

Management of Technology: approach to building construction quality planning

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Abstract

This paper proposes a quality management concept applied to building construction companies, stressing that quality does not only imply in meeting customer requirements, but also in the efficiency of its own production processes.

Under this approach, this study aims to debate the use of Project Quality Planning, quality management tool focused on the above-mentioned singularities, to integrate the relations among project players and the processes involved, to ensure the best quality and the evolution of Quality Management Systems (QMS).

Taking into account the involved diversity of products, players and processes in a construction project, this paper considers Management of Technology (MoT) introduction as an element that propitiates technological harmonization between players and processes, particularly in projects from Hospitality sector¹, which adopts rationalized or industrialized building construction processes.

In order to propose some guidelines, case studies methodology in the above-mentioned segment were carried out trying to identify the relations established between involved players, in which the Management of Technology could be put into an actual procedure.

Keywords

Quality management; construction technology

1 Introduction

We notice in the present social and economic situation, that technological development has affected the rules of international market and created such

¹ Market segment that involves Flat Services and Hotels

opportunities as problems to societies development (1). This landscape lets technology as an important agent of economic development and over all, as an instrument of strategy in the subsection of building construction² after parity with others sectors of the industry. So, the technology must be selected appropriately, developed and diffused in the sphere of organizations action, conducting them to a larger efficiency and efficacy.

Presenting this discussion in Brazilian building construction, we notice a considerable increase of the competitiveness of its enterprises and its market consciousness to a minimum standard of offered products qualities. This way, the subsection has been the scenery of a real 'run' in direction of quality and the insertion of new constructive technologies in its worksites and management processes. This can be analyzed as a strategy to reach competitively and make possible products with more generated value³, under a process not only efficacious but also efficient.

Therefore, due to intrinsic particularities, the segment still doesn't presents sufficient results to desired evolution.

Taking this 'strategies'- the implantation of Quality Management Systems (QMSs) in contractors and the way in which technology has been introduced in worksites – the main idea is focused: theoretical exploration on the possibility of adding value to high performance building processes in the hospitality sector. Also taking as a premise, the integration between the QMS and the Management of Technology (MoT), based on harmonization of criterions that define hospitality sector project qualities.

Hospitality sector is adopted as focus in this study due to the characterization of design products created by its projects: buildings of a high performance. The 'Hotel (seen as a building)' owns minimums demands, as shorter time of execution and delivery, that takes the necessity of higher grade of rationalization product; own demand of building performance in use with the aggregation of facilities and services in edifying (for example building automation and services performance is often being increased); and, equally, due to the utilization demand, the constant maintenance during its operation phase.

We believe that these are key points to the beginning of what we know about Projects Quality Management⁴, an instrument to Quality Management Systems (QMSs) that makes possible its adjustment to particular interests of each project in building construction.

2 MoT contribution to QMSs and its projects

2.1 Projects and its function in building constructions segment

Considering its activities related to a transformation process, civil construction sector represents a group of activities of industrial configuration that is considerable in

² A subsection in Brazilian Civil Construction.

³ In the segment of Building Construction value generation into products means to enter in the matter of technical training and management enterprise practicing Constructive Processes that consider actualized techniques plus mechanization in the processes and lower job of workmanship (this its the more qualified) and over all conducted by a management without interference and the most optimized possible. We must think also in training of claims involved under an appropriate management to the internal context of the organization (contractor)

⁴ To systems focused in the productive Building range (projects of new products) that delimit the estimate criterions of its quality.

Brazilian economy performance, in representing a considerable parcel of GDP (Gross Domestic Product) and has an important social function (2).

These activities, linked through the project, configure a complex process, “a sequence of phases, generally with hierarchizing in the decision levels, great diffusion of responsibilities and low grade of integration between players” (3).

Thus, the production process (here) represented by the project shows an organizational structure divided in phases of distinct objects: conception, construction and use of the building; associating the fact that for each one of those phases exist a responsible factor for its conduction. It originates, then a series of activities that delimitate project life cycle, as a choice and acquisition of a land, its planning, introducing and commercializing in the market, beyond the definition and team coordination of the operational development (involving building processes: project and production) by the entrepreneur player.

Finally, we compare the project with a group of ‘enterprises’ working, parallel, in order to gain a common purpose: the building construction (Figure 1).

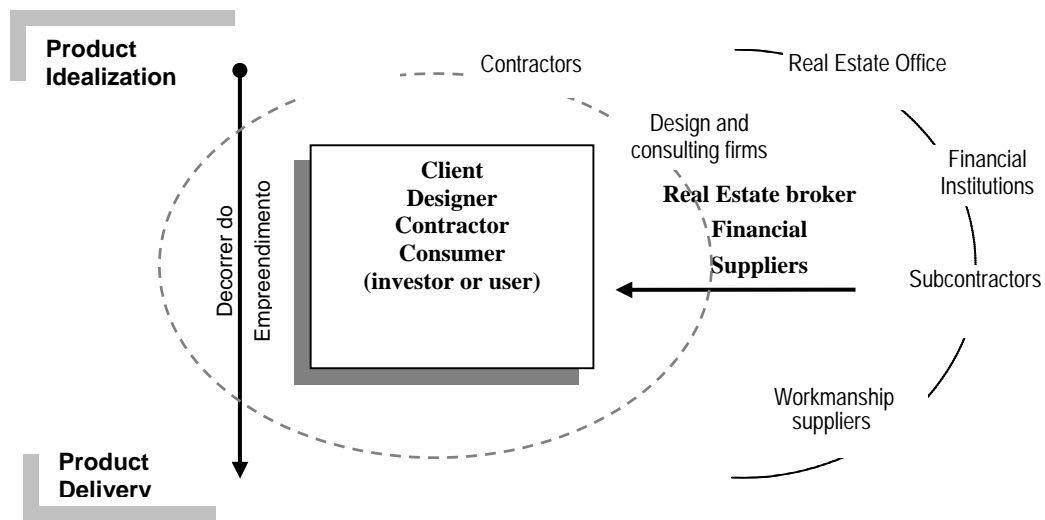


Figure 1 - Agents involved through the development of the project.

We observe that the project isn't exactly an independent organization - its existence depends on the initiative of an entrepreneur or enterprises, whose interests are represented in the projects. On the other hand, can be considered as independent production system, because its dynamical and own purposes: introducing, commercializing, and producing a product in the market. Here is being focused that projects, over all in the hospitality sector, involves an own management to each product introduced and for this reason, configures the ‘elementary cell’ (or elementary part) of the system delimited by Building Construction, once that the activities of these segment circle around the projects. It can be seen as a sort of ‘project-enterprise’!

Understand the project as an elementary part of the segment BC take as bases the proposal of equalizing the Management of Technology (MoT) to Quality Management Systems (QMSs) ‘formatted’ to projects that introduces new products in the market.

Another particular characteristic of projects is the paradox ‘standardization *versus* specialization’ realized when the purposes were commented. In one aspect is the necessity of rationalizing the production and on the other exists the necessity of expressing a character of exclusivity in each project, in order to reach commercials

purposes and client satisfaction. So, the continuity of works, which intend to reach total standardization of projects, becomes difficult due to its interests, requiring an adjustment between these variables.

This appreciation about projects can be understood as a fruit of its processes specialties in its production process and the technological and management diversity involved. We consider also, the fact that building construction segment (considering the contractors and incorporations) doesn't present a grade of technological uniform development, existing buildings produced by building processes since the most traditional to the most rationalized.

From the context approached before, we conclude the fact that in Brazil, building construction presents reduced productivity (90 to 100 Mh/m²) if compared to indexes of developed countries (30 to 35 Mh/m²) (4). Considering this, adaptations had been done since production models came in series industry⁵ that are after alternatives that bring technological and organizational stages higher than production in the manufacturing character dominant in this segment.

QMSs also shows one of those instruments if considered as a management model inserted in an organization that makes possible, theoretically, products and services quality guarantee. Therefore, they are connected to building constructions environment and not to the 'project-enterprises', the elementary part in which activities are created in building construction segment.

2.2. From Quality Management s Systems to Projects Quality Plans

When we talk about Quality Management Systems (QMSs), the intended focus towards building construction is the one highlighted in GEHANI's work (1). When he quotes qualities awards such as the Baldrige National Quality Award in USA and the Deming Prize in Japan. Quality is understood as a product attribution, in an improving continuous process that allows its appropriate performance and that surpasses customer satisfaction, considering also process efficiency related to ways in which production occurs.

QMS represent a global management that delimits the quality politics in organizations that interact in order to gain a common purpose: projects and enterprises process management systematization (5). They represent an instrument of management considering more efficiency and efficacy gave to an enterprise, resulting in higher quality of offered products and its client's satisfaction.

Standard ISO 9001 version to the year of 2000, for example, besides showing an effort to different aspects involved in organizations aim products characteristics conformity, focusing in topics that involve product procedure in its totality, allowing and creating then its various activities, allowing the transformation of its enters and exits (6).

Once that we notice the initial integration between the certification process to the real necessities of its enterprises and its projects, SJOHOLT (7) proposes an double to QMS: considering since the plan topics and the projects that take the supportable changes in enterprises, until the praise of the applications of these systems applications in projects life cycle parallel to the insertion in the ambit of each involved player.

Although this hostile character we have to know also that the QMS evolution in building construction must continue trough constant revision of standards, in the sense

⁵ Lean production had been turned to lean construction, and the same happened with 'just in time system'.

of a higher overture to the specificity of its projects, 'cells' of the system shown by building construction.

For application of above-mentioned values to the project scale, it would be necessary the identification, analysis and formalization that are frequent in the respective operations. This action leads to the so called 'Quality Plan', tool of QMS that allows agents interventions optimization and structures integrated actions within organization QMS scope, resulting in its fit to the project specification and quality assurance of the products to be generated. (8).

The statement given by Engineer Ércio Tomaz reinforces the idea that *“investing in the quality of management, procedures, documents, is not bad, since it is seen as a way of organization. The problem happens when it does not aggregate technical knowledge. For example, today it is very common that large corporations manage a construction like an independent branch, with separate management, separate resources and separate management of the techniques. It is necessary to correct what did not work out in the construction to avoid its repetition in other buildings”* (9).

It means that it is not enough to implement in the company a QMS which guarantees the quality of the final product, if there is no incorporation of technical-technological values in its respective management and projects.

2.3. Technology and Innovation

To make the insertion of Technology feasible in project practices it is necessary a systematic view over its plan and operation. So, as a consequence, it is necessary to make use of Management of Technology (MoT) integrated with Projects Quality Plans.

The understanding about the implementation of MoT in the segment of buildings designed for the hospitality sector⁶ implies in the distinction and use of expressions as 'technical' and 'technology' several times used in a different way from the actual sense.

Technical is understood as a set of practical rules to determine certain objectives involving professional skills to make some things and skills to be transmitted orally, for example the use of hands, instruments, tools and machines (10). It means the act of knowing how to do

On the other hand, Technology means *“the study and knowledge of the technical operations or technical. It involves the systematic study of instruments, tools and machines used in the various branches, gesturtes, work time and costs of materials and energy consumed”* (10). It implies in the use of methods derived from natural sciences representing the evolution in accordance with changes, which occur in society's evolution.

By transporting this rationale to a program of system organization it means that the Technology makes use of means and knowledge to enable better quality and low cost products. So, technology may generate both: a major productivity and product quality as well as lead to the discovery of a new production technique or a more efficient management.

This idea is associated with the eight fundamental points of Technology: (1) *“products, operational process, intellectual property, information process, promise (of quality and trust), the qualification of people, project and plan, pioneering strategy to attract financial gains”*. Ribault et al (11) say: *“Technology represents a complex set of knowledge, means and know-how organized towards production”*. Under these

⁶ High Performance hotel Buildings.

terms, the adoption of 'Technology' concept applies not only to the segment of building industry but also to the Technology of products (materials, components and construction systems) and construction processes (building technology), and also to the project management technology, including the interaction between all agents and processes involved.

2.4 Management Of Technology And Innovation

Essentially, Management of Technology (MoT) is described as a process of development, choices and diffusion of Technology within the scope of a process or a project (11). This represents the configuration of the system policies, management, and procedures that outline the strategy and operation, which will enable the achievement of project purposes.

MoT represents not only the capacity to allocate resources to the Research and Development (R&D) but also the commitment of these resources to other complementary capacities inherent to the chain of an organization's technical values (1), such as project plan, the carrying out of building construction and its respective maintenance as well as the integration among activities involved in its life cycle.

Due to this reason, MoT implies gains of competence and competition during its life cycle. These gains occur, according to the logical of Porter (12) by costs domination, products differentiation or in the concentration of a specific market or by the necessity of working with strategies in project environment. After all without a strategy there is no plan and without a plan the uncertainties predominate, wrong options may be taken and there is no learning derived from the experience.

The limits of understanding over MoT universe are established considering policies to choose, define, develop, implement and spread rationalized constructive technology within projects scope. MoT main key points to be identified along projects life cycle must be based on the phases of motivation for the adoption of Technology and innovation, its selection, R&D, implementation and operation, diffusion and learning for re-innovation (13).

Motivation involves "detecting signals in the environment about potential for a change, that could be the result of a competitor action or from the interplay of several forces, some coming from the need for change pulling through innovation and others from the push which comes from new opportunities" (13).

It is part of this stage the identification of key factors which lead to companies involved in the project to an innovation: core competencies involved in the process and in the tasks to be done.

Research and Development (R&D) involves the combination of new and existent knowledge, available inside and outside of the organizations involved, which are oriented to find problems solutions that arise along building construction. Ways out that characterize the product at this phase of MoT process are the changes that advance to a higher stage towards a more efficient stage of a certain process of the project.

The main point at this stage is the innovation that comes from a collection of ideas to a concrete reality. In this way we can outline which resources are to be applied, search for more information, inside and outside of the organization or project (benchmarking) and finally determine the detailed activity of innovation development or its adaptation. This process must be understood as a concept of routine "*in which the organization develops a particular way of behavior that sets the manner of doing things and reflects the culture of the organization*". (14)

Implementation, the center Mot and innovation processes has as ways in the clear strategic concept, and technological innovation introduction into the project; while its ways out are the developed innovation associated with the domestic and external markets (13). So, the procedures are settled, the human resources are capacitated and the suppliers begin to be informed about the changes that were implemented.

The technological innovation was developed and implemented in the organizations and as a result there arises an environment propitious to the respective operation and diffusion and it becomes inherent to organizations daily activity.

The **learning and re-innovation** represent the way out from this MoT process. The creation of new motivation to define again new projects life cycle. If the product or project fails, we obtain valuable information regarding what has to be changed in a next time.

It is true that it is not easy to manage such a complex and uncertain undertaking, moreover when it is applied to building processes projects. TIDD et al (13) explain that it is a delicate matter to develop and to refine a new knowledge as the adaptation and application of this knowledge to new products and procedures, to convince the directors of the companies involved in resources application, to accept long term use, etc. These are difficult issues, but possible.

'Innovation' is a process, not a singular event; consequently it has to be managed in an appropriate way: "*the influences over this process can be handled to affect the ways out, that is, it can be managed*" (13). Another critical point emerges from the research. It is that the innovation needs to be managed in an integrated form, considering all the agents involved in the projects and not only manage or develop the skills separately in some of the organizations involved in a building project.

About the handling of this integration, we believe that the Project Quality Plan is the tool that balances projects requirements and interests, relative to the respective QMS and MoT of agents involved. Therefore, when thinking about integration it is necessary to consider the integration between QMS and MoT.

3 Integration

The discussion about the integration between QMS and MoT begins when it is admitted that integration exists in the daily activity of organizations. It is enough to identify the links existing between a QMS already formalized and a MoT practiced informally by the contractor and the incorporator and even applied to projects.

These links occur under the form of two vectors: in the first (1) QMS are conditioning the MoT and the second (2) represents the influence of MoT over QMS.

It is clear that the vector (1) predominates over the productive structure of a company, as the QMS formalized in the organization (not always certified) is able to exercise more influence over the MoT practice. Illustration of these vectors can be listed:

1. QMS interacting in MoT – when the quality requirements or procedures are settled in the QMS they limit or determine which technology will be used. Delivery terms are an example: if QMS requirements establish that these cannot be postponed for more than two months from the clause established in contract, production management, procedures and processes for building construction must be efficient enough to enable the delivery within the delivery term. The requirement 'delivery term' will choose,

therefore, the production technology that will ensure a shorter construction period, either through the use of pre-existing components or through an innovative system of production management.

2. MoT interacting with QMS – Considering the same example, the requirement ‘terms’. If one criterion adopted for the choice of technology is based in the search for shorter terms, the technologies used will be efficient and effective to ensure the term, with implication in a major control of the procedure and consequent quality of final products.

Another criterion for the choice is the technological risk. Once accepted the risks (either relative to costs, terms or technique application), the implementation and choice of technology in projects building processes may result in a loss of quality or in the default of a quality requirement.

It is pointed out also that the vectors arise as a consequence of the reality of the companies involved in the project. The PQP arises just as an element, which fits the interests of these various agents.

But why contribute and integrate?

As it can be observed the link exists in an interactive form. It is necessary to have sound criteria to identify these links in order to have a balance in this interaction and so establish the efficiency and productivity derived from the procedures and technologies applied⁷. These balanced with the efficiency of same (always associated with the QMS but not necessarily with the efficiency of the operational procedure). Finally it is shown that both systems interact between themselves, but are not thought under a synergetic way. The example is just the vectors of interaction (1) and (2) coexisting without balance if compared to the action of one with the other.

It is necessary, also, to practice MoT and QMS in accordance with the demands from the market (proprietors and users of the building) and with the necessity of surmounting ‘companies–project’ productive capacity.

4 Case studies development framework

Considering that hospitality sector projects aren’t conducted by only one organization or player, but for a pool of enterprises; we propose the case studies framework, which translates the discussed elements.

The goal is showing the practical results from interaction between involved players in hospitality sector projects, considering also technological relationships occurred into these processes. We understand also that these results can be analyzed as results from application of the Quality Planning tool, which can improve those interactions.

This way, practical results of this work can be translated in good practices for Projects Quality Planning in Hospitality Sector.

Once we intend to cover the whole process of projects in Hospitality Sector, we understand that the beginning should starts from the end. It means that, we must attempt to the results gained during the operation phase of the project (the building and its uses), trough Post-Occupancy Evaluations (POEs), which supplies vital information – related to the facility of maintenance and acceptance of users – to the retro-alimentation of future projects.

⁷ Purposes of the MoT

These data are the links that able an efficient tool for the initial approach case studies, once that they concern the practical results from phases of conception and implementation (construction) of projects in hospitality sector.

Figure 2 establishes a model to guide this work, considering projects life cycle.

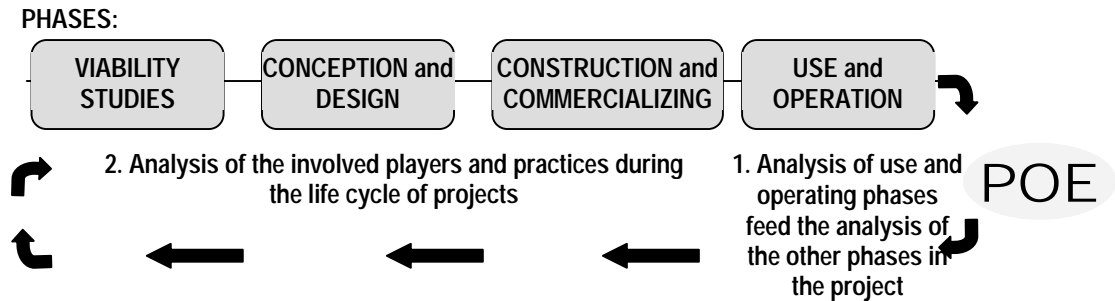


Figure 2 - 'Proto-model' to the analysis of the study cases. The model considers that 'the beginning comes from end'. The results from use and operation phase bases the characterization of the life cycle of a project, considering also the practices of MoT and relations that comes from application of a Project Quality Planning.

In a second stage, we must initiate the identification of practices of QMS and MoT of players that conduces and operate the technology production in buildings, the entrepreneur and the constructor without disrespecting the other factors involved in it.

Once dominating the information related to the practical application of conception and construction solutions, there are established an accurate environment for detailed characterization of the project, which is related to: the factors and players involved, the building process, the quality management system.

These all leads with better conditions to formulate (or collaborate) models of project Quality Plans that regard this integration. See Figure 3.

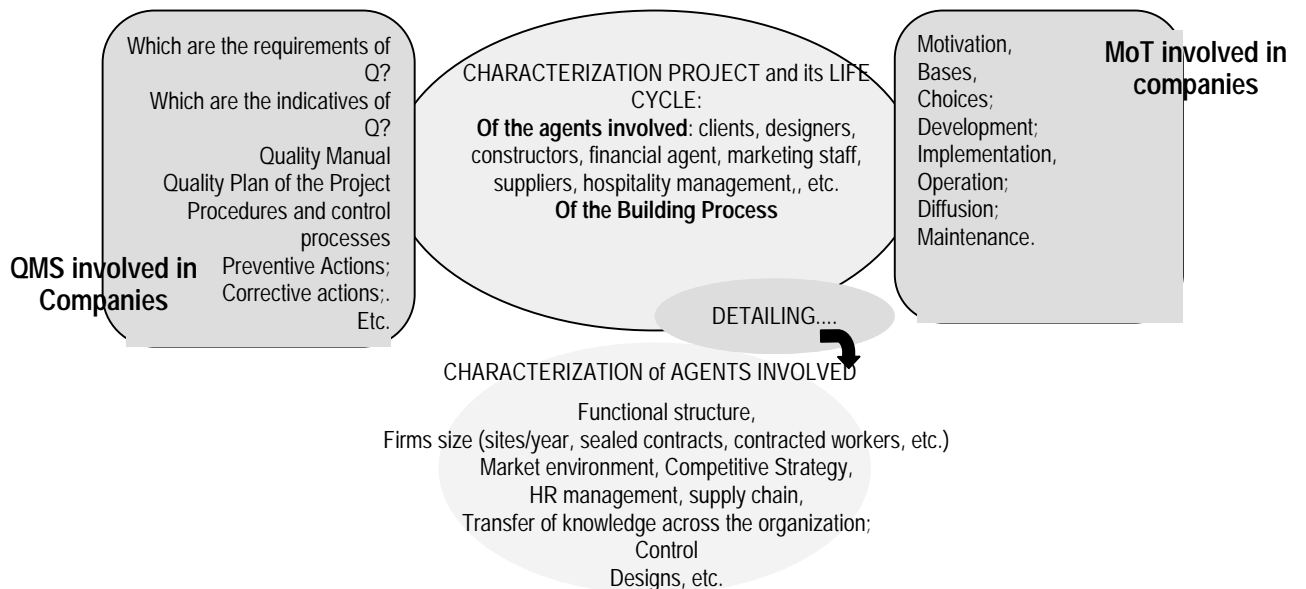


Figure 3 - Matrix to the detailed survey datum in the case studies.

5 Conclusion

Considering QMS to MoT integration purpose practiced along hospitalities project life cycle through Projects Quality Plans, the discussion raised around MoT still considers the environment of serial industry. It is necessary an analysis which leads this discussion to the issue building construction, considering high performance buildings in hospitality sector, and matters that meet the specific requirements of each project combining involved agents interests. In connection with integration, preparation of spread sheets for case study and its analysis shows how extensive is the research, confirming the thesis that integration comes to frame an organizational and productive structure for projects. The intention is to make clearer the limits of agents involved roles, its respective interaction and the consequent conversion of their joint efforts towards the obtainment of an efficient building production.

Just to finalize, a critical point arises from the study, that is, project MoT and not only the management of some organizations involved in it.

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