Collaborative actions, technology and smart design.

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ABSTRACT: The future of civil construction industry in Brazil is directly connected to the adoption of a new industrial logistic and the enhancement of collaborative actions allied to sustainability. We know that this innovation has a direct relation with the economic, historical, business and cultural moment of the country. In being so, innovation will happen when these variables are capable to produce competitive advantage and increased productivity. We live in a moment of impasse, when there is no longer place to improvisation or "rework". The low quality of projects and the lack of compatibilization are still the main problems of our civil construction. To work while thinking and to think while working is one of the most relevant aspects in the use of technology and in its application on architecture. The BIM modeling can allow the development of new actions of information on how the elements are constructed (parameterized geometries) and technical-constructive performance, including sustainability. The most targeted desire is that AEC industry in Brazil will change the constructive chain, leaving the low process of conventional production behind, to become agile, efficient, economical, profitable and with quality: make more with less. In our recent market, it is difficult to deal with little quality of projects and their compatibilization and with manpower (disqualified workers and lack of them). The adoption of new technologies necessarily comes from the complete reformulation of the design process conception – the adoption of smart design. Our current model cannot evoke new techniques or technologies. It is expensive, heavy and slow and wastes physical, human and financial resources. Companies must rethink the process of project conception, the use, maintenance and destination of final waste. It is a challenge that goes through planning, technological development and cultural changing.

1 COLLABORATIVE ACTIONS

1.1 *Benchmarking and collaborative actions*

Nowadays it is a consensus that groups of professionals and companies share knowledge about problematical situations in order to find better solutions. (BOXWELL,1994). This sharing of knowledge through benchmarking is crucial to the development of indicators, allowing performance comparison which will show the best practices of design process, management and sustainability actions.

Benchmarking collaborative groups might happen between companies as well as between individual beings. In the process of designing, by example, through internet groups and social networks, the company or team work may receive suggestions for the enterprise's name and useful ideas for design, sustainability, and technology. Afterwards, these collaborative actions handle information to the creation of the infrastructure: efficient systems to the conception of smart design, like the use of local material, water reuse and construction waste recycling. Therefore, collaborative groups develop knowledge, generate innovation and make the process clear, establishing an open and trustful environment with equality for experiences exchanges. This sort of group allows commitment between its participants.

2 THE AEC INDUSTRY IN BRAZIL

Beside the design technologies, Brazilian constructive system, focused on multifamily housing, experienced great changes over the past 20 years: company's size was reduced, several barriers were established in the entrance of the industry and the period was marked by strong competition, with great reduction of profit margins, difficulties in financing and high interest rate.

Since the establishment of PAC (plano de aceleração do crescimento), a Brazilian governmental plan, the market's behavior was marked by made-to-order buildings and by real state incorporation (pre-sales housing market) with high competition influenced by the plan.The funding offer and the decline of interest rates set a new scenario and a new economic order, with clear definition of market prices for conventional products.

These issues induced developers to adopt a new economic sustainability for the sector with the releasing of products more appropriated to consumers (the market as the great definer of the prices). In order to cooperate with these new demands, companies have had to increase their actions of planning and construction management, besides constructive optimization process and quality programs.

In order to answer these new demands, companies are seeking certification processes and outsourcing of the most necessary activities for production. This search is still based on the adoption of incipient technologies and on the improvement of technology insome areas of the constructive process, still based on the main use of concrete cast *in loco*. The main goal is to reduce the costs, benefiting the internal customer (IIR).

Some companies have realized that the adoption of a more conscious activity at the stage of design conception (design quality improvement) increases the value of the products from the user point of view, and not only the economic price of the product, privileging the final user and attending the requirements of constructive technical and building performances. (KOSKELA, 2000; ISO – 6241; ABNT, 2000; FOLIENTE, 2005)

What happens, however, despite the desire of pursuing these new requirements, is that Brazilian construction industry is conservative and slow in innovation processes. The owners aren't willing to change this reality yet. Companies are economically weak, with no political power, low-tech, low competitive intelligence, low power to make profits and short time of performance in market.

These companies haven't much experience in mechanization, so their production is subjected to changes in the weather. They have low productivity and high levels of accidents plus much improvisation on site. Thereare also performance problems with accuracy, quality and losses (human, material and financial), besides under skilled and temporary manpower that work on dirty, dangerous and tiresome environment work.

Another relevant aspect is the lack of social commitment: the non-preoccupation with social, urban and environmental consequences. Companies are focused only inbuilding new units in short time, sonormally the products are expensive, with low quality and high level of inadequacy.

The desired future through collaborative actions, technology and smart design is innovative, flexible and sustainable construction. For this model it is necessary the adoption of actions that reduce losses and the design focused on industrialization with the use of ICT (information and communication technology). Besides environmental sustainability, there must be incorporated social and economic sustainability, which generate good work conditions and career plans, capable of attracting more qualified professionals.

This dichotomy between the reality and the desired future has as main cause the lack of dialogue between companies, universities, government and professionals. This conflict is the cause of many problems, as the high consume of material and manpower and the high production of waste along the building's circle of life. These problems could be reduced if greater efforts were dedicated in the beginning of the design process. Experience shows that some failures are more expensive and difficult of being solved after this period of planning and conception is over.

3 ADOPTION OF NEW TECHNOLOGIES

3.1 *Misuse of technology*

New design technologies based on CAD, help architects to produce more precise designs. However, they still produce problems related to the compatibilization of design (rework and waste at construction period). These problemspoint to the misuse of software in the process of design. As stated by Richard Sennett (2012) "How could such a useful tool be misused? (...) What we conclude from this misapplication of CAD is that what appears on the screen provides an impractical coherence, composed in a way that never occurs in the physical view."

Designing in CAD can reveal some basic problems that result from the misuse of software: difficulties in understanding the different phases of a design, the limited view of the design on the screen and the effects of the zoom that hide mistakes and design failures. Another relevant fact is the disconnection between the proportions that are represented on screen to the designer, because of the use of different scales, and that will never be substituted by someone on site, which means that there are solutions on screen that will never be verified on the sight of someone on site.

The difficulties of civil construction point to mistakes of design as the great villain of incompatibilities between the different sorts of designs (architectural-structural-infrastructure) that produce rework and delay in building chronograms. The origin of this kind of error is due to the lack of knowledge of the potentialities of a tool so useful and yet, so misused. This is a big problem of capacitation that starts at college graduation.

The use and teach of CAD reflects recent university graduation. Few colleges make an effort to pass a deeper knowledge of the program to the students. Many times not even teachers dominate it. The rising of new other 3D designing tools too make it difficult to know which one is the best option in the process of graduating the student into a professional. Not even the professionals have a consensus about this. Most students that dominate any designing software have gained that knowledge by themselves or at stages.

3.2 *Change of technology Culture*

Civil construction in Brazil must be allied to an industrial logistic. The constructive model "modeled in-loco" must give way to new technologies of production and for setting the building up, with software of management associated to smart design. To simply put the pieces together on site and make a building has got to become a reality, for it is no longer admitted improvisation that leads to a rework which wastes time, material and, therefore, money. Yet, the overheating of the market and the imposition of each time shorter deadlines push the conventional construction, filled with pathologies, into changes. Complains about deficiencies on delivered buildings and on the delay of the deliverance of them point to the frailty of the present model of construction. The actions focused on quality management system, TIC (communication and information technologies), processes of production and adoption of new constructive techniques may add quality to the product, diminishing construction pathologies.

3.3 *The Manpower problems.*

The reality of civil construction nowadays reveals an arising on the difficulty to find manpower to work on site, for the same manpower is disputed by different sectors. The existing model isn't capable of providing better payments, besides the inexistence of incentive programs and of guaranty of maintenance of the workers in possible moments of crises. Manpower blackout might be overcome with productivity, training, planning and awareness of businessman and trade associations.Insome building phases, workers are better paid by civil construction than by factory, but this is a very punctual aspect. The dispute for manpower is so that, being qualified or not, there is lack of workers.

4 BIM TECHNOLOGY AND ITS APLICATION IN AEC.

4.1 *Design process quality.*

BIM (Building Information Modeling) is a technological innovation that modifies the process of building in civil construction and its product (ANDRADE & RUSCHEL 2011). BIM proposes the integration in the development processes of design through the collaboration and the multidisciplinary work of the team (stackholders). By a change in the paradigm of the design process, all people involved in it work in a single virtual model that contains all information (geometrical and non-geometrical) that characterizes the building, with significant reduction of time, costs and rework, and adding quality in the process and in the product presented. (EASTMAN et al 2011)

According to Crespo and Ruschel (2007), BIM is a digital model composed by a data bank that allows adding and producing information in the virtual model of the building for various purposes and with a gain of productivity and rationalization in the process. It is the development and use of a computational model to simulate the construction and operation of an enterprise. (NASCIMENTO et al, 2011) The model is a representation of the building with

parameterized elements of which it is possible to obtain and manipulate technical and physical information that help in the decisions on the design, on the maintenance and on the operation of the building.

4.2 *Difficulties on Implementation*

As any other technological information, there are difficulties in the implantation of BIM in the whole AEC chain. Some of them are:

a)Costs on implantation – the price of the software and license, besides indirect costs generated by the low initial productivity during the process of training the staff.

b) Resistance by professionals – BIM represents a change in the paradigm of the design process and so finds resistance among professionals already familiarized with the traditional processes (Senior's culture) and that are not willing to learn new design processes. There is also a natural resistance to any kind of innovation. For Junior & Amaral (2008), construction industry has a great resistance by professionals in assuming risks on uncertainties in implanting technological innovation.

c) Training staff – training professionals on the use of BIM means new investments, which might be another barrier on the implantation of this new technology. Companies must invest on the design staff with time, resources, physical space, etc. However, businessman are not always willing to invest in this, even that it means possibilities of future return.

d) Latest technology – for BIRX (2006), the fact that BIM is a new technology implies that softwares are still being improved. The fact that the chain of designs and other consulters and collaborators still haven't adhered to the innovation implies on the need of trained professionals for the market and a long transition period.

4.3 *The software interface and interoperability*

BIM bases its design process on the interoperability, which is the capacity of exchange of information of the model between different softwares and disciplines. Interoperability in BIM proposes sharing information through archives in IFC format. IFC is a model that has been elaborated since 1994 by IAI (International Alliance for Interoperability) , now called Building Smart International and approved by ISO (International Standardization Organization) that facilitates the interchange of architectural and construction information between softwares with intelligence based on the object – like BIM. (OLIVEIRA, 2011; BIAGINI, 2007). Interoperability is the ability to exchange data between applications, which smoothes workflows and sometimes facilitates their automation. (EASTMAN et al. 2011)

Interoperability guaranties that various experts on design in different phases of the process add information independently on the software that is being used or the phase of the enterprise. The virtual model of the design on BIM concentrates various objects as well as parameterized information.

4.4 *Noise about creative process an new technologies*

The implementation of a BIM design process suggests a change on the steps of the traditional process. It is believed that this change is only going to happen when new methodologies of architectural design incorporate the dilution of the rigid division between the phases of the conception and development, seeking to strengthen the architectural conception. (BULHOES, 2012; FLORIO, 2007; EASTMAN, 2011)

Today's paradigm among designing professionals e those that perform the work of building is the distance between the diverse knowledge. While some know about design tools (CAD and BIM), others dominate the knowledge necessary to make the building come true. This feedback of knowledge is a great challenge to the professional reality. It is important to establish an exchange of information between those that dominate tools of design and those who dominate construction techniques.

4.5 *sustainability actions*

One of the advantages of BIM is the possibility of simulations while designing. BIM enables architects and engineers to use digital information to analyze and understand their projects' performance before they are built, developing and evaluating multiple alternatives. At the same time, it enables easy comparison and informs better sustainable design decisions.

Design decisions made in the beginning of the process can deliver significant results when it comes to the efficient use of vital resources. Employing sustainable analysis tool helps architects and engineers to make more informed decisions earlier in the

design process and enable them to have a greater impact on the efficiency and performance of a building design. (AUTODESK, 2010).

BIM provides superior ways to measure simulation and analyze performance, with its integrated data of building & service system elements, GIS context and definition of human and related activities (MITCHELL, 2011). With this anticipation, designers can make better decisions and use a smart design to build. BIM encourages trying better solutions in design process.

5 CONCLUSION AND RECOMMENDATIONS

The big challenge in our days is the production of sustainable buildings with decreasing costs, reduction of deadlines without losing quality, technological innovations of design and smart design. For these characteristics, there should be expected:

-Opened professional environment, with equality and with collaborative actions;
-Planning attitude. Investments in technology, incorporation of actions related to sustainability and TIC for adapting to digital revolution;
-Smart design through new designing technologies associated to the resolution of faults, imprecision, incompatibility and haggard orientations when compared to the digital model;
-Digital enhancements to minimize and avoid rework in the production caused by the misuse of design technology;
-Improvement and made current the practice of simulation to anticipate solutions for the design and evaluating environmental, technical and constructive performance.

This action starts since the conception of the design, passing through the construction of the building, operation and maintenance of it, till recycling and discarding waste. It doesn't mean just the reuse of the rain's water or implementing solar plates, etc. Today's challenge is wider, involving implantation of systems supported by new technologies to the development of design and the transformation of the model 'modeled in-loco' to 'pre-modeled'.

Therefore, our design, laws, culture and demands should evolve at the same time. The development of new products, technology and capacity is the true technological revolution that must have too a cultural revolution in the development of the country.

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