DESIGNING FOR SECOND GENERATION VALUE – FUTURE PROOFING CONSTRUCTIONS

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ABSTRACT

Lifecycle consideration in terms of environmental impact and total cost of buildings attract increased focus in construction. Here, total cost and environmental impact both involves: erection, operation, maintenance, demolition, and disposal of the building. The mindset of Lean Construction is focusing on eliminating waste and adding costumer value to both the design and build phases. But in this aspect waste and value is only viewed in the first generation owner perspective with fixed usage. Through theoretical considerations this research looks into the change of costumer value. Changes happen, so do changes in usage of buildings. Organisations and structures change, the result is often changed requirements or changed value perceptions. Costumer value is decreased since the owner has a building not fitting the present demands. Hence, there is a need of a construction redesign or in a worst case scenario the building end up unused. If, in the design process thoughts have been put into the *"value-lifecycle"* including second and even third generation usage, the transformability process of needs from generation to generation could be improved. This way value is kept in the building. Keywords in what could be called Flexible-Value-Design are multiple usage possibilities, flexibility and transformability.

Keywords: Flexibility, Lean Construction, Transformability, Value, Waste.

VALUE CREATION IN CONSTRUCTION

Value is an important element in Lean Construction and design. Here, the basic concept is to remove waste in order to increase the value creation (Freire and Alarcón 2002; Koskela 1996; Koskela 1992). According to the Lean philosophy value is to build what the customer wants or desires. Thus, it is a fulfillment of the customers' whishes, demands, and requirements. Johnson & Kaplan (1987) defined value this way: *"value of any commodity, service, or condition, utilized in production, passed over into the object or product for which the original item was expended and attaches to the result, giving it its value."*

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The question which needs to be asked is: who is then the customer? In Lean an activity is said to have two different customers (Wandahl 2004). Construction projects consist of multiple trades with interacting and interdependent activities (Bertelsen 2003; Salem *et al.* 2006). The first customer is the trade which have to follow up on the completed activity, i.e. the next link in the supply chain. The successor is dependent on the quality of the work and it being ready on time. If the previous activity is not completed or rework is necessary his own work cannot be conducted timely. If he has no buffered activities his productivity will decrease. Furthermore, because the construction is restricted by a tight sequence delays in one activity will easily be transmitted and therefore affect other subsequent activities (Lindhard and Wandahl 2012). The second customer is the end customer, user or the owner of the construction. Here, functionality, design, quality, cost, time, etc. are affecting the end customers' perception of value at the acquisition date.

Value creation is said to be a fulfilment of the customer's needs (Freire and Alarcón 2002). The Lean Construction philosophy seeks increased customer value. But value is only viewed in relation to the 1st generation owner and with fixed usage. Thus, focus is only on capturing and fulfilling the present needs of the owner (Freire and Alarcón 2002). Therefore, only the current needs are in the design process captured and transferred into design specifications (Ballard and Koskela 1998). The owner's present needs represent only a snapshot of the owner's value perception which over a period of time will change (Flint *et al.* 1997). Usage of buildings follows the changing needs of the owner and users and does therefore also changes with time. Therefore, the perception of the buildings value decreases when the building no longer fulfils the owner's needs.

More attention and new approaches is needed in order to overcome the owners changing value perception and preserve the value of the building. Moreover, when designing buildings it must be taken into consideration that the building at some point will change users and even owner. Here, the building now has to fulfill the needs of the new users or the 2nd generation owner. Furthermore, when the building is put up for sale the transferability is important, and together with the market value it composes a large share of the owner's value perception of the building.

In order to preserve the value of the building the buildings fulfillment of need has to be flexible making it possible to adjust for future needs. Therefore, when designing and constructing with multiple usage possibilities in mind much more value can be added to the building. Furthermore, to future proof the construction, 2nd and 3rd generation owner value should also be considered to increase the buildings value in the whole lifecycle.

A CHANGING ENVIRONMENT

The world is not static but dynamic and changing. Companies and cities develop through time and causing the surrounding environment to change. The developing companies have continuously to make organizational, infrastructural, and constructional changes to adjust and fit into the new reality (Simons 1994). Still constructions are when designed and constructed viewed as static monuments.

The companies changing constructional needs lead to redesigned, sold, or in worst case unused or demolished constructions. Thus, sold constructions do reflect the tendency of changes in the owners' value perception and needs. Historical evidence

show that the usage of constructions change. Therefore, in an attempt to picture the changes in usage of construction the national statistic of registered sales in Denmark is shown in Table 1. The figures have to be related to the number of inhabitants. Denmark is a small country with approximately 5.4 million residents.

Table 1 Registered Sales in Denmark (DST 2012)

Sales: Year	**2006**	**2007**	**2008**	**2009**	**2010**
Factories and warehouse buildings	1.756	1.617	1.219	705	1.240
Agricultural property	5.498	5.598	4.782	3.556	3.595
Business property	2.069	2.061	1.545	1.006	1.289
Mixed residential and business property	3.448	3.122	2.306	1.538	1.799
Apartment block	3.765	3.526	2.476	1.738	2.333
Single-family homes	58.950	58.270	46.138	40.551	46.504
Owner-occupied flats	22.098	20.834	15.567	13.540	15.943
Holiday homes	11.412	9.858	7.522	7.000	8.020

From Table 1 the total business related sales can be calculated. This includes factories and warehouse buildings, agricultural property, business property, and mixed residential and business property. From 2006 to 2009 the total business related sales varied from 6.805 to 12.771 sales. During the financial crisis the sales dropped down.

Despite a concomitant changing effect which was expected to race sales the crises did moreover affect the companies' solidity and the propensity to invest. Furthermore, the crisis did make it difficult to receive mortgage loan. This made the property difficult to sell and the prices dropped (Brunnermeier 2008). Therefore, a lot of companies' have been forced to keep constructional facilities which do not fit the current needs. To keep the construction still useful transformability and flexibility has been extremely important.

Not only big financial crises affect the owners' constructional needs. Small changes or developments in the surrounding world continuously change the owner's value perception. Changes happen both inside and outside the company and forces changes to the constructional needs. Everything can change and affect the usage of the construction. Thus, changes are influenced by an infinite number of parameters which make the changes complex and impossible to forecast.

Changes in the organization will always induce changes in usage of the constructional facilities. The owner can chose to ignore these changes by accepting a reduced fulfillment of needs, he can chose to redesign the construction to fit current needs or he can chose to sell the constructions where after the 2nd generation owner has to redesign the construction to fulfill his needs. To fit the building to the new demands the building has to go through a transformation process.

Transformability is important. Multiple options promote the likelihood of a redesign of the constructions. If the construction is not transformable it is a risk that it

sometimes in its lifecycle will end up unused or demolished before necessary. The key is to design the building so the transformation has to be as little and as simple as possible. Thus should changes be as quick, easy, and cheep to complete as possible. To promote transformability the building needs to be designed for a changing environment. Thus, the design process should consider the whole *"value-lifecycle"* of the construction which has to fulfil the changing needs of both 1st 2nd and 3rd generation owners. The question which needs to be answered is:

How do we handle the changing needs of the customers and how can we increase the constructional transformability to make the constructions fit to current needs?

The research is explorative, open-minded, and visionary; it tries through creativity to avoid the limitations of a narrow-minded and traditional way of thinking. The reseach presented is grounded on theoretical considerations alone but will be followed and supported by further research. The future research will focus on the changing constructional needs of companies in Denmark.

HANDLING CHANGES IN USAGE

Companies are continuously affected by their surrounded environment which changes their needs and value perceptions. Often these changes are related in the marked and therefore difficult to forecast. The outcome is changed usage of the company's constructional facilities. It is important to secure that the building is fully utilized and still fulfil the company's needs. Therefore, to enable the company to respond to changes, constructions need to be adaptable.

Even though changes in general are difficult to forecast some changes might be predicted and should be considered already in the constructions design face. Many future problems can be caught before emerging by carefully contemplate the construction design. Tendencies in the surrounding environment and the existing marked can be analysed and predicted just as in real business life.

Foresight is important. Here, the company's plans and expectations to the future are in particular important. For instance, it would be stupid to build a construction with a non-expandable max capacity if the company is experiencing or expecting high growth. One way to capture the future needs could be by making the owner conduct a *"lifecycle"* plan of his expectations to the future usage of the building in its lifetime. Thus, the design face should proceed based on the owner's *"lifecycle"* plan. Predicting the future is difficult. Therefore, it is important to notice that the *"lifecycle"* plan is only expectations which thus are not necessarily fulfilled.

In order to optimize the value-fulfilment the *"lifecycle"* plan needs to cover all relevant focus areas. One example to a focus area to carefully consider is the location. A lot of factors have to be taken into consideration. For instance: Does the location fulfil potential future needs? Does the location make it possible to upgrade and expand the facilities? If a future expansion is considered should surrounding acreage be purchase? How do geographical changes in the marked and organizational changes in the company affect the location? How is the location in relation to transport options and logistics and can the location fulfill potential future needs with increased sales? Is it possible to attract a qualified labour force? If a future sale is necessary would the location promote a future sale? All relevant questions need to be answered and considered already when the construction is designed.

There are a lot of other relevant focus areas besides the location. Another example could for instance be environmental concerns including future environmental requirements, energy consumption, and the company's external appearance as an environmentally preferable company. It is important to state that the list is not considered exhausting. The number of questions and consideration continue almost infinitely. If all concerns have to be considered the design process will become very complex and cost full. Therefore, the purpose with the *"lifecycle"* plan is to let the company identify the relevant key issues. These key issues do then form the groundwork to the subsequent design of the construction.

Furthermore, since plans does not always become reality the contemplate design with relation to the owners *"lifecycle"* plan should be supplemented with an increased flexibility and transformability in the construction design.

Flexibility is understood as the ability to change the constructional usage without needing to make constructional changes. Thus, increased flexibility makes the construction agile because the ability to adapt to the changing environment is increased. The key to flexibility is design the construction with multiple applications in mind. This could for instance be by making the inner shape of the room flexible. This could be achieved by using walls or interior which are easy to displace.

Constructional flexibility would make it less cost full to change the design since it reduces the need of transformation in the adaption process. But instead will the creation of flexibility in the construction most likely induce increased cost to the erection of the construction. Therefore, both related expenses in cost and time and possible savings have to be taking into consideration in the design face. Therefore, every initiative, which purpose is to increase the flexibility of the construction, has to be considered individually with the owner as the decision-maker.

Transformability is the ability to change usage of the constructional facilities. Opposite flexibility the construction is transformed in the process. The constructions transformability is determined in relation to the cost, time, and the resources spend in the transformation process. Basically there are two different types of transformability. Here, one type of transformability is related to the ability to transform the existing structure in order to adapt to the changing environment.

One approach to achieve transformability in the existing structure could be by reducing the number of load-bearing wall which penetrate the inner structures. This increases the adaptability in the inner design of the construction where light wall easily can be broken down or dissembled.

The second type of transformability is related to the ability to ad structures to the existing structure. This form of transformability could for instance be related to the possibility to add an extra floor to an existing construction, building an expansion, or constructing an entire new structure. Since this transformation has to be completed without ruining the design of the constructions both design and structural concerns are critical. Since increasing the transformability of the constructional structures, likewise flexibility, is cost full a cost-benefit analysis needs to be preformed. Again the initiatives have to be considered individually where it in the end is the owner's call to make the final decision.

It is important to notice that the effects of value changes not are limited to be handled in design. Changed values and needs can have an impact already in the construction phase. Often the owner does, in collaboration with the architects, continuously make changes in the design. This is often small changes related to materials, textures, or colors but sometimes the changes are having a greater impact even at the structural design. Therefore, construction planning and scheduling does not only have to cope with the complexity and changing nature of a construction site it also has to be able to handle the owners changing needs satisfactorily. Changed design caused by changed owner values or needs bring uncertainty into the schedule. The scheduling tool needs to be able to handle this uncertainty and still keep a steady workflow to maintain high productivity.

Today most changes evolve unforeseen. Changes can happen at any time and therefore interrupts the making ready process. To minimize the impact changes has to be foreseen. One approach is to investigate the triggers which cause changes. This helps site-managers to understand and predict future changes. A second approach to foresee upcoming changes and react faster is to improve the communication between construction site and owner and architect. If structural changes are needed the flexibility and transformability of the construction is once again important to adjust the construction to fit current customer needs. Moreover, the flexibility and adaptability is important in the workforce and in construction process itself. Communication and collaboration are essential when handling changes. It takes teamwork to work around the changes to find and exploit new possibility and to optimize the process. Furthermore, communication and collaboration does minimize misunderstandings.

FUTURE RESEACH

This research is an initial part of an on-going research that emphasises Lean Construction and creation of customer value. The main focus is on how to coop with changes in the customer's value perception in relation to usage of the constructional facilities in the constructions lifetime. The purpose of this research is to create a broader understanding of values not as static but dynamic. Additional further research is needed to support the research and to form guidelines for achieving flexibility and transformability in the design face.

Future research areas include:

- What are the root causes to why companies replace or redesign the constructional facilities.
- Understanding the dynamics which drives and triggers changes.
- How constructions are adapted to the changing environment and which parameters do increase this transformability.
- How flexibility and transformability can be achieved in an constructions
- What are the key parameters which should be considered in order to future proof a construction.
- How and when foresight is achieved.
- Improving the schedule in handling unexpected changes

CONCLUSION

In relation to the Lean Construction philosophy value is achieved by fulfilling customer needs. To respond on a changing environment constructional usage needs to adapt to respond to the changing world and fit to the present needs. Even so constructional value is in design considered as static. Thus, the design process should consider the whole *"value-lifecycle"* of the construction which has to fulfil the changing needs of both 1st 2nd and 3rd generation owners.

In order to preserve the value in the construction the constructions fulfillment of needs have to be flexible making it possible to adjust for future needs. Changes are difficult to forecast but instead of ignoring the changes tendencies in the surrounding environment and the existing marked can be analysed and predicted. The company's plans and expectations to the future are in particular important. Therefore, it is suggested that the owner should conduct a *"lifecycle"* plan of his expectations to the future. Thus, the design face should proceed taking the owner's *"lifecycle"* plan into consideration.

Since forecast not always are reliable the construction still needs a flexible and transformable design to increase the adaptability to changes in usage. Flexibility is understood as the ability to change the constructional usage without needing to make constructional changes while transformability is understood as the ability to change usage of the constructional facilities by transforming the constructions. The constructions flexibility and transformability is determined in relation to the cost, time, and the resources spend in the adaption process.

Transformability can be categorized into the ability to transform the existing structure and the ability to ad structures to the existing structure. Since transformation has to be completed without ruining the design of the constructions both design and structural concerns are critical. Opposite is constructional flexibility achieved by designing the construction with multiple applications in mind.

Increasing constructional flexibility and transformability, to make the construction agile to changing usage, is cost full. Therefore, both related expenses in cost and time and possible savings have to be taking into consideration. Every initiative, which purpose is to increase the flexibility or transformability of the construction, has to be considered individually with the owner as the decision-maker.

The tendency of changes in customer needs is often already experienced during the construction phase where the schedule has to handle the unexpected changes in the design satisfactorily. If a change requires structural changes flexibility and transformability of the construction is once again important. The impact of changes can be reduced by understanding the triggers to predict future changes. Furthermore, the impact can be reduced by improved communication and collaboration at site.

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