Value Creation in Design-Build Projects

The Role of the Designers

Jon Harald Bremdal[a]*, Amin Haddadi[ab], Svein Bjørberg[ab], Jardar Lohne[a], Ola Lædre[a]
[a]Department of Civil and Environmental Engineering, Norwegian University of Science and Technology, Trondheim, Norway
[b]Multiconsult, Oslo, Norway
*jon_brem@hotmail.com (+47 97142519)

***Abstract*: This academic research paper addresses how designers contribute to value creation in design-build (DB) projects. In addition to identifying contextual constraints, this paper suggests measures on how designers can maximize value creation.**

The results are based on a literature review in combination with three separate case studies of Norwegian building projects. Each case study consists of interviews with key personnel and a document study, evaluating value creation for clients and users.

Findings show that the concept of value is ambiguous, making value creation confined through the subjective perspectives of various stakeholders. Therefore, to create value, designers must understand how the intended receivers of value interpret the concept. In addition, value creation by designers in DB projects is rather oriented towards whom their costumer is – the contractor, than towards the client and users. This is substantiated in literature describing how contractors obtain the opportunity to trim process and building qualities, provided that the client's mandatory project requirements and functional descriptions are fulfilled.

Proposed measures include 1) early involvement of the contractor's designers, 2) project partnering, and 3) establishing direct communication between the designers, client and future users. The benefit-to-cost ratio of implementing such measures is high.

Keywords: Value Creation; Designers; User; Client; Design-Build

I. INTRODUCTION

The general framework conditions in the Norwegian building and construction industry experience a change. As opposed to the traditional design-bid-build (DBB), an increasing number of Norwegian clients are implementing design-build (DB) as their preferred delivery method for new building and construction projects. E.g. Statsbygg, the Norwegian government's key advisor in construction and property affairs [1].

Additionally, key figures presented by Statistics Norway, the national statistical institute of Norway, illustrates a stable annual turnover growth (between 5.0% to 6.8%) over the last four years in the industry [2]. Record-breaking investments are also suggested allocated the building industry in Norway's National Budget for 2017, as a response to more extensive and complex public building projects [3].

Whilst the industry is facing such economic growth, the Norwegian Broadcasting Corporation (NRK) reports on tougher competitive conditions for contractors, due to increasing international interest for Norwegian projects [4].

The described development is seemingly beneficial, but when demanding tender competitions result in added pressure on the winning contractor, this pressure will also affect the designers and their value creation in building projects. Especially in DB projects, where main contractors are principally free to minimize process and building qualities, given that their client's minimum requirements are met [5]. Such situations imply that the influence of a main contractor's competitive situation limits the designers' ability to create value for the client and future users of a DB project.

The literature reviewed in the process leading up to the research presented in this paper provide limited discussion on how designers contribute and how they could maximize their value creation in DB projects, hence contextual constraints. Through the studies of three separate cases of Norwegian building projects, this paper addresses this knowledge gap. The research questions (RQ) are as follows:

RQ1: How do designers contribute to value creation in design-build projects?

RQ2: What contextual constraints in design-build projects prevent designers in maximizing their value creation?

RQ3: How could designers maximize their value creation in design-build projects?

The three cases examined are limited to the standard Norwegian DB-contract model between clients and main contractors, NS8407 [6]. As for the designers' compensation format, those used in the cases vary between lump sum and cost reimbursement. In Norway, the standard rules and regulations for contract models distinguish these compensation formats in two standardized contracts for assignments between employer and designer, NS8401 [7] and NS8402 [8].

The definition of value is portrayed as ambiguous in the reviewed literature [9-12]. The interpretation of value will therefore be based on Eikeland's characterization in context with value creation in building projects [13-14]. Additionally, value creation will only be assessed in the perspective of users and clients.

II. METHODOLOGY

The research reported on in this paper is based on a literature review and three separate case studies.

The literature review was carried out according to the procedures described by Webster et al. [38], mainly exploring the concept of value, value creation in building projects, DB project delivery and project partnering. Literature has been collected by using research databases (primarily Compendex, Google Scholar and Scopus), the Norwegian library database (Bibsys), along with citation chaining of reviewed articles as outlined by Ellis [39].

The case studies, based on interviews and document studies, were conducted according to the principles of Yin [40].

Based on the availability of data, three Norwegian DB projects were selected for the case studies: Two office building projects (*case A* and *B*) and one multidisciplinary high school project (*case C*). *Case B* and *C*, had project partnering implemented in their early design phases. *Case B* started in 2013 and ended in 2015. It consisted of one building, 13.500 m^2 in total. *Case C* started in 2010 and ended 2013, consisting of one 18.500 m^2 building. *Case A* started in 2016 and is expected to finish in late 2018. It consists of two buildings, of 24.000 m^2 together. Former and current employment by three of the authors within the design firm involved in the examined cases provided access to internal documents and key personnel.

A total of twelve senior professionals from the three cases were interviewed. The interviewees included four discipline leaders and two architects from design firms (from now on termed designers), three project managers (client), together with two project managers and one assisting project manager (contractor). The interviews were conducted as semi-structured in-depth interviews, carried out in accordance to the prescriptions of Yin [40]. Nine out of ten interviews were conducted individually. The remaining interview was conducted in a group of three interviewees, similarly to focus groups as described by Gill et al. [41]. One of the individual interviews was carried out over telephone, whilst the rest were conducted face-to-face. All interviews lasted approximatively one hour. A predetermined and common interview-guide was utilized. The interview-guide included both case-specific and general questions regarding the field of study. The interviews were verbatim transcribed and consequently validated by every interviewee.

The studied documents consisted of case-specific information and were obtained through the interviews. The received documentation included organization maps, schedules and plans from all three cases. These documents were studied according to the prescriptions of Weber [42].

III. Theoretical Framework

A. The Concept of Value

Kelly et al. [15] conclude that the most traditional form of expressing value is equal the ratio between function (a characteristic activity) and cost (the price to be paid for that specific activity). They [15] further describe this representation of value as not a true mathematical expression, but rather as an expression on how units of function are achievable for a unit of cost. I.e. that the ratio between function and cost decide the degree of value. Furthermore, Norton & McElligott [16] include the aspect of time when defining value as an interweaving relationship between cost, time and function. This approach is substantiated by Best & De Valence [17], who refer to Atkin's illustration of the so-called *iron triangle* [18] when arguing how time, cost and quality together embodies the decisive influence on generated value. Best & De Valence [17] explain the balance between these criteria and their anticipated impact on finalized projects by exemplifying how achieving a high degree of quality also leads to an increase in time and/or cost. I.e. there must be a compromise in the balance between the different criteria of value. Kelly et al. [15] expand this approach by addressing the value as the relationship between time, cost, risk, functionality and variables of different qualities clients' want to generate in projects. Linked to their definition, Kelly et al. [15] emphasize that value nevertheless is a subjective concept, implying that the concept of value is anchored in the subjective perspectives of various stakeholders. This is supported by Thyssen et al. [19], when recommending characteristics that should be considered when addressing the concept of value. Most of their reviewed interpretations characterize a subjective perception of value. Bertelsen & Emmitt [20] illustrate this perception of subjectivity when portraying how value can be interpreted differently by three key stakeholders in traditional building projects. Various priorities over time are also believed to influence the individual views on created value in projects [14], reflecting the portrayals by Bertelsen & Emmitt [20].

B. Value Creation

When addressing value creation in context with building projects, it's important to separate this term from added value. In this paper, added value is considered as generated value that was not originally planned in the value creating process. I.e. project delivery method.

Eikeland [13], similarly to Emmitt et al. [22], characterizes value creation in building projects into two convergent expressions. Eikeland's characterizations translates into internal efficiency and external effectiveness.

Internal efficiency is specified as factors directly effecting costs, resource and time consumption in project processes expected to produce a result of a certain quality. A high degree of internal efficiency correlates to a minimum usage of resources, time and costs to yield the intended project result. I.e. internal efficiency corresponds to "doing things right" to achieve cost-effective deliveries and enhance productivity in building projects [13].

External effectiveness on the other hand, expresses the building process's ability to realize goals, requirements and priorities described by the client in synergy with future users. I.e. external effectiveness addresses "doing the right things" in the building process to create value for clients and users [13].

1) Value creation for clients

In building projects, as in most procurements for a certain result of value, content clients often correlate to satisfied users. Eikeland [14] portrays value creation for clients as the consideration from users (tenantry) added with the direct value the project result generates for the clients, subtracted with investment costs in addition to costs related to facility management (FM). In context, Eikeland [14] regard clients also as future owners as a whole, even though ownerships are likely to change within the lifespan of the building.

Accordingly, long and short-term ownership may alter clients' perception of value creation. Investment costs related to materials, design and technical solutions in addition to consequential FM costs, are assumed to be of a lower priority for clients who plan short-term ownerships [14]. In contrast, clients who plan long-term ownerships are bound to undertake rehabilitation and demolition of the building after its lifespan. It is therefore essential for these clients to prioritize sustainable materials and solutions, besides giving priority to FM-costs [14]. This differentiation is also commented by Thyssen et al. [19], when addressing different perspectives of client values regarding the construction process.

The grounding of Eikeland's approach on value creation for clients relates to his descriptions of internal efficiency [13, 14]. In similarity to the criteria described by Norton & McElligott [16] and Best & De Valence [17], Eikeland base his approach on the balance between the following criteria:

- ***Quality****:* Achieving all functional and quality requirements that define the physical scope of the project.
- ***Cost****:* The building process is in conformity with budget, cost estimates and other financial commitments.
- ***Consumption of time****:* Progress is in accordance with schedules, completion date and start of operation.
- ***Process requirements****:* Fulfilling requirements set for the actual design and construction process. I.e. prerequisites ensuring Health, Environment and Safety (HES), public relations as well as interaction between participating actors in the project.

Related to external effectiveness, the following criteria are linked to the direct value the project result create for clients. These criteria are similar to how Kelly et al. [15] expand the *iron triangle* in relation to the functional properties of buildings in affiliation to the users' wishes and needs, in addition to the adaptability of the building itself and the optimization of LCC [14].

- ***Generality****:* The building's functional features cover different users' needs, as well as the ability to adapt to future users with a potentially altered usage requirement without significant technical adaptation or rebuilding.
- ***Flexibility****:* The building's functional features and aesthetic values can adapt to future users and a potentially altered usage requirement by rebuilding quickly with low conversion costs, good customization and minimal disturbance of current users.
- ***Elasticity****:* The building is adaptable for physical extensions to meet future needs. With high elasticity, extensions can be done both cost-effectively and quickly, with the least possible disturbance of current users.
- ***Functionality****:* The buildings functional features and esthetic values correspond to the wishes and needs of the users. I.e. users' practical needs, identity and desired image.

Additionally, buildings' esthetic qualities, architectural attributes or other environmental symbolic features, could benefit clients in terms of increased market value and social interest [14]. I.e. strengthening the image of the building and therefore the client itself. Social interests are also highly relevant for clients as they are the basis for obtaining permission to realize projects [14].

2) Value creation for users

Value creation for users is primarily based on buildings' ability to meet users' needs and their requirements [13]. In context, Eikeland [14] emphasizes that building projects are dependent on user involvement to achieve this ability, hence success. Bertelsen & Emmitt [20] share this way of thinking, when addressing the importance of user involvement. Related to this, Haddadi et al. [9] describe how user involvement alone is not necessarily enough to maximize the value creation in a building project, expressing the need of innovative solutions that fulfill users' known or initially unknown needs. Separating known and unknown user needs is relatable to Kano's model and descriptions of "attractive requirements" [23]. In context, these requirements translate to unforeseen user needs, neither expressed or expected, which significantly increase enthusiasm for the project result if fulfilled. However, if these requirements are not fulfilled, there are no dissatisfaction among users [23]. Eikeland [14] also stress that users' needs and requirements will change over time due to dynamic and evolving user identities, in addition to user activities could change in character. Users' expectations for a building will also change in accordance to comparable qualities in other new buildings and how worn down the building is [14]. Maintenance, in addition to implementing sustainable and adaptable qualities, can limit the building's loss in value from a user perspective [14]. When the building's loss in value becomes too comprehensive for users, it's necessary to upgrade the building by rehabilitation and/or rebuilding. A building's degree of adaptability to changing user needs is determined by the generality, flexibility and elasticity of the building [14]. Among other elements of value from a user perspective, the need for adaptability in buildings to create and maintain perceived user value is also emphasized by Bertelsen & Emmitt [20] and Haddadi et al [24].

In relation to the ambition level of buildings' architectural expression and overall level of quality, addresses Eikeland [14] esthetic and social values related to users. This is substantiated by Haddadi et al. [9] who emphasize how users also need to have a hedonic value fulfilled. This approach is substantiated by Eikeland's descriptions on how users desire a positive building image in accordance with their own perceived image. This applies, not only to the confirmation of self-image, but also to create a positive impression on their surroundings. E.g. an office building, where the users want the image of the building to appear as an extension of their own marketed self-image.

C. Design-Build Projects

In DB projects, the client outsources the responsibility for most of the design process to a main contractor, in addition to the construction phase [5, 25]. This implies that the main contractor assumes risks associated with time, cost and quality related to the design process. Furthermore, the main contractor also assumes the responsibility and risks concerning relations between technical subcontractors and their appointed technical designers [26]. This reduces the need for management capability of the client, as there is only one contractual part between the client and main contractor [5]. On the contrary, a client's communication with subcontractors and designers will have to go through the main contractor [5, 26]. If the client

rather decides to manage the design process himself and selects a prime contractor who procures and manage technical subcontractors for the construction phase, this would characterize as a design-bid-build project (DBB) [5, 25]. Kristensen et al. [26] present findings stating that DBB facilitates for improved retrieval of essential information for the designers when responding directly to the client (DBB), rather than a main contractor (DB).

Typical Norwegian DB projects mainly occur in two separate variants. In one of the variants, the client describes the intended ambitions and functions of the DB project, based on desired technical standards and other requirements. I.e there is no preliminary design of the project before the main contractor is procured. This indicates that the client only develops conceptual plans with functional descriptions as tender documents. In the other DB variant, the client prepares a preliminary design based on their own conceptual plans and functional descriptions [27]. This initial design material, consequently serve as tender documents for the final design phase.

Due to the division of responsibilities in DB projects, main contractors gain major influence on the project design, hence the designers are subject to the main contractor in addition to the fact that the design process is in principle only being based on the client's functional descriptions [28]. This appear as the main drawback of DB projects, since main contractors are free to lower their costs by reducing solution qualities [5]. How much a main contractor can profit on reducing qualities depends on the accuracy of the functional descriptions, but if the solutions meet the minimum requirements set for the project, the main contractor can avail of less expensive solutions [5]. The described drawback is also believed to have long-term consequences effecting projects operating costs, if main contractors decide on implementing solutions not optimal in relation to LCC [26, 29]. In context, designers can feel pressured between a main contractor's financial priorities and a client's desire for optimized solutions in a lifetime assessment [26]. This illustrates the importance of clients ensuring a thorough early design phase to concretize tender documentations in DB projects, by striving for unambiguity and clear descriptions of features, qualities and form.

D. Project Partnering in Design-Build Projects

Project partnering (PP) in DB projects, as in any other project delivery method, involves the implementation of collaborative working relationships between participating actors in a project [30]. Despite several efforts on defining PP in context of the Norwegian building and construction industry, the term is seemingly too vague to finally conclude [30-33]. This ambiguity represents a major challenge associated with the implementation of PP in Norwegian building projects, hence participating actors' lack of a common understanding of what PP is and what it implies [31, 35].

PP, in this paper, will therefore be regarded in accordance to the descriptions of the Norwegian Agency for Public Management and eGovernment (DIFI). DIFI [43] specifies PP in DB projects as implementing an interaction model, that begins with the client contracting a group of collaborating actors. This group consists of the client itself, contractors, users, designers in addition to any other key stakeholders. The group is responsible for collaborating in the early design phase until a preliminary design with a target value is finalized for the tender competition [43].

The most agreed upon benefits with PP from reviewed literature by Hosseini et al. [30], are increased efficiency and quality, in addition to the reduction of litigation. Other identified benefits are innovation, increased customer satisfaction, sustainability and reduced risk. As for the designers, establishing direct lines of communication with other key actors are believed to be fruitful for the information flow in the design process [26]. Hosseini et al. [30] also specify challenges related to creating a collaborative environment in building projects, like the need for thorough preparation and commitment from all participating actors. In context, Tune [35] explores if it's enough to only implement measures of PP or if there must be an adaptation of the culture within the industry to ensure greater interaction of actors. Bresner & Marshall [36] conclude that there is no set answer to this issue, but emphasize that partnering actors must be aware of the dynamics and complexity in their interplay. Such collaborative challenges correspond to the soft elements of partnering as described by Wøien et al. [33], hence personal relations among key personnel are believed to be decisive for whether a project is successful or not [33, 37]. E.g. mutual respect and trust is addressed as vital for the collaboration between designers and contractors [37].

However, early involvement of key actors is identified as one of the most important elements in PP, allowing the client to utilize the actors' competence at an earlier stage of development [30, 33-35]. E.g. early contractor involvement has potential advantages such as improved constructability, cost estimation, communication and risk management [37]. Early contractor involvement, is also concluded to have more advantages than disadvantages for the designers, when collaborating with contractors in early design phases [37].

Other recommended elements for implementation in PP is co-localization and external facilitators [34-35]. However, Bresnen & Marshall [36] express potential "over-communication" in co-localization as a hidden disadvantage. Weekly co-localization, rather than daily are believed to minimize such drawbacks [35].

IV. Findings and Discussion

RQ1: How do designers contribute to value creation in design-build projects?

Findings from the interviews related to RQ1, indicate that there are two main aspects on how the various designers (architects and engineers) contribute to value creation for clients and users in DB projects. Considering this, the term "designers" will from now on imply both architects and engineers, beyond that separately.

Firstly, there is a common consensus across all cases and the majority of the interviewees, that architects are to understand the client's descriptions while being the main influence on a building's level of functionality, adaptability and esthetics, providing the premises for all other design. As presented in table 1, only one client mentioned how architects contributed to value creation in the planning phase.

TABLE I. SUBSTATIATING CITATIONS RELATED THE 1ST ASCPECT OF RQ1

	External effectiveness
Clients	"Architects contributed to zoning and outlining the plot plan in the planning phase."
Main contractors	"You are completely dependent on the architect when it comes to ensuring functionality and adaptability in the building. They lead the creative process." "Architects account for a large portion of the value creation by establishing the premises based on the client's descriptions and specifications. The other design subjects should assist the architect in finding the best solutions." "The architect is the main contributor of a building's level of adaptability and functionality [..]." "If the client specifies aspects of flexibility, it's the architect's task to make such elements visible." "[..] the architect gives premises for all design related to a building's functionality and adaptability."
Designers	"Architects conceptualize the building, but exactly how things are to be solved are the other design subjects' job." "Architects gives the premises for entire building design based on the client's specifications for functionality and other related aspects, while the other designers act as the architect's playmakers." "The architect is the driving force for a building's adaptability, functionality and esthetics, which is based on the client's descriptions of these aspects." "Engineers doesn't contribute directly to functionality or adaptability. This is the main task of the architect, while we aid them."

[a.] Summarization of relevant citations categorized into groups of actors.

The second main aspect relates to how the interviewees state that the other design subjects (structural and technical engineers) are supposed to aid the architects by understanding their conceptions while developing cost-effective solutions. I.e. solutions which are well-defined and efficient for production, in addition to being in accordance with building technology regulations and other subject-specific principles.

TABLE II. SUBSTATIATING CITATIONS RELATED TO THE 2ND ASPECT OF RQ1

	Internal efficiency
Clients	"Engineers develop cost-effective and time-efficient solutions."
Main contractors	"Engineers contribute by reducing the time consumption of the project and help maintaining deadlines by designing solutions efficient for production." "Well-defined solutions contribute to an efficient production phase of the building project. If the engineers neglect this, it will lead to production delays and subsequent amendments." "Engineers contribute by designing cost-effective solutions."
Designers	"Engineers contribute by delivering solutions in accordance with the project's plan of progress. These deliveries must be well-defined to facilitate an efficient production, reducing the production time." "Engineers contribute by designing sustainable solutions, which also covers building technology regulations."

[b.] Summarization of relevant citations categorized into groups of actors.

These findings correspond to value creation for both clients and users, hence Eikeland's [13, 14] criteria for internal efficiency and external effectiveness. I.e. architects conceptualize the building project's external effectiveness (adaptability, esthetics and functionality) while the engineers are expected to solve this conceptualization in consideration of internal efficiency (quality, cost, process requirements and consumptions of time).

The following figure serve as an illustration of the coherence between how the designers contribute (contrib.) to value creation, in addition to which actor being are responsible (resp.) for the different phases of the DB project. Noteworthy, there is no identified contribution of value creation by designers in the operational phase of DB project. In the planning phase, there is solely contribution from architects.

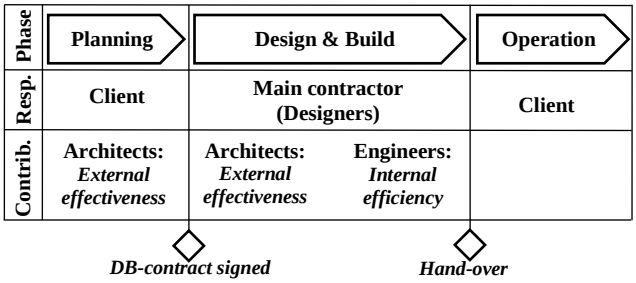

Fig. 1. Illustration of the coherence between phases, division of responsibility and how designers contribute to value creation for clients and users in DB projects.

RQ2: What contextual constraints in design-build projects prevent designers in maximizing their value creation?

As for elements of constraints before the DB-contract is signed, short-term perspectives among clients are believed by several interviewees to affect the value chain of the whole design process. E.g. one designer stated: "If the client plans to sell the building, the client is most interested in cost and progress." Substantiating this, another designer emphasized: "[..] aspects like the building's maintenance and operation are not of significant interest for a client who plans to sell the building."

The interviewees also stress clients' inconsistent relationship between project responsibilities and expectations, as a second element, independent of perspective. In context, one designer argued: "[..] there is too much focus on the investment costs of the project there and then, and not LCC and the flexibility of solutions." Another designer from the same case, emphasized: "I wonder if clients actually understand what they are getting when signing the DB-contract and if someone has told the client about the minimal opportunities for alterations."

Foremost, when referring to elements of constraints before the DB-contract is signed, the interviewees pointed out that clients are seemingly negligent towards their influence on tender documents. When asked if clients tend to forget their responsibility related the importance of adequate tender documentation, one main contractor replied: "Yes, always. [..] tender documents must specify requirements, e.g. levels of functionality, for it to be covered." Another main contractor substantiates this statement by emphasizing: "[..] if the client's functional descriptions and quality requirements are met, the quality will not surpass what is specified. [..] Our pricing reflects the features and requirements described in the tender documents."

Every interviewed main contractor, alongside all six of the designers addressed the inadequacy of tender documentation as an element of constraint. Noteworthy, only one client addressed this topic, specifying: "[..] the client must ensure a sustainable preliminary work to prevent the main contractor's trimming of qualities."

The main contractor's opportunity to trim qualities, due to the division of responsibilities in DB projects, were addressed on several occasions during the various interviews. One of the interviewed main contractors illustrated this element of constraint with the following example: "Most clients when buying a building want an *Audi*, while a *Skoda* has 85% of the same parts in addition to having the same function. In tender competitions based on price, the *Skoda* will be offered or else you [the main contractor] won't get the job." On the contrary, one designer mirrors this aspect by stating: "The client never gets what he believes he gets. Whenever they [clients] engage in a DB-contract, having describe intended qualities and functions for the project result, they will get the absolute cheapest thinkable solutions in relation to their descriptions and requirements." A second designer from a different case concluded: "We answer to the main contractor [..] it is therefore important with adequate tender documents that excludes the main contractor's opportunity to trim solutions." A third separate designer concluded: "The main drawback is that no matter how good or bad the client's description is, it's the only one that applies."

The majority of the interviewees connect the trimming after the DB-contract is signed, to several other elements of constraints. E.g. the main contractor with the car-example acknowledge that the designers inherit the pressure to make the *Skoda* look like an *Audi*. When asked about the trimming, one designer concluded: "We [the designers] are subordinated the main contractor and we have to serve them. They are interested in delivering quality, but only to a certain extent."

In context, one of the interviewed clients argued: "If the client accepts a very low price on the project and assuming the main contractor intends to spend a fairly low number of hours on the designers, it will affect both designers and the quality". Consequently, a designer from the same case emphasized: "[..] the price the main contractor offers to win the DB-contract, implies that they haven't got more than 1-2 months from signing the contract, before they have to start production. [..] it goes without saying that a concurrent detail design phase and building phase (concurrent D&B) is imminent, which often gives less thoughtful solutions and adds to more errors." Related to concurrent D&B, interviewees argue that is not ideal for value creation, but common.

There is a common consensus among the interviewees that the main contractor can restrain the line of communication between the client and the designers, due to the designers being subordinated the main contractor. An interviewed client substantiates this by pointing out that: "[..] after the contract is signed, the communication between the client and the designers have to go via the main contractor." In context of this statement, a designer concluded: "The main contractor has the opportunity to facilitate proposed amendments by the designers as desired. [..] main contractors rarely accept the designers' requests for change if the main contractor himself doesn't get additional payments for it."

Consequently, some designers conclude that their opportunity to contribute to value creation in the detail design phase of a DB project is set. E.g. one designer stated: "After the [DB] contract is signed, the premises are given and you can't really change anything, even if you find potential improvements or even if the accepted offer isn't good enough."

The interviewees also indicated elements of constraints only relatable to the designers. E.g. a client emphasized: "I've experienced several times that even at larger firms, the design subjects working on the same project doesn't communicate. [..] it is vital that they [the different design subjects] coordinate solutions to ensure quality and to avoid mistakes." Another client argued that the designers tend to forget the importance of viewing their own solutions in coherence with other the design subjects: "[..] designers often forget that an interdisciplinary perspective is essential when designing solutions." In addition, one designer emphasized: "It's vital that all designers wish to contribute and are able to interact at an individual level."

TABLE III. IDENTIFIED ELEMENTS OF CONSTRAINTS RELATED TO RQ2

Client	*Main contractor*	*Designers*
Short-term perspective	Trimming of qualities	Inherited pressure
Inconsistency	Concurrent D&B	Limited possibilities in the detail design phase
Inadequate tender docs.	Low price - less time	"Tunnel vision"
	Restrained communication	

[c.] Summary of identified elements of constraints categorized in relation to the relatable groups of actors.

When interpreting these findings, several of the described elements are better specified as effects and causes, instead of actual constraints preventing the designers in maximizing their value creation. E.g. Short-term perspectives, also addressed by Eikeland [14], and inconsistency among clients are rather considered to yield inadequate tender documentation, than being a direct constraint for the designers. Nevertheless, such elements are needed to substantiate the main identified constraints as presented in fig. 2. Noteworthy, one of the presented constraints in fig. 2, is labeled as *Perverse incentive*. This label reflects the main contractors pursue for profit in DB projects, regardless of the other constraints. *Inadequate tender docs.* and *Perverse incentive* are therefore viewed as separate constraints, even though the results indicate that the former induce the latter. Lastly, *Tunnel vision* corresponds to the addressed elements of constraints only among the designers.

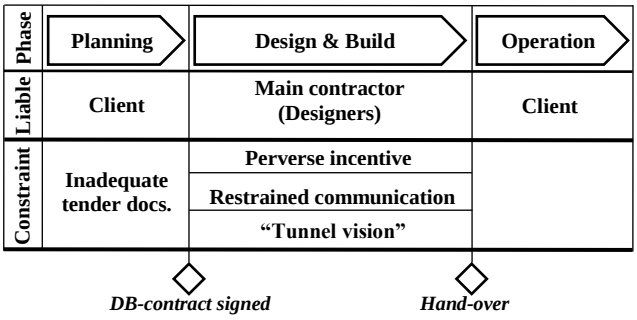

Fig. 2. Illustration of the coherence between phases, division of responsibility and main constraints preventing designers in maximizing their value creation for clients and users in DB projects.

RQ3: How could designers maximize their value creation in design-build projects?

All interviewees addressed project partnering (PP) as a possible measure to help designers in maximizing their value creation. E.g. one of the designers emphasized: "[..] it's important with an open dialogue between the client and the designers. [..] this is the main benefit of PP, hence the contractors, designers and the client working close together

already in the preliminary design phase." In addition, another designer stated the following: "To create the best possible project, it is essential for the designers to be involved as early as possible. Particularly when the main contractor could price a project without consulting with, say a structural engineer, first. This creates a difficult start from the get-go."

In context, one main contractor concluded the following when asked about PP in DB projects: "We are very dependent on competent designers in PP. They give the client something we can't. It's there the value creation is enabled."

Furthermore, several interviewees across the various case studies argued for the forwarding of designers, given the variant of DB. This implies transferring the client's potential designers to the main contractor when the DB-contract is signed. The interviewees substantiated this recommendation as measure to conserve the client's thoughts of value through e.g. the architect, in the transition from before and after the signing the DB-contract. In context, one client stated the following: "[..] they [forwarded designers] already know the project well, in addition to having a sense of ownership and responsibility for the solutions they already have planned". Noteworthy, two out of the three interviewed main contractors addressed this measure as beneficial.

The interviewees also addressed co-localization, BIM (Building Information Modeling) and design management as possible measures for after the DB-contract is signed.

Related to co-localization, one of the main contractors stated: "[..] the best thing with co-localization is that the client is present and able to dismiss or accept solutions". However, the same interviewee demonstrated that the main contractor still wants to oversee the communications between the co-localized client and designers by expressing: "[..] but we don't want the designers presenting suggestions on solutions directly to the client without conferring with us first."

Pertinent to BIM, one main contractor concluded: "BIM is invaluable [..] digitalization by utilizing BIM makes things go faster, while everyone gets an easier overview."

Several interviewees, notably three out of three clients, addressed the importance of having a design manager facilitating the design process and the coordination of the various design subjects. In context, one client concluded: "you need a design manager to make sure that all solutions are of the right quality and on time. [..] the role should facilitate communication among the designers and make them work towards a common goal."

TABLE IV. IDENTIFIED MEASURES RELATED TO RQ3

Project partnering	Co-localization
Early involvement of designers	Utilizing BIM
Forwarding of designers	Design management (manager)

[d.] Summary of identified measures.

The presented measures in table 4 are in the following figure distributed in accordance with the various phases of a DB project and the earlier portrayed constraints in fig. 2. Take notice, there is no planning phase in fig. 3, due to there being no relevant measures identified for this phase. Also, *Forwarding of designers* should be regarded as an overlapping measure from before and after the DB-contract is signed.

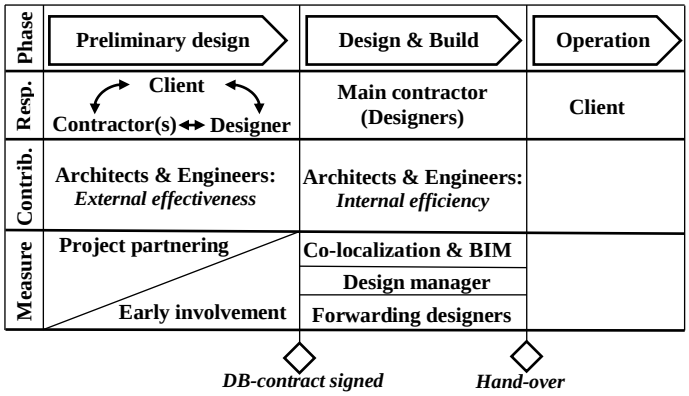

Fig. 3. Illustration of the coherence between phases, responsibility, contributions and measures on how designers could maximize their value creation for clients and users in DB projects.

V. CONCLUSION

This research paper sets out to answer the following research questions: RQ1) How do designers contribute to value creation in design-build projects? RQ2) What contextual constraints in design-build projects prevent designers in maximizing their value creation? RQ3) How could designers maximize their value creation in design-build projects?

Findings from three separate case studies of Norwegian DB projects, implies that there are two main aspects to how designers in DB projects contribute to value creation for clients and users. Firstly, architects contribute to value creation by conceptualizing the building's level of esthetics, functionality and adaptability. In reviewed literature, such contributions are described as criteria for external effectiveness, which are of value to both clients and users. Engineers are expected to solve this conceptualization in consideration of the project's cost, time consumption, in addition to ensuring that solutions are in fulfillment of quality (building technology regulations). These contributions correspond to criteria of internal efficiency, which reviewed literature mainly portrays as of value to clients.

Both reviewed literature and the case studies indicate that these contributions are influenced by the main contractor's ability to trim such qualities after signing the DB-contract. Noteworthy, the case studies demonstrate that inadequate tender documents can induce this trimming, in addition to other adverse constraints affecting the designers' ability to maximize their value creation (fig. 2). However, findings suggest that project partnering before the DB-contract is signed, counteracts such constraints. I.e. involving the designers early to ensure adequacy of tender documentation, making value creation by designers in DB project more tangible.

Findings also indicate that main contractors may restrain the communication between clients and the designers, while pursuing profit. Additionally, not all constraints identified in this research are entitled the client and the main contractor. As presented in fig. 2, *Tunnel vision* among the designers prevent the designers in maximizing their value creation as well. To prevent such constraints after the DB-contract is signed,

forwarding of designers in addition to co-localization, where the client also is present, is suggested. Implementing attributes as a design manager and BIM in DB projects, are also suggested to curtail the addressed constraints.

The main basis of this research are three separate Norwegian case studies. Readers should have this in mind, hence justification of the results. However, the presented findings and conclusion could be useful for stakeholders planning to participate, start or manage any DB project.

Lastly, this research paper covers only parts of the addressed knowledge gap. For further work, its recommendable to explore measures interweaved with the operational phase of DB projects.

REFERENCES

[1] Statsbygg (2016). *Samspillsmodell gir billigere og bedre bygg*. Retrived [14.01.2017] from http://www.statsbygg.no/Nytt-fra-Statsbygg/Nyheter/2016/Samspill-modell-gir-billigere-og-bedre-bygg/.

[2] Statistics Norway (2017). *Turnover growth in construction*. Retrived [03. 05.17] from https://www.ssb.no/en/bygg-bolig-og-eiendom/artikler-og-publikasjoner/turnover-growth-in-construction

[3] Statsbygg (2016). *Statsbudsjettet: Rekordhøyt investeringsnivå i 2017*. Retrived [14.01.2017] from http://www.statsbygg.no/Nytt-fra-Statsbygg/Nyheter/2016/Statsbudsjettet-okte-investeringer-i-2017/.

[4] Bjørgum, H., & Kjernli, E. (2016). *Hevder norske aktører stenges ute fra byggeoppdrag*. Retrived [22.01.17] from https://www.nrk.no/norge/hevder-norske-aktorer-stenges-ute-fra-byggeoppdrag-1.12810135.

[5] Lædre, O. (2006). *Valg av kontraktsstrategi i bygg- og anleggsprosjekt*. PhD Thesis. Norwegian University of Science and Technology: Faculty of Engineering.

[6] Standard Norge (2011). *NS8407.E:2011 – General conditions of contract for design and build contracts*. Lysaker: Standard Norge.

[7] Standard Norge (2010a). *NS8401.E:2010 – General conditions of contract for design commissions*. Lysaker: Standard Norge.

[8] Standard Norge (2010b). *NS8402.E:2010 – General conditions of contract for consultancy commissions with remuneration on the basis of actual time taken*. Lysaker: Standard Norge.

[9] Haddadi, A., Temeljotov-Salaj, A., Foss, M., & Klakegg, O. J. (2016). The Concept of Value for Owners and Users of Buildings–A Literature Study of Value in Different Contexts. *Procedia-Social and Behavioral Sciences*, 226, 381-389.

[10] Ahola, T., Laitinen, E., Kujala, J., & Wikström, K. (2008). Purchasing strategies and value creation in industrial turnkey projects. *International Journal of Project Management, 26(1)*, 87-94.

[11] Drevland, F., & Lohne, J. (2015). Nine Tenets on the Nature of Value. *In Proceedings: Global*.

[12] Salvatierra-Garrido, J., Pasquire, C., & Thorpe, T. (2010). Critical review of the concept of value in lean construction theory. In Proc., 18*th Annual Conference of the International Group for Lean Construction* (pp. 33-41).

[13] Eikeland, P. T. (1998/ rev. 2001). Teoretisk analyse av byggeprosesser. *Samspill i byggeprosessen, prosjektnr, 10602*.

[14] Eikeland, P. T. (2016). *Byggeprosjekter*. Kolbotn: D. Eng. Per T. Eikeland.

[15] Kelly, J., Male, S., & Graham, D. (2014). *Value Management of Construction Projects* (2nd ed.). Hoboken: Wiley.

[16] Norton, B. R., & McElligott, W. C. (1995). *Value management in construction: a practical guide*. McMillan.

[17] Best, R., & De Valence, G. (1999). *Building in value: Pre-design issues*. London: Arnold

[18] Atkin, B. (1990). *Information management of construction projects*. TW Crow Associates and Crow Maunsell.

[19] Thyssen, M. H., Emmitt, S., Bonke, S., & Kirk-Christoffersen, A. (2010). Facilitating client value creation in the conceptual design phase of construction projects: a workshop approach. *Architectural Engineering and Design Management, 6(1)*, 18-30.

[20] Bertelsen, S., & Emmitt, S. (2005). The client as a complex system. In 13*th International Group for Lean Construction Conference: Proceedings* (p. 73). International Group on Lean Construction.

[21] Björnfot, A., & Stehn, L. (2007). Value delivery through product offers: a lean leap in multi-storey timber housing construction. *Lean Construction Journal, 3(1)*, 33-45.

[22] Emmitt, S., Sander, D., & Christoffersen, A. K. (2005). The value universe: defining a value based approach to lean construction. In 13*th International Group for Lean Construction Conference: Proceedings* (p. 57). International Group on Lean Construction.

[23] Sauerwein, E., Bailom, F., Matzler, K., & Hinterhuber, H. H. (1996, February). The Kano model: How to delight your customers. *In International Working Seminar on Production* Economics (Vol. 1, No. 4, pp. 313-327). Innsbruck.

[24] Haddadi, A., Johansen, A., & Andersen, B. (2016). A Conceptual Framework to Enhance Value Creation in Construction Projects. *Procedia Computer Science, 100, 565-573.*

[25] Toolanen, B., & Olofsson, T. (2006). Relational contracting and process design promoting cooperation. *In Annual Conference of the International Group for Lean Construction: 25/07/2006-27/07/2006 (pp. 191-203).* Catholic University of Chile, School of Engineering.

[26] Kristensen, K. (2015). *Kontraktstyper og avtaleformer for prosjektering*. MS Thesis. Norwegian University of Science and Technology: Faculty of engineering.

[27] Haugseth, N. (2014). Partnering in Statsbygg. In 22*nd Annual Conference of the International Group for Lean Construction: Understanding and Improving Project Based Production, IGLC 2014*.

[28] Ottosen, T. (2008). *Totalentreprise: Utvalgte risikoområder*. MS Thesis. University of Oslo.

[29] Kristensen, K., Lædre, O., Svalestuen F., & Lohne, J. (2015). Contract models and compensation formats in the design process. Proc. 23*rd Ann. Conf. of the Int'l. Group for Lean Construction. Perth, Australia*, *July 29-31, pp. 599-608.*

[30] Hosseini, A., Wondimu, P. A., Bellini, A., Haugseth, N., Andersen, B., & Lædre, O. (2016). Project Partnering in Norwegian Construction Industry. *Energy Procedia, 96*, 241-252.

[31] Aarseth, W., Andersen, B., Ahola, T., & Jergeas, G. (2012). Practical difficulties encountered in attempting to implement a partnering approach. *International journal of managing projects in business, 5(2),* 266-284.

[32] Stene, T. M., Lædre, O., & Andersen, B. S. (2016). *Samspill i gjennomføring av byggeprosjekter - Former for samspill og effekter*. SINTEF Technology and Society.

[33] Wøien, J., Hosseini, A., Klakegg, O. J., Lædre, O., & Lohne, J. (2016). Partnering Elements' Importance for Success in the Norwegian Construction Industry. *Energy Procedia, 96*, 229-240.

[34] Haugseth, N. (2014). *Partnering in Statsbygg*. MS Thesis. Norwegian University of Science and Technology: Faculty of engineering.

[35] Tune, H. T. (2015). *Samspill i norsk bygg- og anleggsbransje*. MS Thesis. Norwegian University of Science and Technology: Faculty of engineering.

[36] Bresnen, M., & Marshall, N. (2000). Partnering in construction: a critical review of issues, problems and dilemmas. *Construction Management & Economics, 18(2)*, 229-237.

[37] Sødal, A. H. (2014). *Early contractor involvement: advantages and disadvantages for the design team.* MS Thesis. Norwegian University of Science and Technology: Faculty of engineering.

[38] Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS quarterly*, xiii-xxiii.

[39] Ellis, D. (1989). A behavioral approach to information retrieval system design. *Journal of documentation, 45(3)*, 171-212.

[40] Yin, R. K. (2013). *Case study research: Design and methods*. Sage publications.

[41] Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: interviews and focus groups. *British dental journal, 204(6)*, 291-295.

[42] Weber, R. P. (1990). *Basic content analysis* (No. 49). Sage.

[43] Difi (2017). *Samspillsentreprise - BAE.* Retrived [02.05.17] from https://www.anskaffelser.no/temaer-bae/gjennomforingsmodeller/samspillsentreprise.