ABSTRACT

Durability, a main goal in the building process and also seventh “hidden” essential requirement in Directive 89/106/EEC, deals with the capability of construction works to maintain its performances for a specified time span, in defined conditions of use. A lack in durability involves loss of added value, hence the aim of this paper, to propose a systematic usage of two “new” tools for durability, both focused on added value analysis: Business Process Reengineering (BPR), renamed recently Re-valuing Construction (RVC) by CIB, and Value Analysis (VA).

The “theorem” is as follows: if BPR and VA can assure cost reduction, time contraction and customer satisfaction, then BPR and VA can assure durability as well.

This paper starts from preliminary results of research activities under work at DIET, University of Pavia: the core of research activities aims to define a suitable model of “reengineered building company”, nevertheless some aspects of the investigation brought to take into consideration durability as a crucial requirement while discussing the relationship among reengineering, customer satisfaction and requirements. This suggested the idea that reengineering, as well as related disciplines such as value analysis, might give a contribution to set up problems and possibly sort out some solutions whenever durability is involved. In this paper, different assumptions are reported on this subject through the following steps:

- report about the general conditions of the building sector,
- notes about durability and its links with other essential requirements, with comments on the state of the art in the definition of durability
- considerations about how BPR and VA can assure essential requirements, and influence durability design.

An example of BPR application is presented, postulating the transposition of BPR outcomes at Autokit, an existing car fittings company where a reengineering project was experimented, to Edilkit, a “hypothetical model” of construction firm.

KEYWORDS


NEW STRATEGIES FOR SURVIVAL

The building sector nowadays, even if solid part of the Italian economy and even if reported with positive growth rate, is marked by a substantial slowdown when compared with the past; the growth expected for year 2002 is still positive, but reduced of 3 points compared to year 2001 while the middle-term perspective shows a slowdown, due both to specific aspects in different sub-sectors and
to a changing, variable, economic climate (Bellicini 2002). These are hardly any aspects of precariousness and turbulence in the present building environment (CRESME 2002).

The building sector is only one, if quite substantial, in the worldwide economy that reported a great slowdown during year 2001: the worldwide gross growth rate has increased of 2.5%, but this represents just fifty percent in comparison with the previous year (+ 4.7%). The productivity slowdown has marked also the Italian economy: the GNP growth rate during the year 2000 is 2.9% in respect of 1.8% in year 2001 (ANCE 2002).

All firms do need fresh tools and effective strategies to overcome the present unfavourable period, marked by shoddy economical results and by inadequate income prospects, resulting for a construction firm in poor manufacturing quality and lack in durability. In other words, to survive despite turbulent markets and their competitive dynamics, all companies should operate on their DNA (Baraldi 1999), beginning a radical organizational change based on a new way of thinking and on a critical vision of their activities. All firms should adequate their organizational structure to innovative process models suitable to overcome critical periods. The most recent research activities suggest different evolutions in management models: Business Process Reengineering, Facility Management, Knowledge Management, Re-valuing Construction, Total Quality Management, Value Analisys, Value Engineering, Value Management, and others.

Two of such tools, Business Process Reengineering (BPR) and Value Analysis (VA), seem suitable to the present situation and might be suggested as a solution to problems about durability: this contribution proposes a sort of “theorem” aimed to emphasize the link between durability and non conventional management tools.

THE PROPOSITION

If Business Process Reengineering (BPR) and Value Analysis (VA) guarantee process cost reduction, time retrenchment, greater quality and performance, efficacy and efficiency enhancement, greater customer satisfaction and - finally - economical results improvement, so BPR and VA should guarantee also durability.

Autokit / Edilkit: the comparative method

Before “proving” the theory, this contribution proposes a case study where a comparative method (Mercandino 1979) is put into operation: a lemma related to the analogy existing between two companies, Autokit, the benchmark company, and Edilkit, a construction company assert that it’s possible to transpose BPR results from Autokit to Edilkit. The comparative method matches the construction company trend with benchmark company’ past trend, according to similarities between the companies. Such method consists of three steps:

• identification of a relationship “R” between Autokit and Edilkit,
• determination of the time gap between the two companies,
• projection into the construction company of benchmark company’ trends through “R”.

The benchmark company is Autokit, nickname for an existing car fittings company where a reengineering project was experimented. The relationship “R” might be considered as a temporal transfer: Edilkit trend today is similar to Autokit trend in the past. In short, apart from such postulate, the similarities between Autokit and Edilkit are: matching functional- organizational structure, and matching radical changes, endured in the past by Autokit and presently by the construction firm. The main aspects of those changes are growth and spread of customer requirements, and the challenge of European integration; in other words, each company is challenged by real competition, by a system more and more centred on customer protection, by the absolute need for a reliable industrial policy, by the must of a solid tie with the market, and finally by a competitive environment relying on fresh technological and organizational abilities (Costantini & Norsa 1996).
Durability: a Brief Survey of Definitions

Durability, seventh essential requirement “hidden” in the 89/106/EEC directive, regards the capability of a construction work to maintain its performances for a specified time span and use. Nowadays no unanimously shared definition of durability is available; basically, durability is not a material property, but it’s related to the ability of a material, a component or a system to maintain specified features and/or performances, according to a fixed complexity level, for a specified time span and under established exposure and use conditions. Other equally convincing definitions of durability are in the follow:

- Durability - the ability of a material to resist weathering action, chemical attack, abrasion, and other conditions of service (ASTM C 1180)
- Durability - in weathering, a measure of the retention of original condition and function of a material after exposure to a specified set of conditions (ASTM G 113)
- Durability - the property of an article of being resistant to physical or chemical damage, or both, under the usual conditions of service, and of being useful over extended periods of time and use (ASTM C 1145)
- Durability - a general term for resistance to deterioration (informal definition by Geoffrey Frohnsdorff – member of CIB Working Commission W094 – Design for Durability)
- Durability - capability of a building or its parts to perform its required function over a specified period of time under the influence of the agents anticipated in service (ISO 15686-1)
- Durability - a relative term indicating degree of permanency (ASTM D 16)
- Durability - ability of a structure to meet the requirements of serviceability, strength and stability throughout its intended service life, without significant loss of utility or excessive unforeseen maintenance (informal definition by Sérgio Lopes – member of CIB Working Commission W094 – Design for Durability)
- Durability- the actual period of time during which the building or any of its components performs without unforeseen costs or disruption for maintenance and repair (Canadian Standards Association Document CSA A478 Guideline for Durability in Buildings)
- Durability - ability, at a single point in time and measured in terms of time, to resist or accommodate agents and mechanisms of deterioration in the service environment, and thereby perform the required functions (Chown 1999)
- Durability - capability of a component to maintain, in an established time span, its performance above a critical threshold over which the component show pathologies and an irreversible obsolescence process (Di Giulio, 1991).

Among such definitions, it may be useful to linger over the ISO definition 15686-1 and on the New Zealand Building Act definition. ISO 15686-1 (ISO/FDIS 15686-1: 2000) emphasizes that durability is no inherent property to the material or component. Besides, according to ISO 15686-1, nearly 50% of expenditures in the building sector are spent in building maintenance and the annual cost for maintenance amounts up to 3% of the building cost. To go through this inconvenience, USA, UK and other countries have adopted durability as keystone in the building process. The New Zealand Building Act (New Zealand 1992) “The Building regulations 1992” debates about durability as one of the two aspects of “stability”, together with “structure” and identifies a main goal to be assured: a building should maintain, during his service life, the performances stated by the law. The Building Act declares: “building materials, components and construction methods shall be sufficiently durable to ensure that the building, without reconstruction or major renovation, satisfies the other functional requirements of this code throughout the life of the building”. The Building Act finally recommends the use of components with the same durability or the easy replacement of components with lower durability.

Consequently – in respect of the building outcome - durability is an “essential” requirement at the same level as “stability” is, becoming a “macro-requirement” of some sort, assuring requirement satisfaction during building service life, finally resulting as sum of the durability of each component. Under this view, durability (Di Giulio, 1991) depends also both on the functioning model and on management interactions: hence, the importance of operating on the “system as a whole”, that is on the building process.
By the way, it is widely recognized today that every building process should be marked by sustainability, meaning a stable balance among present and future costs, building duration and building performance. A sustainable building process on the other side might be characterized by a construction activity led on the basis of scientific principles (Blachère 1971), that is an activity based on experimental modelling, as Evidence Based Medicine (Liberati, Cartabellotta 1997) does for instance in the medical sector. Durability is a construction science, and building means to solve problems about economical and social requirements (usability, economy, duration), about given environmental or user-induced agents and about standard or special conditions of use and activity (Blachère 1971). In this vision, durability is considered in the group of economical requirements, because of the necessity to estimate duration, quality and price while establishing the value of a certain building operation. Therefore, setting off from the point of view of sustainability, durability is shown again as a particular shape of each essential requirement, which means that if all essential requirements are assured for a suitable, specified span of life, durability is assured as well. Which leads us again to the statement: if BPR and VA assure essential requirements, they can assure durability as well.

BPR and VA assure Durability

Business Process Reengineering (BPR)

BPR (Hammer & Champy 1993) is a tool that could determine radical and effective changes in firm organizational structures, redesigning such organizations as process-oriented structures (Manfredi & Testoni 1995). BPR consists in removing activities that don't add value to the process, integrating and linking various activities, advancing and “de-serializing”, synchronizing, adapting incentives, measuring results and looping in the process, assuring greater value to the customer and sharing responsibilities. The principal character of a BPR project is the process owner, who first redesigns the process and then manages the reengineered process.

Value Analysis (VA)

Value Analysis, born in the USA during second world war, is a science with the capability to reduce total cost of products, following different ways from traditional ones (new investments, indirect cost reduction, precise evaluation of internal costs) (Weiller 1995). In particular Value Analysis is a science (Miles 1989) aimed to identify and cut unnecessary costs, which are linked to characteristics not required by the customer. If value is a relation between performance and cost, a value-oriented activity should either improve performance while keeping costs unvaried, or decrease costs while performance is kept unvaried.

A BPR case study: Autokit (Racheli & Perrone 1997)

Such a case study summarizes a BPR project implementation at Autokit, a car fittings firm. Autokit is a stock company working on Italian and European markets. The organizational structure is classically based on functions, and the period is critical as far as economical results and income perspectives are concerned: levels of customer requirements are increasing, the new values point towards higher quality, better service, deeper personalization, greater accuracy in delivery, increasing levels in product after sale support, a strong competition - consequence of hardly manageable and checkable market globalization – is changing the rules of the market. As a consequence, a radical change is strongly needed.

Change comes through reengineering. BPR project begins with analysing existent processes - As-is models analysis – sketching time diagrams and defining priorities, after developing a strategic vision, after determining aims and objectives, after identifying processes for innovation, after allocating resources, after establishing guidelines and after determining program steps. Final task of BPR is a radical redrawing of processes: when the new processes are identified, each of them is committed to a responsible “station”. The results for Autokit are a time reduction in managing customer’s orders of 75% (from 28 to 7 days), an absolutely significant store reduction (35% in the first year, 50% in the second year) and finally a reduction of structural costs of 30%.
Value Analysis: a method (Miles 1989)

Value Analysis is shown to consist in four steps, among which the first, according to Lawrence D. Miles, founder of the discipline, is divided into several sub-steps: to define analysis object, to identify working team, to determine rhythm of work, to determine scopes and deadlines. Value Analysis is aimed to obtain equivalent performance at a lower cost, basing on the supposition that a stable economy is determined by offering to customers a greater value in relation to a required price. Miles suggests a method based on the character/competence of the value analyst, who works as some sort of deus ex machina acting on the answers to a string of questions.

Which is the object? How much does it cost? How does it work? Which new object might possibly replace the old one? How much alternative solutions might cost? Such questions are preliminary in Value Analysis, which reveals to be a sort of steeplechase, obstructed by impediments among which stands a paradoxical resistance at management level - conscious or unconscious - known as “the manager’s embarrassment”.

Besides such preliminary questions, the basic question is: which is the function of the object?

A case study: the refrigerator (Miles 1989). This case study, revived and adapted from Miles, deals with the implementation of Value Analysis to a refrigerator with the aim to improve a “mature” product, reducing cost from 125 euros to 100 euros. The first step consists in pinpointing functions (both use functions and aesthetic functions, in this case, to contain, cool, insulate, control, please), relating each of them to present cost and to required cost as in the following diagram, left. The second step consists in analysing each function, identifying sub-properties and related sub-costs, as shown in diagram, right, for the function “control”. The aim is to determine alternative solutions allowing a cost reduction while assuring the same performances. In short, the steps are: to identify the object functions, to determine the required cost for all functions, to identify present costs of all functions, to determine the impact of each partial cost on the total cost, and finally to prorate costs drop.
Diagram 1. Value Analysis of a refrigerator

**BPR and the construction firm: a case study**

Edilkit, a construction firm, is a limited company born from the partnership between entrepreneurs and professionals skilled both in design and in construction; the firm deals with new construction, rehabilitation and restoration, using advanced technology, forefront equipment and qualified alliances in the field of construction engineering and estate management. It takes part in public contracts and private contracts, and promotes its own business. Customers of the firm are private subjects, cooperative housing societies, public boards, public or public-participation service companies and societies, the firm itself (managing self-financed projects based on internal design or design developed at qualified suppliers of engineering and architectural services). Edilkit carries out works of different types: its activities cover construction, civil infrastructures and facilities engineering; the production concerns both traditional building and building integrated with third parties prefabrication elements. Edilkit developed its own ISO 9001 quality management system showing a function-based organization, and promotes ad hoc and continuous professional training in the field of quality. The scope is to reach full customers’ satisfaction with progressively reduced re-work costs, and in fact Edilkit seems to be a “good firm”: level of customer satisfaction in the past is good, no proceedings for delay in job completion, customers’ quality complains or reports of breach of contract are recorded, and consequently no significant contentious have ever been filed, while the firm is registered in qualified supplying lists of important customers.

Even if a “good supplier”, Edilkit obtains customer satisfaction sometimes after long series of reworks. For example, an Edilkit nonconformity is the following: in a bid document of concrete supply (not responding to Mix Design’s rules), mechanical resistance and relationship between water and concrete were fixed. The order was made specifying only mechanical resistance, but not water/cement ratio. Concrete was accepted in the building yard and control was made just on mechanical resistance and not on W/C. Inspection surveyed that concrete was used for the walls of a steep slope in a freezing climate, both inadequate conditions for the chosen W/C ratio, and consequently for durability. If the aim for Edilkit may be maintained to zero reworks (customer satisfaction with no re-intervention), corrective actions on the quality management system are probably insufficient (in this case the requirement transcription was probably missed due both to poor competence and to information loss through the various interfaces): hence the importance of rethinking the whole organization. All recorded non conformities exiting in bugs for durability are due to organizational faults deeper then might be overcome through progressive corrective and or pre-emptive actions: for Edilkit, the keynote of the challenge is value.

Preliminary steps of BPR are:

- to develop a strategic vision,
- to set up a coherent scheme of scopes and objectives,
- to allocate convenient resources,
- to identify guidelines for action,
- to plan operational steps of the BPR project itself.

After that, the BPR action starts sketching a new organizational structure, processes-oriented instead of function-oriented. To think in terms of process-oriented firm might mean re-valuing, deepening, dilating and modifying roles and responsibility of each construction manager, hence proceeding from a vertical, hierarchical organization to a horizontal organization. A construction manager is a project manager (Merlino 1997) whose job is bringing to reality and usability a virtual, “theoretical” model, with no chance of reference to prototypical experience, but nevertheless with stringent ties of cost, time, and stringent requirements of suitability and completeness. Furthermore, while performing his job, the construction manager today has a lot to do when other functions in the firm show antagonism or irreconcilability, and a lot of responsibility when something has gone wrong: he has nevertheless no responsibility in terms of choice nor independence in terms of decision. As a matter of fact, at present, several centralized functions manage “together” one or more construction jobs, too often extending construction time, losing the vision of the job and underestimating the job problems (client’s problems!) in respect of their own problems. On the contrary, in the company organization chart, the
position of the construction manager should be absolutely emphasized, with the attribution of the whole range of responsibilities, and a very extended management capability on the whole construction job. The projection of Autokit results into Edilkit might show:

- 75% (!) time reduction in the construction job execution,
- increased number of bids in construction competitions (this item is comparable with Autokit store cutback),
- cut in production costs due to drastic reduction of re-works.

Of course 75 % in time reduction when the building and construction field is involved is a patent exaggeration due to faults in the comparative method itself: nevertheless, that’s why the construction manager should be the process owner.

Value Analysis in the building field: choices in envelope technology

If the customer’s satisfaction is the goal, the choice of a suitable functional model for a building element, specifically in case of building vertical envelopes, seems to take origin through the rules of Value Analysis. Let’s consider at first the functional model of a traditional external wall (resistant layer on the external side and internal insulation, Forteleoni & Galimberti 1995): using suitable materials and products, and setting them out in a suitable way, probably it will be possible to assure the greatest part of functional requirements. On the other side, the solution with internal insulation may cause, in absence of complex and expensive precautions, the presence of concentrated thermal dissipations along the wall horizontal borders: consequently wall thermal resistance decreases and risk of surface condensation increases. Such a solution is dangerous also for internal condensation, producing moisture in the layer between insulation and the resistant element. Besides, internal insulation decreases thermal inertia of the wall. Furthermore, such model doesn’t assure border acoustical control while the resistant element has no protection from thermal variations. This means that a wall with internal insulation implies higher costs in exchange for poor performance, whenever used in a unsuitable contest: for instance, enveloping spaces used with discontinuous occupation.

An alternative might be a functional model provided with a vapour barrier adopted to fight internal condensation completed with stiffening layer to protect the insulating material from collision and to allow suspension loads to be applied (even though a vapour barrier may have some negative implications in terms of moisture trap and material durability). Different alternative solutions might be envisaged, considering isolated, ventilated-chamber walls, which do not request steam barrier, or externally isolated walls.

What is remarkable in this case is the strong similarity between Value Analysis process and the process of choosing suitable functional models. Functional layers in our model correspond to refrigerator's functions, and each layer has its own performance and costs related both to single layer and to the whole model. A suitable functional model is selected according to essential requirements recorded during contract review, and so also according to customer requirements. Such a case, like Value Analysis, is based on pinpointed questions: Which is the function? What is the object? How much does it cost? How does it work? Which object could replace it? How much does an alternative solution cost?

Re-valuing Construction

The International Council for Research and Innovation in Building and Construction (CIB), considering the disrepute of the term “reengineering”, renamed Construction Reengineering into “Re-valuing Construction” (CIB 2002), emphasizing connections between reengineering and value, and therefore between BPR and VA. Re-valuing Construction focuses on value increase. BPR and VA have the same objective, both playing the idea of value and both adopting similar techniques such as to charge a “coach” of the management of working teams. Besides, it could be possible to put on the same footing BPR and VA various levels:

- to identify a refrigerator's functions might correspond to establishing a company profile
- to determine required cost might correspond to scope definition and priority definition
to identify refrigerator's present costs and effect of each partial cost on global cost might correspond to identification of existent processes and with As-is models construction

• to prorate cost drop might correspond to the identification of processes for innovation, to the definition of To-be models and to the allocation of To-be to stations.

Nevertheless, BPR and VA are not alternative tools, but significant, complementary tools aimed to the same result: it might be meaningful to speak of Re-valuing Construction in terms of “reengineering according to value”.

The connection between BPR and VA is sanctioned by value, the same concept that is the foundation of “corporate finance” (Brealey & Myers 1993), a set of tools to solve problems and to manage real situations in the financial management of a company. The two fundamental tasks of a financial manager are identification of activities where to invest money and capital borrowing. The financial manager is the co-ordinator of investing and financing resolutions of a company. His aim is to assure the best conditions for shareholders and so to create value. Value becomes the unit of measurement of company success and a good financial action consists in purchasing a real activity with greater value than cost, that is an activity that makes value: a value analyst is like a financial manager, while customers are the shareholders.

Connection between BPR and VA might be enlightened also by a methodology to produce durable concrete - Mix Design - that might be considered both a reengineering project of concrete production process, and a Value Analysis procedure applied to the same process. As a reengineering project, Mix Design allows to drop a “functional spinneret” and to adopt a “process-based spinneret”: concrete is obtained after analysing and working out various inputs jointly and not separately. As a Value Analysis procedure, Mix Design is a sort of obstacle course to obtain a suitable concrete without unnecessary cost, where obstacles are, for example, ratio between water and concrete or conditions for aggregate largest diameter.

During the development of a generic process (Brealey & Myers 1993), trying to assure customer satisfaction, many unnecessary costs are added to the global cost. The more we introduced abundant, complicate steps in the process, the more we added unnecessary costs to the product: an acceptable solution consists in process reengineering, which is able to identify and remove unnecessary processing, and to cut unnecessary costs while assuring increased value to the process.

BPR and VA: a way to assure essential requirements

The EEC “New Approach” introduced the concept of “products that are fit for use “: a product is presumed fit for use when it satisfies proper requirements under normal condition of use. The New Approach “Manifesto” – the Council Directive 89/106/EEC of 21 December 1988 on “the approximation of laws, regulations and administrative provisions of the Member States relating to construction products” – aims to assure that construction works do not compromise users’ safety. It defines as “fit for use” a product that is produced, sold and used in conformity with harmonized standards; as far as they are concerned, harmonized standards include specific requirements in order to put on the construction market products that satisfy at least the essential requirements. Harmonized standards therefore, aimed to state product suitability, are drawn up from essential requirements. Essential requirements are further specified through the contents of more detailed interpretative documents: they are general and specified criteria that construction works should be assured. Essential requirements regard work safety, health, durability, energy economy, environment and some other important aspects. Construction works basically consist in addition of products, so if each single product is fit for use, and their integration is correct, the whole work assures essential requirements satisfaction. Each essential requirements plays: “The construction works must be designed and built in such a way that...”. Therefore requirement satisfaction is assured by an integrated action of project and production work; essential requirements are referred to the whole work and not only to single construction products, and work suitability is assured by product suitability as necessary condition. Hence essential requirements satisfaction is assured by the way in which the whole building process is managed and the building process should be managed in such a way to assure essential requirements.
If BPR and VA can assure greater customer satisfaction and if customer satisfaction includes also essential requirements satisfaction, consequently BPR and VA assure improved reliability in essential requirements satisfaction. The general idea of customer satisfaction might be put into better focus considering the satisfaction of both default and expressed requirements, that is to say the idea of “quality”.

With regard to this aspect, in its aim to assure quality comprehensiveness, ISO 9000 requires specific actions, referred in the 1994 edition as “contract review” and in its present edition as “identification” and “review of customers’ requirements”. This requirement consists in reviewing and checking, before any contract is be assumed:

- the legally binding requirements (including 89/106/EEC essential requirements),
- the requirements specifically expressed by the customer, and
- the requirements that the construction manager deems necessary to assure in the context of a specific job.

On the other hand, according to Miles (Miles 1989), Value Analysis assures product aptness: as a matter of fact, the thirteenth Value Analysis’s technique starts off from the question “would I spend my money that way?”. As a consequence, if VA assures a product fit for use, VA assures essential requirements satisfaction as far as a product fit for use is produced in conformity with harmonized standards, being them defined to oblige essential requirements.

Hence the conclusion: if BPR and VA assure essential requirements, then BPR and VA assure also durability, as far as durability is a *summa* of essential requirements.

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Direttiva 89/106/CEE del Consiglio del 21 dicembre 1988 relativa al ravvicinamento delle disposizioni legislative, regolamentari e amministrative degli Stati Membri concernenti i prodotti da costruzione.


