LCM - Life Cycle Management, Integrated management philosophy for building projects

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ABSTRACT: Nowadays Investors and users require sustainable buildings, low operating costs and flexibility. These requirements are a result of current problems such as extremely high operating costs due to high-tech buildings or difficulties in the maintenance due to inflexible structures. The management philosophy Life Cycle Management in construction is the sustainable way to cope with these requirements. For life cycle orientated design and build it is essential to consider the experience of future project phases (operating phase, rebuilding, ...) during project development and design. Furthermore the integration of environmental-, employee-, market- and customer-orientation in the management philosophy is essential to achieve sustainable building projects.

1 LIFE CYCLE –ORIENTED DESIGN FOR ALL PROJECT PHASES

While construction project management concentrates mainly on the phases project development, design and build, Life Cycle Management means focusing on all project phases. The whole life cycle of a building, from the start of project development to construction and operating, if necessary alteration and finally demolition respectively recycling of the building, is taken into account. Furthermore a first operating phase (lifetime e.g. 20-30 years) is followed by a second one (till the end of the life cycle) after alteration or altered utilization. Therefore the experiences and knowledge from these phases (operating, alteration, subsequent use) should be used in early project phases.

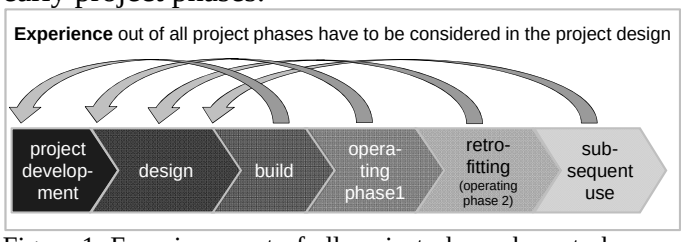

Figure 1. Experience out of all project phases have to be considered in the project design

The following four measures base on this approach: (Stempkowski. 2011.: LCM Philosophie.)

1) Experience from later phases (has) to be considered during all design phases
2) Optimization of projects for operating phase
3) Design has to take into consideration both altered utilization and subsequent use
4) Projects have to be designed user-oriented

1.1 *Experience from later phases to be considered during design phases*

The basically clear demand for optimal use of experience from later phases turns out to be a real organizational challenge in regard to its actual implementation. Depending on the respective form of organization, in many cases the specific operator of the construction project may not be known at the planning phase. Therefore most often an architect whose draft has already set the relevant course is entrusted with the design and further planning process. Subsequent designers and consultants of different special fields can only develop a suitable solution according to these basic conditions.

The **Integrated Planning Team** offers a solution-oriented approach. There at a very early stage (project development, pre-draft phase) the entire planning (design) is carried out by a team that involves not only an architect and a structural engineer, but in particular also consultants in the areas of building services engineering, electrical engineering, energy technology, building physics, acoustics, façade construction and depending on the type of project fur-

ther specialists (e.g. company organization, kitchen designer,…).

A key role is transferred to the Facility Management Consultant who provides the experience from operating and within the range of facility planning can ensure that the building functions are economically in operation.

In order to be able to consider relevant experience from the construction phase during the planning phase, in particular concerning the realization of building contracts (e.g. accounting or deviations from specifications), the construction supervision should take an active part already in the phase of preparation, when the specifications and the bill of quantities get established.

An optimal involvement requires the development of a structured process for the progressive introduction of the individual specialists. “At the earliest stage possible” does not necessarily mean that all participants have to meet immediately. Since some specialists need first drafts or the preliminary design before being able to evaluate functionality and profitability, they have to get integrated step by step.

Furthermore, an intensive coordination among consultants and any additional tasks in the course of the joint project optimization have to be taken into account in the scope of work and determination of fees of service agreements.

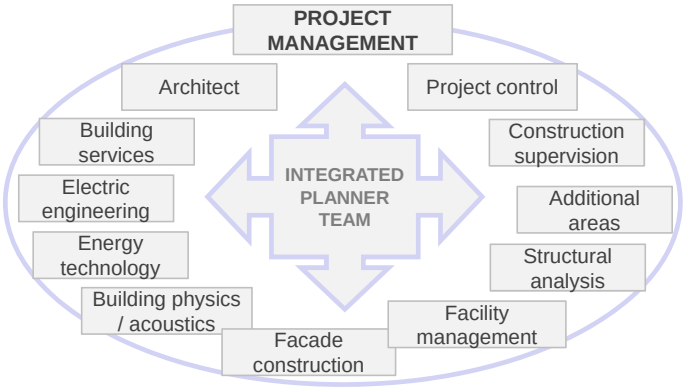

Figure 2. Integrated Planning Team

1.2 *Optimization of projects for operating phase*

Since it is well known that a building’s investment costs cover only a small part of the entire life cycle costs, the focus always has to be put on those in regard to profitability. The current standard ON B 1801-2 of April 2011 now determines a new and comprehensive definition and organization of the entire life cycle costs and can be used as new standard for all life cycle cost estimates.

Due to the authors’ point of view this overview has to be expanded towards financing costs, if the LCC-calculation is meant to determine e.g. the requirement of finances, a liquidity plan or an economic (respectively for tax purposes) result over a specific period. Figure 3 illustrates an example of an office building (100% debt financed)

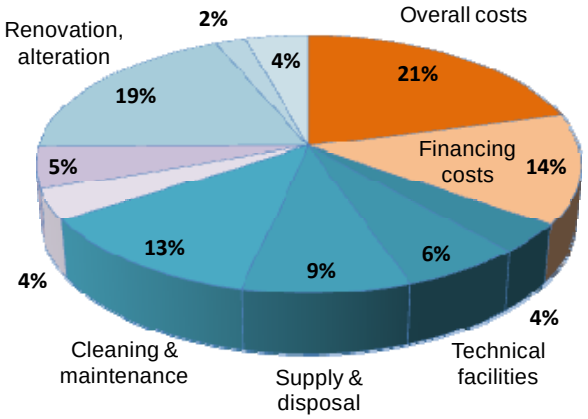

Figure 3. Distribution of LCC according to the new structure of ON B 1801-2

The predominant aim is to optimize individual cost components in respect of optimal use which in many cases means to minimize them.

Apart from investment costs (= overall costs such as in ON B 1801-1) and financing costs the major cost areas are

- Operating costs which derive from the technical building operations (maintenance, sewage system and waste disposal)
- Cleaning costs and
- Repair costs and alteration costs.

In order to minimize the **operating costs** there are numerous possibilities in regard to the conceptual design of a building (energy technology, building services engineering, E-engineering, facade, building physics,…) which range from low-energy buildings to plus energy buildings.

Optimizing the design considering the demands of **cleaning** is interesting, however, most often less recognized. Depending on a specific assumption of lifetime it may constitute in total nearly as much as the total investment costs during the first building phase. The aspect of cleaning at any rate has to be considered concerning the choice of surface materials, of facades and of the design of outdoor facilities and entrance areas.

In order to minimize **repair costs** and any future alteration costs, future restorative measures and possible constructional alterations already have to be taken into consideration during the design process. Furthermore a continuous and proper maintenance

and regular repairs planned in advance will lead to lower repair costs.

1.3 *Altered utilization and subsequent use / demolition*

As mentioned above, the operating phase of buildings can be divided into two or more operating phases, at the end or beginning of which a major restoration or a conversion or even a change of use may be scheduled. As figure 4 shows, especially in regard to debt financed objects, the second operating life proves to be economically interesting. The first investment will be amortized after 20-30 years, credits will be paid back and in the best-case scenario a budget for a conversion will have been generated so that the income can increase drastically due to the lower costs.

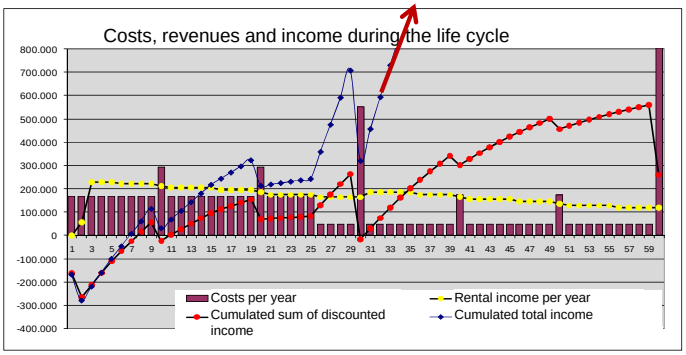

Figure 4. Costs and Income of a Property depending on a Specific Period

Taking these aspects into account, for future assumptions of a lifetime or assessment period, we have to employ periods of two operating phases that are at least 50 to 70 years for the analyses.

Life-cycle costs are low, if a conversion or a change of use can be realized quickly and cost-efficiently. Therefore a conversion or various possible changes of use already have to be considered and planned during the first planning process. Among others the following planning principles are relevant:

- Flexibility in regard to construction of object (e.g. column grid)
- Flexibility in regard to use (mobile or adaptable elements)
- Possibility of simple surface exchange
- Possibility of simple facade exchange

Should it become obvious that the object can no longer be used in an economically efficient way (= end of economic lifetime) while it is still in the operating phase, the phase of subsequent use starts. As illustrated in figure 5, the following steps should be undertaken:

Step 1	Dismantling & subsequent use of elements
Step 2	Recycling / material preparation of elements not suitable for further use
Step 3	Demolition > Separation > Disposal

Figure 5. Stages of Subsequent Use

First all elements that prove to be reusable, have to be dismantled. To this effect, the demolition of elements has to be considered already during the first stage of design, even if this occasion seems to be in the distant future and any further use of the elements in e.g. 60 years cannot be ensured. Taking into account developments in regard to consumption of resources, the reuse of materials and elements will become increasingly important in the future, instead of disposing of them or producing new ones. This approach means a new challenge concerning the choice of material and specifying individual elements, which nowadays are hardly carried out with an awareness of possible reuse.

If the elements cannot be dismantled or reused directly, they should be involved in a recycling process, if possible. Should any further reuse of the element turn out to be impossible, the individual components of that element should be processed for further use or recycling.

Those parts of the demolition which cannot be used any further have to be disposed of only at the last stage. However, the materials at least have to be separated homogenously to keep the proportion of expensive rubble at a minimum.

These steps convey that e.g. composites should be avoided in most cases due to their unsuitability for being reused as entire element which leads to additional costs and problems both in regard to recycling and sorting of waste.

1.4 *User-orientation in the design*

The statement that “Projects have to be designed user-oriented” may seem so obvious one should not think to have to deal with this aspect at all. Unfortunately the customer-orientation or user-orientation mentioned has been neglected with many projects.

If the owner or his designer does not consider the future user appropriately, it will always have an impact on the operating phase, thus leading to increased life cycle costs. The excuse expressing that “one does not yet know the user and therefore cannot consider his requests“, is unacceptable, because the owner and his designers and consultants have to create a

complex idea of a user or possible user to evaluate his demands and the actual usage.

The main challenge is not only to estimate the demands of current users but also those of users in the distant future, in 10, 20 or even 50 years.

Decisive determining factors on the lifetime and life cycle costs of the buildings relate to the actual usage pattern in the operating phase. Is an operation costs optimization also the aim of the users? Is a proper and continuous cleaning carried out at all? Are smaller deficiencies repaired regularly by continuous maintenance? Does any necessary maintenance of technical devices, but also of windows, doors and any other moving parts take place? Are bigger repairs carried out or does the negligence of such measures lead to a so-called maintenance backlog which reduces the lifetime and reasonably increases subsequent costs in the future?

On the other hand there are users who undertake alterations of constructions / or use already after a short period due to a short economic lifetime. This behavior also manifests itself in increasing subsequent costs, e.g. there might be some pressure for converting shopping centers in cycles of less than 10 years or measures concerning adaptation and extension of hotel constructions should be taken every 10-15 years. Since pressure demanding conversions will not occur unexpectedly, respective measures can be taken in advance already during planning.

2 ASPECTS OF SUSTAINABILITY

Building management that is both life cycle oriented and particularly sustainable means that all aspects of sustainability have to be considered in planning and implementation.

Apart from economic aspects which still focus unfortunately often only on investment costs, other economic aspects (e.g. life cycle costs) and ecological and social aspects should increasingly be involved in the decision-making process of the project.

Figure 6 provides an overview of the different aspects. The basis of the sustainability debate were **ecological aspects**, therefore the first aspect focuses on “Green Building”.

Since in practice the focus mainly lies on **economic aspects**, it is those aspects which have to be taken into account in an integrated approach. Only if a project pays off, it will be realized. The following analysis will show that not only the investment costs are of importance, but many other issues have to be considered in regard to economic aspects. The increasing involvement of economic aspects relates to the development from “Green Building” to “Blue Building”.

The last stage covers the stronger integration of **social aspects**. The focus is on the individual person, be it user, client, employees or concerned stakeholders. Only if the object gets accepted and appreciated by the individual, it will turn into a sustainable object in the long term, thus into a success story.

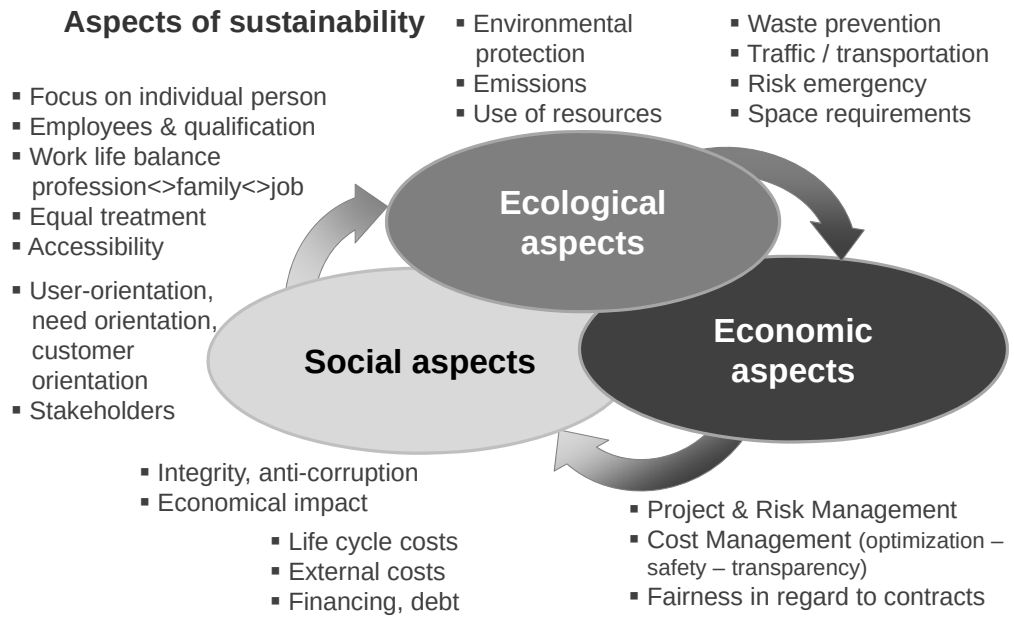

Figure 6. Aspects of Sustainability

Due to the issues mentioned above, it is really necessary to think in terms of sustainability, which means taking into account all aspects and subsequent effects in the long term and integrate them in the project. In respect of the definition of Green & Blue Building we even have to think one step ahead towards a “White Building”. Only the color white really comprises all colors and a White Building would live up to the claim of really having taken all aspects into account. (Fig. 7)

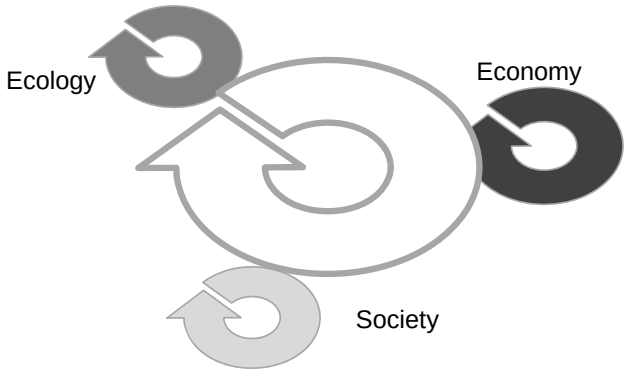

Figure 7. Green > Blue > White building

The following will show an overview of some relevant aspects of sustainable buildings. It should be emphasized that the criteria mentioned do not claim to be complete. Rather it focuses on aspects still inadequately evaluated today in order to raise some awareness for the entire range of an integrated approach.

2.1 *Ecological Aspects*

Apart from traditional environmental protection which actually includes climate protection and emissions in air, water and soil, predominantly the use of resources belongs to the ecological aspects.

Sustainable projects demand an obvious reduction of resources being used, including both material resources and the energy needed for the entire process of material production, for the building itself and for its operating. Approaches in regard to reusability and recycling during the planning will reduce the amount of waste which occurs during operating and subsequent use.

Further aspects which leave a reasonable ecological footprint involve traffic and transport of materials. Even if transport costs still remain considerably undervalued, one should try to minimize the amount of transport clearly.

Emergencies and accidents may have some massive ecological impact. Therefore risks of emergencies (not only since the nuclear accident) have to be taken into consideration in the overall context.

Finally, space requirements belong to the aspects that are still considerably undervalued. If one watches the clear increase of space requirement during the last decades and provides long-term predictions, it quickly becomes obvious that this issue will soon have to be evaluated differently in order to treat this restricted resource in a sustainable way in the next centuries.

2.2 *Economic Aspects*

Costs and their minimizing are a matter of priority in regard to economic aspects. However, nowadays opinions tend to differ concerning the question which costs have to be examined in which period.

A professional cost management on the one hand aims at cost optimization over an entire assessment period or life cycle of an object. In addition to that, aspects of cost certainty and cost transparency and those of a professional Project Management and Risk Management are major requirements of the process of project development. A fair and harmonious coexistence is one of the crucial success factors of the planning and implementation of building projects.

As far as costs are concerned, nowadays they should only be related to in terms of life cycle costs. Apart from the investment costs this involves all subsequent costs as well. The criteria for the evaluation of subsequent costs include aspects like the technical quality of buildings in respect of economic cleaning, intended maintenance, flexibility of altered use and as a matter of fact those of minimizing operating costs by a properly energy-efficient construction of the whole building and its building services.

A further aspect concerns external costs, which have hardly been evaluated properly yet, but which will certainly be given a higher priority in the future. Therefore it can only be recommended to start dealing with aspects of external costs more intensively right now. Especially in regard to costs of transportation, risks, environment and the evaluation of space requirement current approaches diverge considerably from comprehensive approaches of external costs where the consequential effects of the measures are evaluated.

An additional economic aspect with far-reaching impact deals with the question of financing of projects and any related debt of the owner / client. Especially in regard to objects financed by public funds or which are owned by the public sector or related organizations, this question is to be treated critically. After all, sustainability also means not to restrict any scopes of design for the next generation. In

the case of a high degree of indebtedness this demand gets grossly disregarded.

2.3 *Social Aspects*

Considering the social aspects during the developing and operating of building projects, the individual person has increasingly to be brought back to the centre of attention.

On the one hand the orientation concerning users, demands and clients already mentioned, works as assumption for all decisions in the planning process, on the other hand the stakeholders of a building project should also be involved in the planning process. Apart from the immediate neighbors a project manager has to cooperate with citizens' initiatives, media, politics, authorities and other local stakeholders.

On the other hand a project can only be implemented successfully, if the participants cooperate efficiently as team (Topic: Team Building as Necessary Measure), if they have the relevant qualifications (Topic: Basic Training and Advanced Training in the Sense of Life-Long Learning) and the individual employees are content and well balanced in the sense of a work-life-balance where profession, family and job promote a balanced relationship.

Additional social aspects concern the equal treatment of all groups as well as due respect for groups with specific needs, e.g. accessibility has to be a matter of course in modern design.

Eventually, social aspects with a strong relevance for profitability as the integrity of involved companies and persons have to be considered. Thus on all levels active measures for avoiding corruption have to be taken.

Finally relevant decisions should always be taken while considering relevant consequences on economics. An individual project may not lead to a positive result from an economic perspective. However, if considering economics, it may provide a profitable result and respective benefit for society.

3 DIMENSIONS OF AN INTEGRATED LIFE CYCLE MANAGEMENT APPROACH

In addition to aspects of sustainability the Life Cycle Management approach has to cover the following dimensions so that projects achieve sustainable success.

A Life Cycle Manager's core competencies comprise both expertise in the areas of Project Management, construction industry, including contract management, professional knowledge of life cycle oriented design and construction and a high level of competence regarding soft & management skills like team building, communication, conflict management, negotiating, leadership etc.

On the basis of these core competencies the following four dimensions have to be considered:

- Market Orientation
- Environment Orientation
- Customer Orientation
- Employee Orientation

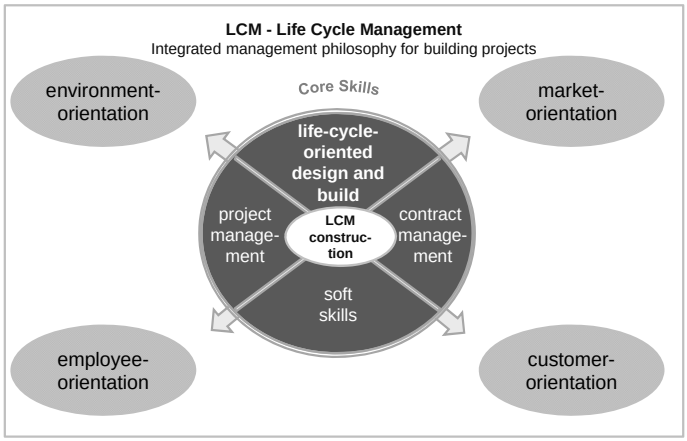

Figure 8. Four dimensions of integrated life cycle management approach

3.1 *Market Orientation*

In most cases acting independently from the market does neither make any sense nor hardly ever achieves sustainable success. Especially at early stages of project development it is required to use a well-founded market analysis as basis for relevant and indicative decisions. The entire marketing of a project should be prepared strategically and not as sum of individual measures, but derived from real need, with clear objectives and with a structured and planned communication with the public. Projects always should be the result of a strategic development of business environment and new business segments.

3.2 *Environment Orientation*

Projects always are compulsorily related to their environment. With reasonable resistance the environment can considerably delay projects and even make them more expensive without providing any added value for the user or developer. Therefore from the very earliest stage a professional management of the corporate setting has to be established. On the basis of well-founded environment analyses the individual stakeholders and sensitive issues have to be identified and respectively taken into account in the planning process and communication.

3.3 *Customer Orientation*

As mentioned above, customer orientation and user orientation as well as their satisfaction are of particular importance. Each successful entrepreneur will emphasize this importance, however, in many cases the client, his demand and the users' demand are not involved sufficiently in the planning and design of building projects. Thus objects of limited acceptance get developed which either cannot be commercialized directly or where constructional alterations have to take place after a period much too short.

Furthermore both the owner and the contractor should aim at being successful in cooperation with the client in the sense of a win-win-situation. If one partner takes advantage of the other one, only in rare cases this leads to added value, it rather leads to unnecessary additional costs for all participants.

3.4 *Employee Orientation*

A successful development and implementation of building projects is a demanding challenge which requires highly competent but also highly motivated employees in the range of all participants. Only if management executives recognize their employees as asset number 1, only if the team of the involved persons regards itself as team, only if the actors really have the technical competence by means of further training and in-house knowledge management, only if the employees are satisfied with their environment and only if they and their work get a proper degree of appreciation, they will be motivated positively and the project will have favorable conditions to achieve sustainable success.

4 PROFESSIONAL MANAGEMENT BY MEANS OF LCM APPROACH

After all, Life Cycle Management represents a specific management approach and it has to be ensured that processes as such have to be specified and implemented professionally.

4.1 *Basic Principle of Management Cycle*

The basic principle of Project Management is very simple. First the objectives are defined, then the planning takes place and afterwards the implementation is carried out. On the basis of respective analyses and target/actual comparisons the project can be controlled by establishing specific measures (Fig. 9). So far, so good. However, the question arises of why in practice many projects show considerable deficiencies concerning project management during the implementation.

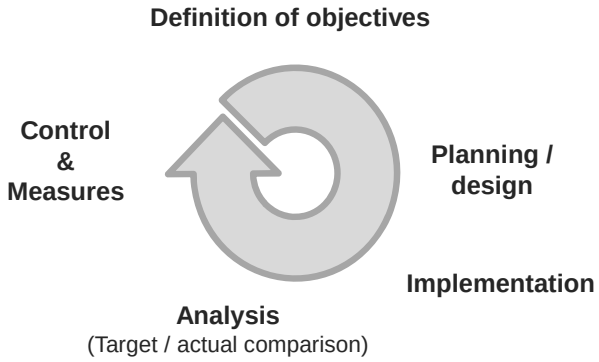

Figure 9. Management Cycle of Project Management

The challenge is to define specific objectives, although at early stages much may remain open. Furthermore there is neither any content framework nor are there organizational conditions that allow professional and target/actual comparison which means control relies on intuition and not on basis of objective data. After all, inconsequent planning of measures lead to further problems although in many cases the causes have already been recognized.

4.2 *When does project management become effective in terms of sustainability?*

Some prerequisites become necessary in order to put project management into effect in a sustainable way.

First there is the basic understanding for the idea of Project Management and the individual participants' awareness in regard to the benefit of Project Management, the management cycle and the individual PM tools.

Furthermore the Project Management has to be well established in the company, the project team cannot reasonably be required to invent the entire PM for each project anew. Rather, all project participants should be able to build on a working system of project management which shows corresponding interfaces to all other management systems and which provides the participants with relevant documents, examples of best practice and an IT environment.

Any implementation on project level has to be mainly carried out by a project manager who is supported by a team of employees and specialists according to a specific project organization defined in advance. The project manager has to define the objectives or at least has to have them approved by a decision-making body, he has to clearly assign the responsibilities, he is responsible for planning and implementation, whereas at the same time he has to carry out continuous analyses and target / actual comparisons in order to introduce an early control in case of deviations. He has to obtain an overview and define necessary measures and delegate them to his team.

Nevertheless it has become obvious that project management has to be regarded as management instrument by a project manager's superiors as well. On the basis of results of a well managed project a superior can appropriately exercise control tasks. Project management has to be actively promoted and results have to be requested regularly.

5 CONCLUSIONS

The authors' experience, e.g. from successfully implementing various Project Management and Life Cycle Management systems, provide the following success factors for developing and constructing sustainable building projects:

(1) Defining and specifying project objectives, structures and the project start as precise as possible. Life Cycle Management considers not only objectives for the building phase but also objectives for operating, alteration and subsequent use.

(2) Well-defined organization and responsibility assignment incl. interfaces between project participants. Life Cycle Management focuses on the Integrated Planner Team and a precise assignment of life cycle-oriented tasks to the individual scope of work.

(3) Emphasis on Time Management in order to increase the quality of scheduling and avoid improvisation at short notice.

(4) Foresighted cost control based on professional cost planning and cost monitoring that consider life cycle costs.

(5) Active Risk Management that allows to identify risks early and result in the implementation of measures to avoid and reduce risks in sufficient time. Life Cycle Management considers not only risks during planning and construction but also during operating and alteration.

(6) Active Opportunity Management ensures that optimization and cost-reducing potentials are efficiently utilized.

(7) Professional Execution of fair contracts with an emphasis on cooperation between parties.

(8) Structured knowledge management that encourage exchange of experience within the project and between projects and therefore lead to continuous increase of quality. Life Cycle Management also considers knowledge from operating like facility management, etc. at early project stages.

(9) Simple and consequent reporting is the basis for the management board to control the project and to represent the project. Life Cycle Management takes ecological, economic and social aspects of sustainability into account.

(10) Formal closure of the project that aims on requiring as much experience as possible for future projects using methods of knowledge management.

One does professional Life Cycle Management, if all above mentioned demands are met in a satisfactory manner.

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