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THE PROCESS OF GREEN BUILDING CERTIFICATION: AN EXAMINATION REGARDING LEAN PRINCIPLES

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ABSTRACT

The United Nations Climate Change Conference in November 2015 resulted in the Paris Agreement where 196 countries agreed to the common goal of reducing the global anthropogenic emissions of greenhouse gases during the second half of the 21st century to zero. The building sector has a large impact on the worldwide production of greenhouse gases as buildings are major consumers of energy from construction through to operations and finally, demolition. Consequently, this considerable potential for savings in emissions will have to be realized. Against this background, sustainable building will receive more attention. Green Buildings, with the emphasis on resource efficiency, comfort and high quality are very challenging for the project participants. In addition, these high demands are even increased due to the requirements of a certification system.

This document is intended to provide insights into how to best meet the above. First, by using the example of the German Sustainable Building standard, the process of Green Building certification and its realization in practice are described. Second, after giving a theoretical overview of the principles of sustainability and Lean Thinking through literature review, a practice-oriented examination of the certification process is carried out. And third, sources of waste during the certification process are revealed and an approach for improvement regarding Lean Principles is proposed.

KEYWORDS

Lean Thinking, process management, sustainability, Green Building certification.

INTRODUCTION

There is no far-reaching consensus about what attributes make a building sustainable. This is due to different statutory provisions, standards and nationally recognized guidelines. Certification systems or Green Building Labels were developed to show guidelines for sustainable construction and to brand a building as sustainable, in effect giving visibility to the public. Many other approaches to integrate sustainable aspects in the construction industry, e. g. Menezes Degani/Ferreira Cardoso (2002), Furtado (2002),

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Luo et. al (2005), Bae et. al. (2007), Klotz/Horman (2007), Rosenbaum et. al. (2012) have also been made. As an example of Green Building certification systems this paper focusses on the German Sustainable Building Certification (DGNB). This certification system consists of a criteria catalogue which provides credit points for achieving specific requirements. The criteria concern the fields of ecology, economy, social and functional quality, technics and processes, with all points being weighted differently. Site factors are evaluated separately. The total amount of credit points determines the level of certification.

As customers have shown an increased interest for sustainability, Green Building Labels have become a marketing instrument creating the chance of competitive advantages and earning higher profits in the market (Miller and Pogue 2009; Holloway and Parrish 2013). Thus, the value added by labelling a building as sustainable can often be compensated due to its bringing a higher value in the market.

However, a Green Building certificate does not guarantee the sustainability of a building to its full extend (Deutsche Hypo AG, 2011, Mehaffy/Salingoros 2013). Considering Kaizen and continuous improvement, the question if a Green Building certificate represents the optimal performance of sustainability arises. Are the fundamental ideas and principles of sustainability completely covered in the DGNB certification system or can Lean Thinking possibly contribute to an enhanced sustainability? This contribution is intended to reveal particular weaknesses of Green Building certification systems aiming for full sustainability by the example of the DGNB Certification System. Process inefficiencies to be diminished using Lean Principles are shown.

THEORY OF LEAN THINKING

Lean thinking is a philosophy that aims at reducing waste in all its manifestations within a production process (Liker 2004, Shah and Ward 2003, Shah and Ward 2007, Scherrer-Rathje et al. 2009, Herrala et al. 2012). Since the first adaption of Lean Production in the construction sector by Koskela (1992) many successful efforts have been made to apply Lean Production in the particular phases of construction projects beginning with the project drawing via designing and construction through to operating and redevelopment or demolition and the need for change has been emphasized (e. g. Koskela et al. 2003).

Womack and Jones (1996) and Liker (2004) define Lean Thinking as a philosophy that mainly follows 14 principles. In this contribution the 14 principles by Liker have been reduced to 5, because these are most useful and crucial to examining the processes of Green Building certification. As they describe processes of production derived from the Toyota Production system, not all of the 14 principles contribute to an efficient examining of Green Building certification processes. Regarding the following 5 principles deficiencies of a Green Building certification are revealed:

1. Specification of value from the customer's point of view

The definition of value is the key task in developing any product which is intended to be marketed successfully. Koskela (2000) defines value as the fulfillment of a customer's requirements. So over-fulfilment or missed requirements cannot be compensated.

Identifying the specific customer's requirements exactly is crucial to defining the value of a construction project from the customer's point of view (Valente et al. 2013). Koskela and Tommelein (2009) state that the client's requirements are not clearly defined at the beginning of a construction project, but are evolving through the process of a Real Estate development project. The project goal is seen here as "moving targets to be managed throughout the production process". Involving the project participants in an early stage of the design and planning process can help to better define the customer's requirements and leads to an optimized result by integrating the experts' experiences.

Given that the equivalent value that the customer is willing to pay for a building is limited to a cap, the need to improve the internal processing to produce profit is obvious.

2. Analyzation of the production processes (value stream)

The analyzation of the production processes aims to identifying the value stream. This is considered to be an array of production stages which all add value to the product and lead to its completion (Womack and Jones 1996, Rother and Shook 1999, Herrala et al. 2012).

Real Estate development projects are special in terms of their production processes. They are, unlike the stationary industry, usually divided into particular sub-processes, e. g. design, construction and maintenance under the responsibility of different project participants. In addition, the interdisciplinary participants typically are not a well-functioning and seasoned team, but working together for the first time and creating a prototype that hasn't been built before. Consequently, a well-structured, conversational project management is eminently important to achieve the defined value and project aims in an optimal way.

3. Ensuring an effective process flow

Womack (2006) defines an ideal value stream as a constant process flow in which one value-adding step is followed by another without waste, e. g. waiting (Womack and Jones 1996, Rother 2010, Herrala et al. 2012).

4. Pull production: produce what is demanded by the customer when it's demanded

The core message of the principles of pull production is producing only what the customer wants when he demands for it (Womack and Jones 1996, Rother 2010, Herrala et al. 2012). In practice, this theory can be implemented as an array of requests for resources along the production chain, but in reverse. One production unit "pulls" a request for e. g. material or information defining exactly its amount from the downstream (or supply-)unit. This procedure allows savings in resources by avoiding overproduction storage (Womack 2006, Herrala et al. 2012).

The theory of pull production implies an exact definition of the customer's requirements. This target requirement has to be translated into subsidiary aims and instructions forming an efficient entire production chain. Efficient processes can only be achieved if the formalities and standards of "pulling" resources are determined at the beginning of the project and are obeyed by every project participant.

5. Continuous improvement of all processes

Crucial for continuous improvement is a working atmosphere which allows the participants and employees to develop new ideas and approaches. A conversational

interdisciplinary project team can achieve great improvements of the product and processes by combining the participants' particular know-how. However, in Germany this discourse and knowledge exchange is not common practice, but rather an exception. The project participants often only consider their own success and profit instead of the overall purpose of an optimized production process and valuable final building. Many project members worry about losing competitive advantages by revealing their know-how in the common tendering and award procedures. Other forms of contracts, e. g. partnering, could counteract these apprehensions and lead to a more constructive cooperation in favour of the project's success (e. g. Howell et al. 1996).

THEORY OF SUSTAINABILITY

The basis of the concept of sustainability is the statement that most resources are finite and thus should not be exhausted, but re-used. Resources which are replaced by nature continuously, e. g. insulation or wind, should be used intensely as "natural income energy". Another basic principle of sustainability is avoiding releases of toxins from resource processing into the environment (Langenwalter 2006). The "triple bottom line" expresses an approach which adds economic and social criteria to the environmental aims of sustainability (Elkington 1997).

The Brundtland Report (WCED 1987) stated the concept of sustainable development. It says that sustainable development should "meet the needs of the present without compromising the ability of future generations to meet their own needs". This report was a valuable stimulus for all industries to rethink their production processes. In fact, incorporating sustainability principles into the business processes can pay off and also improve a company's finances by emphasizing resource efficiency (Langenwalter 2006). The construction sector, as a resource-intensive and great waste-creating industry (Pinheiro 2003) throughout all production stages, has accepted the challenge of adjusting the production processes to sustainable principles.

Kibert (2007) defines the principles of sustainable buildings as reducing and reutilizing resources, utilization of recyclable resources, protection of the environment, elimination of toxic elements, involvement of lifecycle costs and aiming for quality. Sustainability can also be seen as a strategy to achieve a building which is in accordance with its environment taken into account social, economic, biophysical and technical aspects (Asiedu et al. 2009). In a greater context, sustainability in the construction sector cannot be considered an issue of one single building, a town or a country, but as the result of an interaction of all Real Estates on the planet (Augenbroe and Pearce 1998, Huovila and Koskela 1998, Salvatierra-Garrido et al. 2010).

PROCESSES OF DGNB-GREEN BUILDING CERTIFICATION AND LEAN PRINCIPLES

Real Estate development projects which aim to achieve a Green Building certification usually are complex, innovative, pursue a high quality standard and furthermore have to fulfill certain criteria and requirements of the certification system. Lean Thinking, as a philosophy of managing processes efficiently and eliminating waste, can possibly contribute to optimizing the development processes of sustainable buildings with these

especially high challenges and thus even increase the building's sustainability. This is to be examined by analyzing the processes of Green Building certifications (DGNB) based upon the aforementioned 5 principles of Lean Thinking.

1. Specification of value from the customer's point of view

Achieving a Green Building Label itself can be a value required by the customer. One of the main reasons for a Green Building certification is marketing. The aims can be to establish a sustainable business strategy by showing Corporate Responsibility and certifying corporate Real Estates or to achieve better marketing opportunities in Real Estate development projects. Most Green Building certifications are thus not obtained because of environmental protection and the responsibility for further generations, but rather based on a careful consideration of economic factors. The basis of the decision which Green Building certificate to choose often is a comparison of the efforts and estimated costs to achieve the highest level in each case. Quite often, the least expensive one is chosen.

In the development of sustainable buildings according to a Green Building certificate, the fulfillment of the certification system's criteria plays a major role. By deciding to strive for a Green Building certificate, usually a certain standard, e. g. DGNB Gold, is targeted. This target has to be achieved in the course of the project to recover or justify the additional costs and efforts of the certification process. This may lead to the neglect of the real customer's requirements and even replace them by the system's criteria catalogue. Consequently, the detailed determination of the customer's requirements can be impaired leading to a failure of performance and operational problems.

The focus during the certification process is often on achieving credit points, rather than on adding value to the building and developing a useful concept for it. Quite often in aiming for a high number of credit points, the least expensive measures to achieve them are chosen, e. g. building bicycle stands instead of expensive technical innovations. This fact is also mentioned by Parrish (Parrish 2012). Furthermore, measures to improve the building performance at times are not realized, specifically in cases where there are no credit points to be gathered in order to limit the already high project costs. Furthermore, not receiving credit points for an effort is frustrating to the project team and may result in lower performance.

Increased costs due to the usage of innovative building materials or building services and installations and higher expenses for documentation may compromise the profitability of the construction project if these investments cannot pay off during the lifecycle of the building. (Klotz et al. 2007; Koskela 1999; Mogge 2004) Mainly, such buildings are realized as "flagships" or to make an example, but are not efficient. After Lean principles, a waste of financial resources is created.

Design modifications can be a result of changed customer requirements, including the situation where the modification is directly related to the achievement of a Green Building certificate. It is not uncommon that the decision to get a Green Building certificate is made at a time when the planning is nearly finished. Integrating the certification system's criteria can be difficult at this planning stage and results in changes in the building's characteristics. These modifications of planning lead to inefficiencies in

the developing process of the Real Estate and, given that the original planning was based on a precise determination of the customer's requirements, can contradict them. Thus, it is possible that the customer's requirements are not completely fulfilled in favour of achieving a Green Building certificate. In fact, it can occur that value which is actually required is not realized, but measures are taken which do not contribute to an optimal building operation, e. g. the integration of artworks.

Especially under difficult conditions on the market, Green Building certificates cannot only be a competitive advantage, but also a risk. To market the floor space successfully, sometimes significant individual adaptions to the designs according to the customer's requests have to be made. These modifications impair the process planning and may contradict the criteria catalogue. This can lead to a conflict between the value definition of the Green Building Label and the value appreciated by the customer which either threatens the achievement of a Green Building status or the project's profitability.

2. Analyzation of the production processes (value stream)

The DGNB certification system takes all production stages into account. Therefore, all sub-processes, e. g. design, construction, operating etc., have to be analyzed and organized in order to meet the requirements of the criteria catalogue to achieve credit points, e. g. the kind of interdisciplinary working together and project culture, emissions and noise production during the production work or user guidance in the phase of building operation. Furthermore, certain tests, e. g. Blower Door Testing or the measuring of pollutant emissions, and additional requirements and restrictions are required and have to be integrated into the production process.

3. Ensuring an effective process flow

The participants in Green Building projects are often not used to working according to the certification system and their normal business processes don't meet the requirements. As construction projects are usually time sensitive, there is often no detailed explanation of the relevant criteria to the executors. Without a well-structured communication flow with the persons performing the work, process inefficiencies and waste are produced when actions and measures are not done according to the criteria and have to be redone and adjusted. An example is the utilization of not "permitted" process materials, e. g. adhesives, on the site due to the unawareness of the workers and consequently the necessary removal.

During the certification process, the interdisciplinary project team often is unsure of their functions and responsibilities. Especially the form of the documentation of all measures – crucial to achieve credit points – often is unclear. Due to failed communication, evidence and documents frequently are not of the requested form or are not recorded at all. Setting them up once again or afterwards can be very time-consuming and thus creates a waste of human resources.

4. Pull production: produce only what is demanded by the customer when it's demanded

In Green Building certification projects, the information process flow is often not efficient due to inexperience and a lack of awareness amongst the project participants. It is often not defined, who has to deliver what information when and in which way or

quality. Unclear responsibilities and tasks and an unorganized project structure plan cause inefficiencies and a waste of time, material and human resources.

5. Continuous improvement of all processes

The inflexible criteria catalogue of Green Building certification systems does not much encourage the project participants to think out of the box. Thus, the fixed criteria can inhibit an improvement of the building performance in the planning phase and can lead to reduced proactivity and personal initiative where they are only “fishing” for credit points.

CONCLUSION AND DISCUSSION

Process inefficiencies occur in every construction project due to failed communication, problems concerning the practical and technical feasibility of the planning, site conditions, legal restraints etc. Green Buildings due to the goal of a high level of quality, innovation, resource efficiency and comfortability are especially challenging. This is not only because of the ambitious targets, but also a result of the numerous project participants and experts and the requirements of the certification system. The outlined difficulties in the process of obtaining a sustainable building certification show that there is waste which can be reduced by the utilization of Lean principles. Eliminating a waste of resources thus can increase the sustainability of a Real Estate.

Yet, there is not enough attention on the development and production processes of Green Buildings in certification systems, e. g. DGNB. Fulfilling some criteria in the system’s checklist does not represent a project culture of a well-structured communication and information flow. Without a well-organized project management, a waste of resources in all possible forms can result which is not in conformity with the principles of sustainability.

Waste during the process of Green Building certification mostly results from inexperience of the project participants in the procedure and requirements of the certification system. Detailed information and training with regard to the characteristics, systematics, formalities, requirements and opportunities of the certification system can help to achieve an efficient process flow. In this training, not only the responsible, but also the executing persons should be included.

The above-mentioned boundary conditions of Green Building projects and the coordination of the interdisciplinary project team necessitate a well-organized and structured project management. An effective process flow can only be achieved if all project participants in every sub-process know exactly their task and the needed quality of their contribution to the production of the sustainable building. If this prerequisite is fulfilled, a process flow can be planned where one value-added production step follows another without creating waste, e. g. overproduction, incorrect quality or timing.

The target requirement of creating a sustainable building has to be translated into subsidiary aims and instructions. These can be developed into “puzzle pieces” of production – units of information or material specified in their form und quality to be demanded by higher production steps. It is crucial to define these units of the production process thoroughly so that every project participant knows what his due is. Thus, an efficient pull production is created in which every unit has its defined parameters and can

be pulled at the exact time when it is needed. A continuous improvement of the processes leads to a higher efficiency and is the basis of all progress. The defined units and standards of the development, certification and production processes should not be considered as fixed, but following Kaizen, analyzed, rethought, improved and renewed to achieve a greater efficiency.

Without a well thought out design and construction, taking into account local conditions, user behavior and the avoidance of resource waste, no sustainable building can be achieved. It is not enough to fulfill the criteria catalogue of a Green Building Label, but the building as a system with all its influences has to be considered and lead to an optimum. Involving the customers in the development of the building concept is crucial as the user behaviour has a significant impact on the actual resource efficiency and sustainable building performance. However, it cannot be assumed that the customer is always able to anticipate the impacts of his decisions on the building operation. Thus, a precise determination of the customer's requirements and a constructive dialogue are essential. Measures which the customer does not value or which he cannot use (correctly) during the building operation should not be included as this creates waste. If the customer mainly aims for achieving a Green Building certificate, e. g. as part of his marketing strategy, then not just the way of least efforts, but the most reasonable one should be chosen. It may at first sound correct in terms of Lean principles to only deliver what the customer values, in this a Green Building certificate with a minimum resource input, but in the original meaning of sustainability it is not.

Especially Green Buildings as “flagships” of sustainable and responsible building should be drivers of innovation and reach for the best quality, resource efficiency and user satisfaction possible. This can only be achieved by working together across all disciplines, while creatively combining the expertise of all of the project participants. However, strictly following a criteria catalogue choosing the line of least effort does not lead to sustainability at large. This can inhibit the advancement of creative and efficient building concepts and blight initiatives to improve the building performance.

As a conclusion, to encourage the project participants to enhance the resource efficiency and sustainability of the building by developing innovative ideas, a Green Building certification system could be created in which there is no criteria catalogue to fulfill. Instead, guidelines for sustainable building with the integration of Lean Thinking as a maxim for design, planning, construction, operations, refurbishment and demolition as well as for project management, working culture and communication/information flow could be introduced. Thus, the development philosophy and strategy would be certified as a way of project realization. Following this approach, waste in the development processes could be eliminated and better overall building concepts could result through an optimization oriented working methodology of the entire project team. As an incentive, the Green Building Label in different levels could be awarded to a sustainable, efficient building concept after a detailed examination. In this case, the actual building performance should be regarded in terms of theoretical parameters and calculations, e. g. especially related to the heating demand and heat balance, which can differ a lot in the real building operation.

Deregulating, simplifying and making the certification processes more open could contribute to an increased number of Green Buildings. As sustainability must be seen as a sum of the global performance of all Real Estate, the current small number of Green Buildings does not realistically help in reducing the greenhouse effect. In addition, the numerous existing buildings have to be energetically modified and adjusted in terms of the sustainable use of resources.

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