TOWARDS A FRAMEWORK FOR UNDERSTANDING AND DESCRIBING THE PRODUCT VALUE DELIVERED FROM CONSTRUCTION PROJECTS

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ABSTRACT

For the physical construction of buildings delivering maximum value basically boils down to delivering what has been designed with no waste. An imperfect understanding of what actually constitutes value for the customer is therefore of no great consequence. The same cannot be said for the design process, where the specific value that is to be delivered is defined.

It is therefore important that people involved in the design of building have proper grasp of what value is, both specifically on the project that they are working on and in general. Within LC workshop approaches are often employed to determine what constitutes value for the client. This can be useful on specific projects, but is not helpful for developing an intuitive understanding of value in general. Neither are the current definitions of value employed by the community. It has been our experience that they are too abstract to be sufficiently accessible for students and practitioners.

In this paper we present a draft of a framework for understanding and describing the value of the end product of the construction process, the finished building, centred on the customer's business model and processes.

KEYWORDS

Value, product value, business model, business processes

INTRODUCTION

Much has been written about value within the Lean Construction community, but as a concept value is ambiguous (Salvatierra-Garrido et al., 2012) and there has yet to appear an universal theory of value in the construction industry (Salvatierra-Garrido and Pasquire, 2011). Within the LC literature there has been a predominantly waste related view on value. This could possibly be tied to Lean Constructions roots on the production side of construction projects, with design only coming into focus in recent years.

In the production phase *what* is to be delivered has already been precisely defined in the previous phases. Hence maximizing value gets reduced to delivering this as cheaply as possibly at the right time; something that to a large degree can be achieved by minimizing waste. In design what is to be delivered is an open-ended question. It will be a result of the conversation between the ends, means, and constraints of the

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client (Ballard, 2008). Furthermore unlike production, where rework is inherently negative and wasteful, in the design phase iterations can be both positive and negative (Ballard, 2000). But even though iteration might be positive in the sense that it yields a better solution, it might have a negative impact on the value of the project. A marginally better solution can always be found, but at some point the marginal cost of doing more design work is greater than the marginal value achieved from the better design (Meland, 2000).

To be able to maximize the value delivered from the design process it is important that people involved in the design of building have proper grasp of what value is, both specifically on the project that they are working on and in general. It has been our experience from working with students and practitioners that the existing definitions and explanation of value are too abstract. They might be meaningful for scholars and academics, but for the average practitioner or student of Lean Construction they are not very helpful in promoting an understanding of value. Similarly, workshop approaches are helpful for mapping the value on specific projects, but do not help in giving an intuitive understanding of value in general. In this paper we seek to rectify this by presenting a framework that should be conductive for understanding and describing the product value delivered from a construction project.

METHODOLOGY

The framework presented in this paper started out as a list of bullet points on a slide in our class on building design management in the spring of 2011. It was an attempt to render more concrete what actually impacts the value for a client of a building (that is the end product of the design process). This first draft was based purely on our own understanding of value and had in hindsight gaping holes in it. .

When we were revising the slides the following year it occurred to us that we should be able to systemize our bullet points into a more coherent framework. At which point we started looking for common elements and looking more thoroughly into the literature on the subject. Based on our finding we formulated the framework that is presented herein.

So far we have not done any formal testing. What we done is to consider every aspect of value that we have come across in the literature and assured ourselves of that it could be explained in our model. We have also done countless internal brainstorming sessions trying to come up with client needs that could not be placed comfortably into our framework. With a few notable exceptions, which are discussed towards the end of this paper, we have found none.

LITTERATURE REVIEW

The question of what value is can be traced all the way back to Aristotle's and his more philosophical view that value exists in everything (Thyssen et al., 2010) Even in construction / architecture the term Value can be traced back before Christ. Marcus Vitruvius Pollio (died around 25 BC) wrote the first known work on architecture, and believed that all architecture should have three central themes to be valuable; Firmitas, Utilitas and Venutas, which translates roughly into strength / durabilty, functionality and beauty.

Since the days of Arstioteles and Vituvius much has been written about value. The research done on value is represented by authors working in such diverse sectors as for example sociology, business, marketing, engineering, etc (Salvatierra-Garrido and Pasquire, 2011). Even so it seems that a commonly agreed definition of value has not yet been found (Thyssen et al., 2010).

In the IGLC community value generation theory from the TFV model (Koskela, 2000) can be seen as a starting point of the research on value, and research is widely influenced by this (Salvatierra-Garrido et al., 2012). Koskela mainly considerers the importance of delivering value from production systems and how they should be managed in order to do so. With regards to what value is per se Koskela simply defines it as fulfilling the customers' requirements (Koskela, 2000) Subsequent works have been presented by several authors that try to shed more light on what value is.

A number of authors have researched who the customers are and how their requirements should be captured (e.g. Bertelsen and Emmitt, 2005; Miron and Formoso, 2003), commonly advocating workshop approaches for mapping the value in the project. These papers often report of what has been found of value for specific customers on specific projects (e.g. (Jylhä and Junnila, 2012) but seldom try to categorize or generalize what constitutes value outside the scope of the case projects.

The most notable exception to this is Emmitt et al. (2005), who argue that value can be divided in external value and internal value. Where external value is the client / customer value and the value the project should end up with, and internal value is the value by and between the participants of the delivery team (Architects, Engineers and Contractors). Furthermore they divide the external value in product value and process value. Process value is about giving the client the best experience from the design and production of the product. The product value is divided into six areas, included the aforementioned Vitruvian values of beauty, functionality and durability combined with harmony, surroundings, environmental issues and buildability. Unfortunately Emmit et al. do not present any theoretical underpinning nor reasoning of why these areas should be at the top of the value hierarchy.

Others authors have opted for a more theoretical approach to trying to define value, drawing on wide range of literature from a wide range fields. Although there is no common or unifying definition of value some commonality can be found.

Value is usually understood to be distinct from values; the one is not plural of the other (Thomson et al., 2003) Values are the principle by which we live, they are the core believes, moral and ideas of an individual. When individuals collaborate to realize common goal, projects are formed and a value system can emerge if values are expressed and shared between them. Value is related to the assessment about a product. Rooke et al., (2010) propose to distinguish between sociological values and economical value, rather than just values and value because the similarity and the ambiguity between values and value.

With regards to what value is, the most usual expression of value in general is as a relationship between benefit and cost, normally expressed as Value = benefit / Cost (Kelly, 2007). Many different variations of this expression can be found, but they all basically express the same. Within IGLC and other Lean literature these mathematical definitions is usually regarded as being too simple (e.g. Rooke et al., 2010 Thyssen et al., 2010).

The most commonly referred overall definition of value in the LC community is Womack and Jones's from Lean Thinking (1996), where they argue that value can only be defined by the ultimate customer, when it's expressed in terms of a specific product which meets the customers need's at a specific price at a specific time. Compared to the mathematical definition of value the biggest difference is the inclusion of time as a central part of the definition. Bertelsen (2003) argues that the aspect of time makes understanding value a wicked problem, because you sometime can foresee its development and sometimes it comes as a surprise. According to Rooke et al. (2010) value and stakeholders roles change over time and value should therefore cover the whole life-cycle of the built facility.

It is commonly agreed upon that value is subjective. According to Perry (1914 cited in Thyssen et al., 2010) this stems from value being dependent on human interest, i.e. liking or disliking something. Value is also regarded as being relative. It is a comparative concept that is closely related with the opportunity to use (Salvatierra-Garrido and Pasquire, 2011).

UNDERSTANDING CLIENT VALUE

According to Womack and Jones' definition of value it can only be determined by the ultimate customer. We would challenge this by saying that on a construction project the value can only be determined by the paying client. In Lean a customer is anyone who in any way shape or form affected by a building or facility and as such, in a construction project there will be a host of different customers. But in any projects there is exactly *one* customer that actually commissions and pays for the building or facility – the paying client. This could be a person, a company, a conglomerate of companies or persons etc. In this paper we will use the term *client* to differentiate this party from the general customer term.

Ballard (2008) argues that to understand what the client needs it is necessary to work back to the client's purpose. The purpose that Ballard referrers to, is the purpose of the project; i.e. the business need that has spawned it. But to properly understand the client's purpose we think it is appropriate to actually go all the way back to the purpose of the client business itself.

A company's purpose and how it goes about fulfilling it will be described in their business model. Although it might be somewhat of a misnomer to talk about business models for non-commercial entities the principle will still be the same. The organization will have a model, explicit or informal, that details what their purpose is and how they go about in achieving it,

Several different definitions of what a business models is and what it contains can be found in literature (Weill et al., 2005). In this paper we will refer to a framework by Mahal (Mahal, 2010) that has a very clear definition of the role of infrastructure in the whole, and as such is conductive for understanding the value provided by buildings and facilities.

Mahal describes the business model as having two main parts; Planning and Operation. The planning part of a business model consists of Mission, Vision and Strategy; i.e. why the business exists, where the business is heading and how goals are accomplished. This part of the model is stable and stays unchanged over time and is of such of no great concern in the context of a construction project.

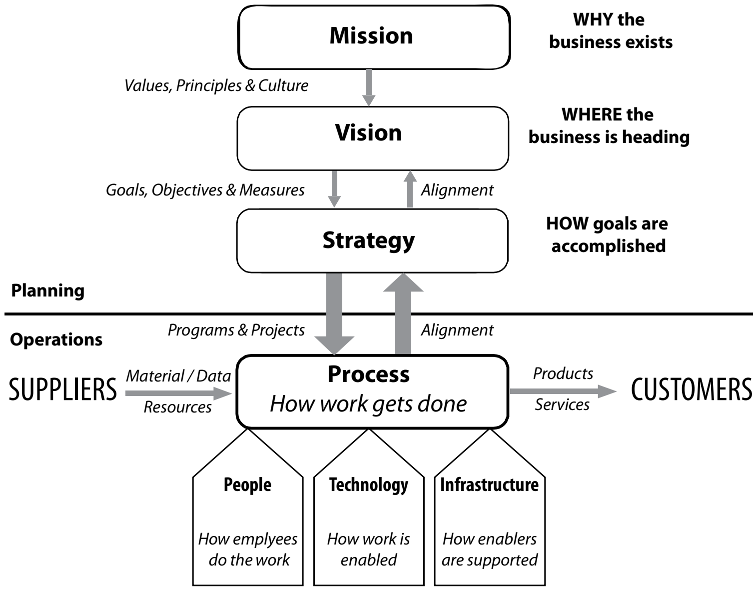

Figure 1 Business model (Based on Mahal, 2010)

The Operation part of a BPM on the other is dynamic and changes in response to business drivers. It details how work is done in the form business processes. Typically a process has inputs that get transformed into outputs or outcome. Within a process people do work enabled by technology and supported by infrastructure.

Another view of value and the clients purpose for a building or facility, that we find to be complimentary to that found in BPM, can be found in (Eikeland, 1998). Eikeland divides value into *instrumental* and *symbolic* value. The instrumental value comes from the building be a production asset for the owner while the symbolic value of the building comes in the form of image and identity. Most businesses and organizations will expend considerable resources in creating an image of their operations and the buildings in which these operations take place will undeniably contribute to this image.

A fully developed business process model will contain processes such as “Attracting customers” and “Retaining employees” and it could be argued that Eikeland’s symbolic value is strictly speaking just another form of instrumental value in the sense that they enable these kinds of processes. We however think that for a practical definition of value it is useful to separate this out. Instrumental value can to a large extent be optimized by enabling the business process in the areas of the building where processes actually take place. Symbolic value on the other hand must typically permeate the whole facility to be optimal. Take for instance any kind of food processing plant. For the sake producing a good quality product it is necessary that the production areas are clean. The cleanliness of the front offices have no bearing on the objective quality of the product produced in the facility, but if a customer’s buyer walks into a cluttered and dirty front office they are likely to subjectively regard the product produced as having lower quality.

A FRAMEWORK FOR PRODUCT VALUE

As a start point for our framework we will go back to the common mathematical definition of value as being benefit / dived by cost. With regards to the benefit we find Eikelands division into instrumental and symbolic to be appropriate; leaving us with Value = (Instrumental benefit + Symbolic benefit) / Cost.

The problem with the mathematical value definition, as has been pointed out earlier in this paper, is that time is not a part of it. To take this into account we will considering four "phases" of the building lifecycle - Investment, use, adaptation and end of life – and explain how benefits and costs are impacted.

Table 1: Product Value Framework

	Investment	Use	Adaptation	End-of-Life
Instrumental benefit	-	Support business processes	Support changed business processes	Support other business model
Symbolic benefit	-	Effect on Image and Identity by Use	Effect on Image and Identity by Adaptation	Effect on Image and Identity by decommissioning process
Cost	Cost of acquiring facility	Cost of running and maintaining the facility	Cost of adapting the facility	Cost of decommissioning the facility

INVESTMENT

We consider investment to be an instantaneous phase where the client pays for and receives the building. The actual time to actually design and build a building will of course be considerable. But that is irrelevant here. Any potential benefits gained there has to be considered a part of the process value, and thus outside the scope of this paper and our framework. The only thing that impacts the product value during this phase is the price paid by the client. This includes the cost of building itself as well as the lot and the furniture.

The reason we have chosen to include Investment as a separate phase is to clearly differentiate the investment cost and the maintenance and running cost of the building. The cost of running and maintaining the building over its lifespan is five times the construction cost (Evans et al, 1998 sited in Construction Industry Council, 2002), a fact that is often not considered sufficiently by the client (Ellis, 2007).

USE

The instrumental benefit comes from how well the facility enables the clients business processes, while the symbolic benefit comes from the identity the business creates for itself while doing so and how what goes on in the facility is perceived by the outside world. E.g. for a bank the instrumental benefit comes from enabling business processes such as handling customer cash withdrawals, meeting with loan applicants etc. while the symbolic benefit comes typically from appearing solid and trustworthy.

The cost aspect here is the cost of running and maintaining the building. I.e. energy cost, cleaning costs, building maintenance cost. The largest cost for buildings is the cost of the employees working there (Construction Industry Council, 2002). But this is intrinsically tied to the business process; a badly enabled business process requires more manpower to be performed. And as such can only be evaluated as a part of the instrumental benefit.

ADAPTATION

Businesses grow and evolve while technology and society changes. With this a business's business model and processes changes as well. This will often entail that the facilities enabling the business processes have to be changed as well, which could range from rearranging the furniture to adding a new floor or wing to an existing building. Doing this adaptation requires time, during which the benefits garnered from the building will be reduced. In our model we therefore consider the use phase of the facility to be punctured by several adaptation phases during the life time of the building.

If a facility is designed and built with flexibility in mind then the negative impact on the instrumental benefit during the adaptation period and the time required for adapting the facility will be lessened (as illustrated in figure 2). Converting an office to a meeting room only requires a change of furniture if the ventilation in the room is sufficient to handle the extra people load.

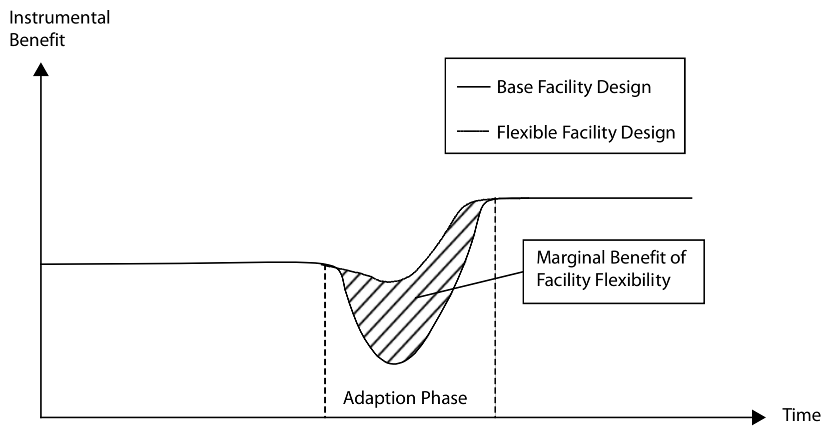

Figure 2 Effects on benefits in the Adaptation Phase form facility flexibility

Another example is international airports, which all over the world seem to be constantly expanding to be able to meet the needs of an ever increasing amount of air-travel. Building an airport facility today that is able to accommodate the traffic growth for the next fifty years would not be an economically sound, but knowing that most likely the airport will outgrow its initial capacity, provisions could be made in the design that would facilitate future expansions in such a way that the impact on to the day-to-day operations and function of the airport could be minimized while the airport is being expanded.

As for the symbolic benefit during the adaptation phase we believe it related to instrumental benefit. E.g. reduced capacity in an airports security or bathroom capacity will have a negative impact on the traveler's impression of the airport.

The cost aspect in the adaptation phase is simply the cost of adapting the facility. This cost will be inversely proportional with the flexibility built into the original design of the facility.

If the facility cannot be adapted at any reasonable cost then it will constrain the business model from developed optimally and the facility will reach obsolescence sooner, and thus the life-time benefits gained from the facility will be diminished.

END-OF-LIFE / OBSOLESCENCE

At some future point in time the facility will no longer be able to support the current business model sufficiently and becomes obsolete. The client could still get a benefit from the facility, either by reusing the facility himself for other purposes or by selling it to another party. Thus the instrumental value comes from the facility's ability to support *other* business processes. If the facility has no alternate use then the instrumental benefit is zero.

The symbolic benefit will come from how the public's perception of the decommissioning and, if applicable, demolition process. This will most likely be negligible for most facilities, but if this process in any way endangers the surrounding environment, e.g. decommissioning offshore facilities, then the business' image could be severely damaged if the process is handled in a way that is unacceptable in the public's opinion.

The cost incurred at the end of life of a facility will be from removing equipment etc. and possibly demolition of the facility if it has no other use. This cost will be substantial if the facility to be demolished for example contains hazardous waste; e.g. demolishing a nuclear power plant will be very expensive due to the requirements imposed on waste and material handling and storage.

APPLICABILITY

We think that what constitutes product value on any project for any client could be explained by the framework that we have presented above. But there are a few caveats to its applicability.

ASSUMPTION OF RATIONALITY

The framework assumes a rational client; i.e. what gives the client value is aligned with what would be beneficial for his business. If a client has *values*, e.g. religious values or green values, then this might not be the case and the framework would fall short and would need to be expanded for it to be usable to fully understand what constitutes value for the client.

THE TIME ASPECT

One of the trickier parts of understanding and describing value is related to time. We have conceptually considered what contributes to the value over the lifetime of the project. But for actually determining the value for the client the exact or estimated points in time were cost are incurred and benefits gained would have to be considered. For example in some projects the earlier the project is delivered the earlier the benefits can be reaped, e.g. starting to sell energy from a power plant, hence a greater value for the client. In other projects getting the building or facility earlier than planned could be of no real benefit to the client, e.g. finishing a school several months before the school years starts.

OTHER VALUE ASPECTS

If we compare our model to the traditional Vitruvian values, we see that Firmitas - strength and Venutas - beauty are missing. We find that neither of these have any direct value to the client, and will be subordinate to the aspects that can be found in our model. That the building doesn't collapse in on itself is a prerequisite to be able to get any kind of benefit from it if. Similarly if the facility doesn't conform to the local building code then a use permit will be denied and again no benefit can be gained. If a facility is to be built beyond that of what the local building code requires, this will typically be tied to the business processes it meant to support. E.g. The Cheyenne Mountain facility in the United States was built to withstand being hit by a 30 Megaton nuclear warhead. The purpose of the facility was to support command and control of the US military forces in the case of all out nuclear war.

Another interpretation of Vitruvius' Firmitas is durability. Having a durable building will be beneficial for the client either through reduced maintenance cost, having a longer lifespan or a larger residual value. But if any of these are desirable, then this should be the focus and durability would be means to an end.

For a rational client beauty has no intrinsic value. A beautiful facility will either be of instrumental benefit by direct impact on the business process (e.g. patients in a hospital will heal faster in a harmonious environment) or be of symbolic benefit by supporting the desired image and identity of the business. Beauty can also influence the likelihood of getting the building permits for a facility. But in this case beauty in itself does not directly give any value to the client; it is only a means to an end. The facility has to be beautiful enough that society will allow it to be built.

Similar arguments could be made for the other value areas that Emmitt et al. (2005) consider. E.g. regard for environmental issues will either be driven by requirements in laws, regulations or building codes, the client's desire for a green image or it will make plain economic sense; e.g. energy consumption over the buildings lifetime is reduced. Buildability is simply a means to decrease construction cost and possibly delivery time of the project.

DIFFERENT TYPES OF CLIENTS

In the description of the model we focused on businesses and organizations commissioning and owning facilities for their own use. But the framework also has its use in understanding the value for a client whose intent it is to rent out or sell. In this case the value for the client of the construction project would be tied to the value provide for his clients, which in turn could be understood through the framework.

In the model description we have also limited ourselves to considering the value if the client is a business or organization that has a stated purpose and a way of achieving it. But we think the framework we have constructed is equally appropriate for considering the value for private persons in residential projects. We would argue that that end goal for each and every one of us is to create quality of life for ourselves and that how someone go about creating that quality of life could be described as their "life model". How someone lives their life could be thought of as their "life processes". And the value of a residence would be tied how well these life processes are supported. E.g. for a family with three teenage daughters a house or apartment with only one bathroom would poorly support the life process of “getting ready in the morning”.

CONCLUSION AND FURTHER WORK

Our goal with this paper has been to make what actually constitutes product value understandable for the average practitioner and student of Lean Construction. We feel that the framework we have developed herein will be conductive of this, but that it should be elaborated on to make it more accessible. We also consider the framework that we have presented here a draft rather than a finished work, that is in need of further testing.

One possible avenue for this could be to do case studies of construction projects using this framework to explain the product value that has been or will be delivered to the client and the reasoning behind it, e.g. what business processes are being supported.

Further along we would like to develop this framework into practical tools that could be used on projects to help the project delivery team and the client to understand and describe the product value that is desirable and to manage the design process in such a way the optimal amount of design work is done. For this to be feasible it will most likely be necessary to look at how each of the “cells” in our framework-matrix can be quantified and balanced against each other.

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