and to lower the housing deficit to 1.5% - but there are already discussions in order to plan and coordinate the expansion of investments in this sector.

All these points reinforce the strategic role of the Brazilian construction chain in all its aspects: environmental, social and economical, being fundamental. Having in mind the increasing investments in the sector, an organized mobilization towards the triple victory of economic viability, environmental prudence and social justice, as proposed by Sachs (2002), in all policies involving this value chain.

Table 7

Need for new houses 2010-2022 (FIESP 2010)

Year	To meet the needs of the new families	To eliminate the deficit	To reduce cohabitation	Total
2010	1.281.560	120.000	120.000	1.521.560
2011	1.307.920	220.000	170.000	1.697.920
2012	1.334.822	220.000	170.000	1.724.822
2013	1.362.277	220.000	170.000	1.752.277
2014	1.390.298	220.000	170.000	1.780.298
2015	1.290.754	280.000	200.000	1.770.754
2016	1.314.905	280.000	200.000	1.794.905
2017	1.339.509	280.000	200.000	1.819.509
2018	1.364.572	280.000	200.000	1.844.572
2019	1.275.726	376.821	260.000	1.912.547
2020	1.297.632	376.821	260.000	1.934.453
2021	1.319.914	376.821	260.000	1.956.735
2022	1.342.579	376.821	260.000	1.979.400
Total	17.222.469	3.627.284	2.640.000	23.489.753

Table 8

Housing Investment, US\$ billion, 2010 to 2022 (FIESP 2010)

Year	Investment on new homes	Investment on rebuilding	Total housing investment	Housing investment (% of GDP)
2010	91,27	23,31	114,58	5,70%
2011	96,91	24,68	121,59	5,80%
2012	102,90	26,13	129,03	5,90%
2013	109,26	27,67	136,93	5,90%
2014	116,02	29,32	145,33	6,00%
2015	114,47	31,05	145,52	5,70%
2016	121,33	32,77	154,10	5,80%
2017	128,61	34,59	163,20	5,80%
2018	136,32	36,52	172,84	5,90%
2019	135,21	38,56	173,78	5,60%
2020	143,12	40,59	183,70	5,60%
2021	151,47	42,74	194,21	5,70%
2022	160,32	45,01	205,33	5,70%
Média	123,63	33,30	156,93	5,80%

Future Challenges for the Building Sector in the Sustainability Context

The effects of human action over nature and its balance are being felt worldwide. Therefore, it is essential that a sustainable development model that can balance the social demands with environmental prudence and economic viability, is developed in which must not prefer one requirement to the detriment of others. The building sector has a large impact on the development of any nation, from maintenance of buildings, roads, power-plants, to building new buildings that enable an improvement in quality of life such as schools, hospitals and houses. This same sector is one of the world's biggest polluters, consuming a huge amount of resources and disposing an equally huge amount of leftovers from construction and demolition, impacting the environmental quality in air, land and water pollution, for instance.

The pressure for sustainable behavior is gaining momentum, perhaps due to more clarified citizens/consumers demands or due to the more frequent natural catastrophes that shock – and affect – all mankind (Jacobi 1999, Manzini & Vezzoli 2002). In this scenario, one of the planet's biggest polluter is not immune to this pressure, therefore, it is fundamental that all actors in the construction chain search and/or develop knowledge that enables them to deliver solutions that fulfill the identified consumer's needs while respecting the environment.

Since the first meetings about environmental issues in the 1980's, several tools have been developed to guide states, companies and civil society in the path towards sustainable development. One of these tools is Agenda 21 that can be defined as “a planning tool to build sustainable societies, in different geographic basis, that conciliates environmental protection,

social justice and economic efficiency” and can be split up from the global agenda into smaller agendas for regional, city levels or even for economic sectors (MMA 2010).

On this work of constructing sustainable sector, John et al. (2001) present the history of Agenda 21 for Sustainable Construction, dedicated to the developed countries and made by the International Council for Research and Innovation in Building and Construction (CIB). The need for creating an Agenda 21 for the sustainable construction in developing countries is also discussed due to the great context differences between these two groups of nations. The discussions were presented in 2002 by CIB and deal, as discussed by John et al. (2001), with the specificities of the developing world, such as the search for sustainable houses made accessible to millions of people who don't have the purchasing power to buy their houses on their own, and the challenge to promote sustainable construction in areas where the basic infrastructure is bad – from the components/materials production according to some specification to bad roads and problems with energy and water supply (CIB 2002). The Agenda proposed by CIB outlines, with actions organized in 6 groups, the main challenges the building sector's agents in developing countries will face in the context of sustainability (Table 9).

Table 9

A strategy for action (CIB 2002)

	Actions for the research and education sector	Actions for the private sector and utility companies as service providers	Actions for clients	Actions for government and regulatory stakeholders
Capacity Building	<ul style="list-style-type: none"> •Build internal capacity. •Expand learning offerings. 	<ul style="list-style-type: none"> •Enable continued organizational learning. •Support the development of external capacity. 	<ul style="list-style-type: none"> •Develop own understanding of sustainability and the benefits of more sustainable choices. 	<ul style="list-style-type: none"> •Create an advisory stakeholder council. •Raise awareness of sustainable construction among government officials and politicians. •Introduce continued professional education.
Access to funding	<ul style="list-style-type: none"> •Identify and access appropriate funding streams. •Be creative in using existing funding streams. •Actively lobby for funding for sustainable construction. 	<ul style="list-style-type: none"> •Provide funding for R&D for own benefit. •Through corporate social responsibility (CSR) budget contribute to funding for research for the common good. 	<ul style="list-style-type: none"> •Use the savings, reduced risks and added value resulting from sustainable construction to leverage the additional capital costs required for its implementation. 	<ul style="list-style-type: none"> •Reconsider scope of own funding programs. •Negotiate better terms and access to funding with overseas development agencies (ODAs). •Provide funding to support emerging businesses and innovative technologies. •Provide funding for training and education.

Partnerships and cooperation	<ul style="list-style-type: none"> •Establish cross-sectorial exchange programs. •Establish an effective South-South network of researchers & educators. •Clarify issues of knowledge sharing. •Pursue research and educational partnerships with other sectors. 	<ul style="list-style-type: none"> •Cooperate on the implementation of the R&D agenda. •Partner with research organizations. •Form industry coalitions to fund pre-competitive research and development of enabling mechanisms. 	<ul style="list-style-type: none"> •Form partnerships for learning with research and education institutions. •Form consumer lobbying groups to demand more sustainable services and products. 	<ul style="list-style-type: none"> •Include the informal sector. •Bring traditional governance systems on board. •Partnerships between local government and research and education institutions.
Internal housekeeping	<ul style="list-style-type: none"> •Revise existing curricula. •Practice what is being preached. 	<ul style="list-style-type: none"> •Assess risk of non-compliance and benefits of compliance. •Devise strategic plans for different industry sectors. •Change organizational values. •Improve resource efficiency and reduce impact. 	<ul style="list-style-type: none"> •Rethink own internal procurement systems. 	<ul style="list-style-type: none"> •Lead by example. •Adopt a regulatory framework for sustainable construction. •Comply with international agreements & frameworks. •Change professional fee systems.
Encouraging and supporting implementation	<ul style="list-style-type: none"> •Technology transfer. •Raising awareness. •Advocacy. 	<ul style="list-style-type: none"> •Assist with the incubation and mentoring of emerging market niches. •Use new technologies and processes. •Create a demand. 	<ul style="list-style-type: none"> •Use government influence to drive the market. 	<ul style="list-style-type: none"> •Change standards and regulations to support sustainable construction. •Provide effective incentives and disincentives, e.g. tax breaks. •Enforce regulations.
Monitoring and Evaluation	<ul style="list-style-type: none"> •Provide independent monitoring to private sector and government. •Introduce mechanisms for own monitoring and evaluation. 	<ul style="list-style-type: none"> •Adopt corporate social responsibility (CSR) reporting systems. •Participate in certification schemes. •Capture information for monitoring and assessment. 	<ul style="list-style-type: none"> •Participate in monitoring and evaluation schemes. •Monitor cost benefits achieved. 	<ul style="list-style-type: none"> •Set up legal structures for monitoring and evaluation. •Participate in monitoring and evaluation schemes.

Several actions proposed in the Agenda 21 are similar to the actions presented as challenges in the prospective study for the future of Brazilian building sector, corroborating the analysis made in this paper. On the global context of sustainability, the Brazilian building sector must make the ongoing transition from a quantitative model of reproducing standardized home buildings to a qualitative performance-based model that delivers the needed amount of housing respecting the environment, society and being economically feasible. All participating actors must assume their responsibility on this transition. The research and education sector must, through the construction of a wide network among developing nations, seal partnerships with public agents, private agents and the civil society in order to disseminate knowledge, finance research of new knowledge, and provide independent service of monitoring and evaluation that guide the other agents towards sustainable construction.

The private sector and utility companies must rethink their values and goals and search for solutions that enable the achievement of these goals inside the new context of sustainability. Through the cooperation with all the other agents of the sector (competitors, governments, research and education institutions and clients), they must develop, adopt, assess and continually improve products and processes, and use this cooperation to promote innovation, an important tool for sustainable construction.

The clients must, as important link for the market existence, use their power – alone or together with other clients – to stimulate the other agents, especially governments and the private sector, to commit to the development and offering of sustainable housing solutions. It is fundamental, therefore, that consumers look for knowledge and information on the sustainability matter, regarding concepts and applicability in construction and their lifestyle.

Lastly, the government and regulatory stakeholders must be responsible for the legal and institutional structure needed to effectively achieve sustainable construction. Through norms edition, professional regulation, laws and specific institutions and policies to incentive (or disincentive) expected behavior to promote this transformation, as well as transform itself, reviewing internal rules and procedures, giving more transparency and power to citizens control their acts.

Conclusion

With the high amount of investments planned in the sector, and with its ambitious goals – like PMCMV's goal of two million houses – it is of great importance to discuss the capacity of this sector to grow without destroying, that is, to effectively build sustainable homes. The matter of use of resources during its production, use, and the durability of the building must incorporate the future expectations of the dwellers' profile.

An Ernst & Young (2008) study showed that from 2007 to 2030 the economic situation of families will change substantially. It is expected that until 2017, 57% of all new families (needing new homes) will be on the base of the social pyramid while after 2017, 78% of all (19.9 million) families will be part of the middle class. This means they will have different expectations for their homes which should be taken into consideration in thinking about sustainability and flexible homes that could be rebuilt rather than completely replaced.

FIESP's study (2010) summarizes the challenges discussed into five categories:

“Workforce: The demand for workers in construction will grow at a rate of 3.1% per year between 2009 and 2022, which means increasing the number of persons employed in the sector of 6.9 million in 2009 to 10.2 million in 2022. Will be 3.3 million new jobs. Attract and qualify the number of young people is a huge challenge, since the growth of the economically active population projected for the period is only 1.8% per year and that during these years will see a gradual reduction in unemployment.

Productivity: Even considering the success in attracting young professionals to build the 6.1% growth of GDP of the sector must be accompanied by an increase in productivity of the workforce 3% years. This increase in labor productivity will come from the qualification of the workforce, the formalization of the activities in the sector, the increased scale of housing projects and the adoption of new construction methods that allow a greater degree of industrialization in the chain.

Capital: The need for credit for housing finance is expected to grow 9.4% annually, from US\$ 42 billion in 2009 to US\$ 136 billion in 2022. Traditional sources of financing the sector (FGTS and savings), despite having a promising growth path, will be insufficient to meet the required credit. Thus, as in the case of labor, the construction sector demand for funds will compete with demand from other sectors, all benefit from economic growth in the country, seeking new funding sources.

Materials: The growth of housing investment in infrastructure and will bring a significant increase in demand for construction materials. This demand can be met largely by local industry or can be filled by imports. The proportion in which it occurs is a mystery today as some basic economic conditions, as the price of energy (electricity and natural gas) and the exchange rate are quite unfavorable for the domestic producer. It is worth mentioning that in a short time, from 2006 to 2010, the materials industry jumped from a surplus of US\$ 1.8 billion to a deficit of US\$ 1.2 billion. Give competitiveness to the domestic industry will be a need to prevent the growth of the sector might be found very high trade deficits and deindustrialization of the chain.

Land: The housing needs of the country involving the construction of almost 24 million new homes between 2009 and 2022. Whereas homes with 60 m² of private area on average, its volume of building entails the construction of 2.1 billion m² and the occupation of more than 900 million m² of land. Meeting these needs housing requires institutional improvements that prevent excessive pressure on the cost of land, which is a factor inhibiting investment.”

Sustainability, as shown before, is also a great concern of this sector, but it can only be achieved with a common effort of all participating actors of this value chain, universities, government, private companies and civil society must get together in order to implement the urban policies in a way that balances all three dimensions of sustainability: economic efficiency, social justice and environmental prudence. Another great challenge that impacts not only the building sector but also the whole country is the inefficient bureaucracy, as stated in FIESP's (2010) study:

“The institutional improvement of a country is a key part of sustainable development. One of the chronic problems being solved in Brazil is that of bureaucratic inefficiency. FGV study this publication in 2009 of Construbusiness estimated the social cost of bureaucratic delays in Brazil was equivalent to R\$ 135 billion in 2007. In housing, this enhancement factor is length - if not non-viability - project. Combating bureaucratic inefficiency must be given priority by governments. For the formation of a positive agenda for housing projects, the study outlined a number of points of improvement:

- Streamlining the review process at the municipal level, with intensive application of information technology in order to obtain quickness and transparency.
- Integration of the bureaucratic procedures of the three spheres of government in a single process to be consolidated in the district, which would eliminate duplication and facilitate procedures.
- Forming evaluation committees of bureaucratic procedures, with government and private enterprise.
- Creating of a single register of the property, which would reduce the number of operations to obtain the certificates.
- Equipping with adequate supervision, to enable a fast and transparent operation.
- Improving the legal environment as a whole, with the streamlining of procedures, intensive application of information technology to reduce costs for businesses and society as a whole.

We must move quickly on these things, because Brazil cannot waste opportunities for investment and more expensive goods of direct interest of its people.”

Recommendations and Future Research

Workforce qualification, partnership among actors, search for continuous innovation and competition, a performance-based legal and regulation framework and constant investments are the main tools to overcome the obstacles to achieve the sustainability goal. These challenges towards sustainability are large and the work to be done is difficult. However, with the right planning and an effective coordination of policies and strategies of all actors, it will be possible to become the most important sector in the transition to a sustainable construction business model.

The contracting paradigm and the actual the delivery system of the Brazilian building sector is another important issue to discuss, although it wasn't object of this article, there is a great opportunity of performance based procurement implementation, according to the current construction industry structure (Chong et al. 2007, Kashiwagi et al. 2009, 2010) in order to solve several problems identified in this paper and promote a continuous development of quality, performance and innovation in this sector.

Although this study is focused on popular housing that is financed by governmental policies and is, nowadays, the most attractive niche in the building sector, the discussion about sustainability transcends this niche. Sustainability has been a market strategy to differentiation and that is, by definition, not sustainable. The responsible use of resources and universal access to the housing product are fundamental to build a truly sustainable society where everyone has a decent place to live and support to develop their capabilities to contribute to the improvement of society. By exposing the main challenges of the Brazilian building sector in the sustainability context, future research in this area was uncovered as: the level of development of each agent identified in the Agenda 21 – how committed to this strategies are they and the impact the transition to a performance-based approach has on the market competition and performance.

References

- Bonduki, N. G. (2000). *Habitar São Paulo: reflexões sobre a gestão urbana*. São Paulo: Estação Liberdade.
- CBCS (2009). *Materiais, Componentes e a Construção Civil*. URL http://www.cbcs.org.br/userfiles/comitestematicos/materiais/CT_materiais.pdf.
- CIB, International Council for Research and Innovation in Building and Construction (2002). *Agenda 21 for Sustainable Construction in Developing Countries: a discussion document*. Pretoria: CIB & UNEP-IETC, URL <http://cibworld.xs4all.nl/dl/publications/Agenda21Book.pdf>.
- Carvalho, M. S. de (n.d.). *PBQP-H: Ferramenta de melhoria da qualidade das obras públicas?* Pernambuco, URL http://www.ibraop.org.br/site/media/sinaop/11_sinaop/PBQP-H.pdf.
- Chong, N., Sullivan, K., Sullivan, M., Kashiwagi, D. (2007). *The Cultural Revolution*. 4th Annual Acquisition Research Symposium, Monterey: California.
- Ernst & Young (2008), *Brasil Sustentável: potencialidades do mercado habitacional*. S/I, disponível em URL [http://www.ey.com/Publication/vwLUAssets/Brasil_Sustentavel_-_Mercado_Habitacional/\\$FILE/Brasil_Sustentavel_-_Mercado_Habitacional.pdf](http://www.ey.com/Publication/vwLUAssets/Brasil_Sustentavel_-_Mercado_Habitacional/$FILE/Brasil_Sustentavel_-_Mercado_Habitacional.pdf).
- FIESP, Federação das Indústrias de São Paulo. *ConstruBusiness 2010 – 9th Brazilian Construction Congress*. São Paulo: FIESP, URL <http://www.fiesp.com.br/construbusiness/pdf/apresentacoes/ConstBusiness2010English.pdf>
- Guerra, G. M., Kern, A. P., Gonzalez, M. A. S. (2009). *Empreendimentos de Habitação de Interesse Social: o desafio na relação área/custo*. Rio Grande: Dunas/Teoria e Prática na Engenharia Civil, 14, 51-58, URL http://www.editoradunas.com.br/revistatpec/Art6_N14.pdf.
- IPEA (2007). *Pesquisa Nacional por Amostra de Domicílios – PNAD*. URL <http://fisenge.org.br/wp-content/uploads/2010/02/jornal-julho-2.pdf>
- Jacobi, P. (1999). *Poder Local, Políticas Sociais e Sustentabilidade*. URL <http://www.scielo.br/pdf/sausoc/v8n1/04.pdf>.
- John, V. M., Silva, V. G. da, Agopyan, V. (2001). *Agenda 21: Uma proposta de discussão para o construbusiness brasileiro*. Canela: ANTAC, URL http://pcc5100.pcc.usp.br/01_Construcao&Desenvolvimento_sustentavel/Agenda%2021%20CCivil%20-%20evento%20ANTAC.pdf.
- Kashiwagi, D., Kashiwagi, J., Savicky, J. (2009). *Industry Structure: Misunderstood by Industry and Researchers*. PBSRG, Performance Based Studies Research Group, URL <http://www.pbsrg.com/downloads/>.

Kashiwagi, D., Kashiwagi, J., Sullivan, K. (2010). The Replacement of Client Decision Making with a Deductive Logic Structure. Proceedings of the 2010 Industrial Engineering Research Conference, Cebu, Filipinas.

Leite, F. L., Schramm, F. K., Formoso, C. T. (2006). “Gestão de empreendimentos habitacionais de interesse social: foco na gestão de requisitos do cliente e no projeto do sistema de produção”. In: SATTLER, Miguel Aloysio, PEREIRA, Fernando Oscar Ruttkey (editores). Construção e Meio Ambiente. Porto Alegre: ANTAC, Coleção Habitare, 7, 208-239, URL http://www.habitare.org.br/ArquivosConteudo/ct_7_cap7.pdf.

Manzini, E., Vezzoli, C. (2002). O Desenvolvimento de Produtos Sustentáveis: os requisitos ambientais dos produtos industriais. São Paulo: Edusp (Trad. Astrid de Carvalho).

Medvedovski, N. S., Chiarelli, L. M. A., Tillmann, P., Quandt, M. M. (2005). Gestão habitacional para uma arquitetura sustentável. Porto Alegre: ANTAC, 5 (3), 49-61.

MMA (2010). Institutional Information. Available at <http://www.mma.gov.br/responsabilidade-socioambiental/agenda-21>.

MTE, Ministério do Trabalho e Emprego (2010). Estatísticas do Cadastro Geral de Empregados e Desempregados – Caged. Brasília, URL <http://estatistica.caged.gov.br/consulta.aspx?mesCPT=11&anoCPT=2010>.

PAC, Comitê Gestor do Programa de Aceleração do Crescimento (2010). 1º Balanço – 4 anos. Brasília, URL <http://www.brasil.gov.br/pac/relatorios/nacionais>.

PBPQ (2009). Institutional Information. URL http://www4.cidades.gov.br/pbqp-h/pbqp_objetivos.php.

PCC, Departamento de Engenharia da Construção Civil da Escola Politécnica da Universidade de São Paulo (2003). O Futuro da Construção Civil no Brasil: resultados de um estudo de prospecção tecnológica da cadeia produtiva da construção habitacional. São Paulo: Poli/USP, URL <http://prospectiva.pcc.usp.br/arquivos/O%20futuro%20da%20constru%C3%A7%C3%A3o%20civil%20no%20brasil.pdf>.

Reporter Brazil (2010). News, URL <http://www.reporterbrasil.org.br/exibe.php?id=1794>.

Sachs, I. (2002). Caminhos para o desenvolvimento sustentável. Rio de Janeiro: Garamond.

Santana, R. N. N. (2009). Forma Mercadoria assumida pela terra e submissão da propriedade à função social: uma contradição nas cidades do Brasil. Rio de Janeiro: ESS/UFRJ, URL <http://www.ess.ufrj.br/ejornal/index.php/praiavermalha/article/download/43/28>.

Seiffert, M. E. B. (2007). Gestão ambiental: instrumentos, esferas de ação e educação ambiental. São Paul: Atlas.

Sousa, A. C. A. (n.d.). A Evolução da Política Ambiental no Brasil do Século XX. s/l, URL http://www.achegas.net/numero/vinteeseis/ana_sousa_26.htm.

Tendenciasmercado (2010). News, URL <http://www.tendenciasmercado.com.br/negocios/construcao-civil-setor-com-mais-emprego-e-melhores-salarios/>

Triana Filho, A. (2006). Habitação Popular no Brasil: análise do modelo operacional de financiamento pelas agências oficiais. Brasília: UnB.

UN Documents URL <http://www.un-documents.net/ocf-02.htm#I>.