ANALYSING THE PROBLEM OF PROCUREMENT IN CONSTRUCTION

Laura Pekuri[1], Aki Pekuri[2] and Harri Haapasalo[3]

ABSTRACT

In solving the prevalent problems of construction industry, clients have an integral role to play. By its procurement procedures, the client influences the way a construction project is executed, as the procedures affect the form of the project delivery system. What kind of procurement procedures are perceived rational, for one, depends on the underlying assumptions about the function of procurement. This research studies the current conceptualizations of the problem of procurement stemming from the fields of economics as well as engineering and construction management. A recognized tenet in Lean Construction (LC) is that production should be conceived consisting of transformations (T), flow (F), and value generation (V). Therefore, this research exploits the TFV theory in analysing the assumptions underlying procurement. On the basis of the analysis it is suggested that the main function of procurement should not be seen merely as overcoming the problem of ex-ante information asymmetry in the moment of awarding the contract nor tackling the problem of ex-post adaptation just by contractual structures. Instead, it is seen necessary to recognize and address the danger of value loss with an equal diligence as the other problems have been to date. To be more in line with the thinking in LC, the mindset within procurement should be set towards procuring the best possible project production system that is fit for its purpose.

KEYWORDS

Construction, procurement, production, project delivery system, TFV theory

INTRODUCTION

Budget overruns, schedule delays, poor quality, low customer satisfaction, and weak productivity development. These are the words that have been, and still are, often used to describe the construction industry, whatever the referenced country may be. Despite the efforts of the construction practitioners in the field and scholars in multiple disciplines, these challenges are far from being settled. As Alves et al. (2012) note, the calls for change during the past three decades have been numerous and severe. Instead of stressing new tools, technologies or skills, the criticism is often targeted towards the fundamental operating logic of the industry. Therefore, incremental changes in how we do things may not be enough and a more profound

[1] PhD Student, Industrial Engineering and Management, University of Oulu, laura.pekuri@oulu.fi
[2] PhD Student, Industrial Engineering and Management, University of Oulu, aki.pekuri@oulu.fi
[3] Professor, Industrial Engineering and Management, University of Oulu harri.haapasalo@oulu.fi

Industrial Engineering and Management, PO Box 4610, 90014 University of Oulu, Finland.

soul-searching is needed to question what things we do and why we do them in the first place.

According to Ballard and Howell (2008), Lean Construction (LC) can be understood as a new paradigm for project management, and it has, in fact, been embraced in the construction improvement debate (Jorgensen and Emmitt 2009). One of the central tenets of LC is that the construction project should be perceived as a temporary production system (Ballard and Howell 2008) instead of seeing it merely as purchasing (i.e. series of transactions) or as contract management (Koskela and Ballard 2006). What is also pertinent is the conceptualization of projects; not as organizations executing the given ends and pursuing the resolution of conflicting needs of the clients and specialists but as entities pursuing the mutual goals of transformation (T), flow (F) and value generation (V) within the production system of the project (Koskela and Ballard 2006). But to function according to the TFV theory (Koskela 2000a), the whole project delivery system needs to support production accordingly. This means that the project organization, the project's operating system (production), and the commercial terms binding the project participants must be aligned (Thomsen et al. 2010). Due to the systemic nature of the project delivery system, adjusting one domain requires adjustments to others in order to prevent outcomes that could be less than optimal.

In previous research, it has been acknowledged that the clients can have a major role in shaping the way construction industry operates. Blayse and Manley (2004), for example, identified multiple studies where the key role of clients in promoting construction innovation was highlighted. Osipova and Eriksson (2011), for one, argued that the client can have a major impact on the risk management of construction projects through procurement procedures. In addition, Briscoe et al. (2004) stated that as it is the client who makes the decisions regarding the procurement of construction works as well as the way in which the procurement is conducted, the clients' role in the integration of construction supply chain is critically important. Furthermore, Kumaraswamy (1998) found mounting evidence that procurement policies can have a major influence – both negative and positive – to the development of construction industry.

This study is guided by the notion that the selected procurement procedures, which form the construction project procurement system (Kumaraswamy 1998), affect the form of the project delivery system (Figure 1). Procurement procedures shape especially the form of the project organization and the commercial terms, and that way they lay the boundaries for the functioning of the operating system. On the contrary, if the operating system of the project is desired to function in a certain way, the procurement procedures should shape the other domains of the project delivery system to support that. The extant research within LC has paid a lot of attention on how the project delivery system can deliver more value to the client. A lot less has been said about whether the client is operating under assumptions that comply with the ones held in LC and ones that promote the new ways of operating. Therefore this research takes the client perspective on construction projects by contemplating the underlying assumptions behind procurement. These assumptions are presented in the form of procurement problems stemming from economics as well as engineering and construction management literature.

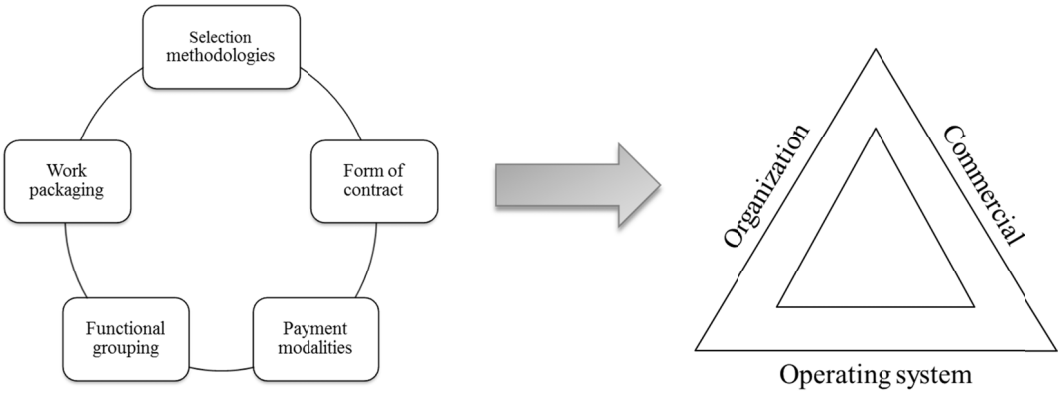

Figure 1: Relationship of the project procurement and delivery systems (adapted from Kumaraswamy (1998) and Thomsen et al. (2010))

The aim of this research is to analyse whether the current conceptualizations of the problem of procurement are supportive of the LC view of construction projects as temporary production systems with the goals of transformation, flow and value generation. Even though the authors do comply with the view of Bertelsen and Emmitt (2005) in that the client in construction should be seen as a complex system, here we restrict the term to mean the entity making the decisions about the procurement procedures. This is seen sufficient for the argument of the paper. The paper begins by presenting the current conceptualizations of the problem of procurement. Then it moves to describing the TFV theory of production. After that, these two are contrasted with each other. Finally, the consequences of the analysis are discussed and conclusions provided.

CURRENT FORMULATIONS OF THE PROBLEM OF PROCUREMENT

THE PROBLEM OF PROCUREMENT IN ECONOMICS

According to Bajari and Tadelis (2001; 2006), most economic analysis assumes that the problem of procurement is stemming from information asymmetry. In general, information asymmetry means that one party in an exchange situation knows something relevant to the transaction that the other party does not know. In modern economic theories, the main concern for the procurement is the ex-ante asymmetric information about the production costs (Bajari and Tadelis 2001). Therefore, the procurement procedures should be selected on the basis that they are able to fish cost information from the suppliers.

The more uncertain the total cost of the procured item is due to, for example, lack of market cost information of similar items, the more severe becomes the problem of information asymmetry related to production costs. One of the most distinctive characteristics of the construction industry is that a major share of its production comprises of one-of-a-kind products (Koskela 1992) and, therefore, the lack of comparable market cost information is often a reality. Thus it would seem that especially within this industry the information asymmetry is really something that the client should take seriously and devote attention to. From these premises the governmental statutes favouring competitive tendering in public procurement seem to have a legitimate status. In addition to its transparency as a way to prevent corruption, the strengths of competitive tendering as an award mechanism include its ability to

promote competition by inviting multiple potential suppliers from many venues with a strong incentive for not to inflate their prices and, thus, enabling fair market price discovery (Bajari and Tadelis 2006; Decarolis 2014).

THE PROBLEM OF PROCUREMENT IN TRADITIONAL ENGINEERING AND CONSTRUCTION MANAGEMENT

In engineering and construction management, the main problem of procurement has been perceived quite differently. Bajari and Tadelis (2001) found little evidence that either the contractor or the buyer has private information at the onset of a project. Therefore, the main problem faced by procurement is not the information asymmetry related to costs of construction but rather the uncertainty related to the design and execution of the project that burdens the client as well as the supplier (Bajari and Tadelis 2006). For example, design failures, unanticipated site and environmental conditions, and regulatory environments can all cause deviations from what has been agreed in the moment of signing the contract (Bajari and Tadelis 2001). In other words, the problem of procurement is not the ex-ante information asymmetry related to costs but the ex-post adaptation related to the shared uncertainty.

The ex-post adaptation severely mitigates the benefits of achieving the lowest price at the awarding stage as renegotiations and change orders compound the amount of total costs of the owner. In addition, they are cut out for ruining the schedule of the project, which again adds costs. On the basis of the above mentioned issues, Bajari and Tadelis (2006) suggest that the procurement problem should be primarily of "smoothing out or circumventing adaptations after the project begins rather than information revelation by the supplier before the project is selected". In other words, contractual arrangements, that have the ability to accommodate adaptation by making reimbursement process easier, are perceived as a solution to the problem of ex-post adaptation (Bajari and Tadelis 2001). Thus if procurement is viewed from traditional engineering and construction management point-of-view, which strongly rests on the principles of contract management (Koskela and Ballard 2006), its main task is not to strive for diminishing the uncertainties per se but to find the most cost-optimal way to bear them.

THE TFV THEORY OF PRODUCTION

Lauri Koskela's seminal work with building the theory of production is laid open in his doctoral dissertation (2000a) and further research endeavours. It consists of three views of production, namely transformation, flow and value generation. These three views can be found from earlier works stemming from different disciplines that hold different guiding assumptions. Koskela (2000b) argues that these three views of production are not alternative, competing theories. Rather they are partial and complementary, which ought to be integrated and developed further as a comprehensive theory of production. In the later work on TFV by Koskela et al. (2007), the authors recognize that the integration of the views is not that straightforward due to the ontological differences in the presuppositions of the three sub theories of TFV. It is also stated in Koskela et al. (2007) that the integration of the theory has to be done by the user of TFV rather than being taken care of by the theory itself. In the following sections, the three views will be gone through

separately, and in the next chapter, we make an attempt to provide an integrating perspective by the analysis of the problem of procurement.

TRANSFORMATION (T) VIEW

In transformation view of production, production is seen as consisting of transforming inputs to outputs. It holds that production can be decomposed into subprocesses and the total cost of the process can thus be minimized by minimizing the cost of each subprocess (Koskela 2000a). It adheres to the reductionist view of the world that has shaped the Western thinking at least since 17th century, when Rene Descartes suggested that whenever one is faced with complexity, "the thing to do is to chop it up into parts and tackle the parts one by one" (Checkland 2012, p.465). In this view, the whole is simply a sum of its parts while the relationships of the parts and the emergent properties that the interactions of different parts create remain neglected (Arbnor and Bjerke 1997).

According to Koskela (2000a, b), the intellectual roots and the rationale for the transformation view stems from economics and Taylorism, which principal tenet was to improve economic efficiency by the way of task management. The idea behind task management is that the proper execution of work requires investigating what has to be done, decomposing it into tasks, and defining the optimal method and order in which they are to be executed. Koskela (2000b) argues that the main deficiencies of the transformation view of production are its inability to realise that there are other phenomena in production than transformations and that it is not the transformations themselves that make the output valuable to the customer but that the output conforms to the requirements of the customer.

FLOW (F) VIEW

What differentiates flow view from the transformation view of production is that time is introduced as an input in production meaning that the interest is extended from mere transformation to the amount of time consumed by the total transformation and its parts. Introduction of time leads to conceiving the production process as a physical process instead of conceiving it as an economic abstraction in the form of costs. What follows is that the variability inherent in production becomes an issue of concern as it is the major issue that affects the time needed to execute the transformation. Another issue that catches the attention here is that time is not consumed only by transformation activities but also activities that are not necessary for the transformation process i.e. that are waste. (Koskela 2000a.)

The flow view of production puts emphasis on waste elimination from the production processes (Koskela 2000b). However, as Mossman (2009) has argued, the pursuit of eliminating waste from a project or an organisation is potentially a wasteful exercise in itself if it is done in isolation from the value purpose of the project or organisation. As waste creates no value to the customer and, at the same time, is a cost for the client, designers and constructors, its elimination is desirable in principle. However, if the sole focus is on waste and not the value that customers seek, there is a risk of eliminating something that is sometimes of value to the customer even if it would generally appear as waste (Mossman 2009).

VALUE (V) VIEW

Value view of production crystallizes in the idea that the value of an output of a production process can only be determined by the customer, and the only goal of production is to satisfy the needs of the customer (Koskela 2000a). The output does not have any absolute value, even if it would have been produced with the lowest cost in the world and with the shortest lead time one can imagine, if it does not correspond to the needs of the customer. Of course, the correspondence gets its degrees on a sliding scale rather than being a judgement between correspondence and no correspondence. It must be rare, even in relation to construction projects, that the output is such a miss that it does not embody any of the requirements that the client had put forward.

Koskela (2000a, p. 77) defines the concept of value loss as "the part of value not provided even if potentially possible". It is the gap between the achieved value and best possible value that could have been obtained. However, the ambiguity of the concept of value and the ability to define it only in relation to a person or entity being a stakeholder of the construction project makes securing the project from value loss a very challenging task. According to Salvatierra-Garrido and Pasquire (2011), the current understanding of value in the construction industry is limited to the concept's objective nature which has been recognized as a common practice also among engineers and economists where they link value to the features that the product or service has. This limited view ignores the relationship with constructed artefacts and the people, who will maintain, use and are influenced by the artefacts after the construction phase is over.

The whole-life perspective poses an additional challenge for the treatment of value, as the built artefact may be in function for decades or even centuries and have a number of different owners and users at different points in time (Jorgensen and Emmitt 2008). As Bertelsen and Emmitt (2005) have argued, the client in construction should be seen as a complex system. It is not just the paying customer whose value should be maximized. It is also the users, the future users, and the wider society whose values should be addressed within construction. Then again, it may feel natural that when the main focus is on construction costs, the paying customer is in the centre of attention and the one whose requirements will be recognized. But as Salvatierra-Garrido and Pasquire (2011, p.16) state, "society is too important to be postponed over particular customer requirements; it does not mean money is not important, but questions whether profitability should be placed in the first priority or accepted as necessary but not leading." However, it must be remembered that considering our long history of equating value with costs, there is a slippery slope to be tackled in our thinking that solving the problem of value loss automatically means a higher price tag for the projects. As Ballard and Howell (2008: 39) note, in the statement "value is provided when customers are enabled to accomplish their purposes" value has no necessary connection to cost.

VALUE – THE UNDERADDRESSED DIMENSION OF PROCUREMENT

To hold the ex-ante information asymmetry about the costs of construction as the main problem for the client in a procurement situation requires few assumptions for it to make sense. As the transformation view of production and the problem of procurement perceived as ex-ante information asymmetry related to costs share the

same intellectual basis i.e. economics, it does not come as a surprise that there are similar assumptions guiding these views. In the economics, it is assumed that the ends are given and that they are separate from the means (Koskela 2011). For the ends to be given, it posits that the client requirements are clear and stable and that the client can articulate these in a comprehensible way. What then becomes possible is the development of a complete design by the designers for the output that is to be procured. What is left for the client to worry about is that it manages to obtain the output as efficiently as possible i.e. with the lowest cost. In this respect, it makes sense that the main task of the client is to screen the suppliers and try to prevent them to inflate the prices under cover of the information asymmetry.

We can see that the economic considerations in the procurement phase do not consider any contingencies or uncertainties related to the realization of the output. But as the flow view of production and the problem of procurement perceived as ex-post adaptation revealed, construction projects are not as simple as they are assumed to be in economic analysis. Against the assumptions of the best possible productive efficiency and momentary production also originating from the economics (Koskela 2011), production does not happen in a single moment of time and the production organizations are not waste-free. In addition, economics phenomena cannot be separated from technical phenomena (Koskela 2011). This all means that the uncertainty, which causes the ex-post adaptation in construction projects and disturb the flow of production, increases both time and costs required to complete the project.

These issues become more severe as the complexity of the project increases. As Bajari et al. (2009) state, the more complex the project gets, the more difficult it is to complete an ex-ante design and, thus, the more ex-post adaptation is expected. Uncertainty increases waste in the production process in the form of iteration which consumes more resources e.g. work, material and time, thus increasing the costs. In short, complexity of the project inflicts uncertainty in the moment of procurement and causes ex-post adaptation after the procurement is conducted. This severely mitigates the benefits of achieving the lowest price at the awarding stage as renegotiations and change orders compound the amount of total costs of the owner and should logically reduce the incentive of the procurer to focus only on cost as a selection criterion.

However, as is the case with production theories, the understanding of procurement requires a third perspective to get the whole picture of the phenomenon. As was stated previously, the value loss is the gap between the achieved value and the best possible value that could have been obtained. The reasons for the gap to emerge can be numerous. As Howell (2012) puts forth, construction projects feature the uncertainty of what is to be built and how it is to be built. This implies that it is not evident from the outset of the project what the client (as the one making the procurement) or the other stakeholders want or need. This may be due to simply not knowing or not being able to communicate the value that is sought by executing the project. The same issues endure the life-cycle of the projects, as the client and stakeholder requirements are usually implicit and evolving (Koskela 2011). And even if the requirements would be explicit, it is often the case that the means are not, which also poses the possibility for value loss to occur.

Due to the unrealistic assumptions behind the economics view of procurement, the problem of ex-ante information asymmetry does not deserve the status as the number one issue to be resolved by procurement procedures. As it is the case in production, it

is also evident in procurement that its function cannot be determined merely with economic assumptions. The economic assumptions make people perceive the production process as a black box and, thus, the considerations of the effect of the procurement procedures on the project delivery system useless. In addition, the considerations of value are limited to equalling the value of the output with the costs of the inputs (Koskela 2000a). This assumption leads to the conclusion that if the only way to increase the value of the output is to use, for example, better materials, it is up to the client's decision how valuable (and expensive) it wants the end product to be. And if value is only a decision, the meaningfulness of the value discussion is close to zero in production as well as in procurement setting.

Engineering and construction management view of procurement is an advancement compared to the above presented economic view in that the reality of the construction projects as being uncertain in many ways is acknowledged. However, if the task of procurement is perceived to be overcoming the problem of ex-post adaptation and it is mainly viewed from contract management perspective, the client is quite unarmed both with reducing the uncertainties and addressing the danger of value loss. Thus this view of the problem of procurement is also imperfect. By focusing on resolving the issue of ex-post adaptation by contract management, the procurement loses its sight on how the uncertainties could be diminished and the value maximized by forming a project delivery system that could operate beyond transformations.

DISCUSSION

ALIGNING PROCUREMENT WITH LEAN CONSTRUCTION

What should be perceived as the function of procurement and the problem it should resolve, then? The authors suggest that the focus of procurement should be shifted beyond the procurement situation itself in order to be more supportive for the production system to operate towards flow and value in construction projects. It is not believed that the value loss or uncertainties can be resolved only by the procurement procedures themselves i.e. concentrating only on how the procurement is conducted. Resolving the issues needs more attention to the question of what is it that should be actually procured. If the end product and the means to attain it are more or less blurred in the moment of procurement, would it be reasonable to concentrate on procuring the best possible production system instead of a product? What is the best possible production system in an individual situation may depend on the amount of the uncertainties and the potential of the value loss. However, whatever the desirable product may be – simple or complex – the client should consider the requirements set for the production system and ensure that the procured production system fits for its purpose.

REVISITING THE TRADITIONAL PROJECT DELIVERY MODES

As was stated previously, the procurement procedures have an impact to the project delivery system of a project. Thus it is not a surprise at all that the prevalent design-bid-build (DBB) and design-build (DB) methods of project delivery seem to possess similar rationales behind them as what has been seen with the previous conceptualizations of the problem of procurement. In DBB, the design is provided by

separately contracted architect/engineer (A/E) firm on the basis of which the client can arrange a bidding competition (Hale et al. 2009) where the problem of information asymmetry can be overcome. This arrangement does not, however, recognize the multiple uncertainties that are related to the execution of the project neither it tries to tackle the problem of value loss related to contractually isolated stages of the project and the complex nature of the construction client.

In DB, for one, the client provides the requirements for the specified project and awards the contract to a single designer-builder (Hale et al. 2009). From the client's perspective, leaving the whole execution of the project on the shoulders of one designer-builder mitigates the risks associated with the uncertainties prevalent in the procurement stage. As the same company is responsible for the design and the construction, it is, for the most part, that company's headache if the construction does not go according to the plans. As such, this arrangement is not formed to tackle the uncertainties either; it just shifts the associated risk related to the realization of the uncertainties. However, this approach has been recognized to produce better results with respect to time and cost when compared to DBB (Hale et al. 2009). Still, the role of the client here is to minimize the costs of the project and it is argued that the client omits to address the problem of value loss as much in DBB as in DB arrangements.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Even though the problem of procurement in relation to value loss has not been researched per se, much has been done already to develop project delivery methods as well as the production systems within the construction projects. Integrated project delivery (IPD) has become recognized as a legitimate option for the traditional project delivery modes, and it is seen as a response to the requirement for more collaborative practices that ensure the involvement of multiple stakeholders inside as well as outside the project team (Thomsen et al. 2010). Other arrangements that promote relational contracting, such as project partnering and project alliancing (Lahdenperä 2012), and which deviate from the logic pertaining in traditional project delivery methods have also been developed and tested in practice.

Although there is a growing interest in changing the way construction industry operates in hopes of overcoming the all too familiar problems with budget, schedule quality, customer satisfaction and productivity, it is reasonable to state that the change is yet in the "early adopters phase". Much wider group is still working under the old assumptions and are sceptical in taking the first step towards collaborative practices, despite the good results that have been achieved in consequence to their adoption. The client's role in mitigating the wider problems of construction industry should not be underestimated and while recognizing the statement's daring tone, the authors' argue, that the clients have some responsibility in the way these problems have come to be. For years, the procurement procedures have concentrated solving a problem which extent has not been recognized fully. Therefore, it may be still hard to see the point in changing the practices, if the old ones seem to do sufficiently well in the view one has selected to comply with.

It is suggested here that future research should aim to make it more visible how the different procurement procedures are worsening, ignoring, or resolving the problem of value loss related to construction projects. The cause-and-effect relationships between the choices made during procurement and how the whole

project delivery system operates after the official procurement stage is over should be put under the microscope to show how big of a role the client may have on the performance of projects. In addition, the performance evaluation should not be limited to time and cost (as in, for example, Hale et al. 2009), as is often the case, but that other parameters that embody the values of different stakeholders and the society at large should be considered as well (as in, for example, El Asmar et al. 2013).

CONCLUSIONS

The aim of this research was to analyse whether the current conceptualizations of the problem of procurement are supportive of the LC view of construction projects as temporary production systems with the goals of transformation, flow and value generation. Firstly, two prevailing conceptualizations of the problem of procurement where presented; problem perceived as ex-ante information asymmetry related to construction costs and as ex-post adaptation due to uncertainties in the moment of signing the contract. Then these conceptualizations where analysed through the lens provided by transformation-flow-value theory of production. It was found that the conceptualizations of the problem of procurement stemming from the fields of economics as well as engineering and construction management are not able to guide procurement towards forming project delivery systems that could support all three views of production. It was suggested that the focus of procurement should be shifted away from the procurement situation itself in order to be more supportive for the production system to operate towards flow and value in construction projects.

REFERENCES

Alves, T.C.L., Milberg, C. and Walsh, K.D. (2012). "Exploring lean construction practice, research, and education." *Engineering, Construction and Architectural Management*, 19(5): 512-525.

Arbnor, I. and Bjerke, B. (1997). "*Methodology for Creating Business Knowledge*." Sage Publications, Inc., Thousand Oaks, CA.

Bajari, P. and Tadelis, S. (2001). "Incentives versus transaction costs: a theory of procurement contracts." *RAND Journal of Economics*, 32(3): 387-407.

Bajari, P. and Tadelis, S. (2006). "Incentives and award procedures: competitive tendering vs. negotiations in procurement." *Handbook of Procurement*, Dimitri, N., Piga, G. and Spagnolo, G., eds., Cambridge University Press, Cambridge, 121-142.

Bajari, P., McMillan, R. and Tadelis, S. (2009). "Auctions versus negotiations in procurement: An empirical analysis." *Journal of Law, Economics & Organization*, 25(2): 372-399.

Ballard, G. and Howell, G.A. (2008). "Competing construction management paradigms." *Lean Construction Journal*, 1(1): 38-45.

Bertelsen, S. and Emmitt, S. (2005). "The client as a complex system." *Proceedings of the 13th Annual Conference of the International Group for Lean Construction,* Sydney, Australia.

Blayse, A.M. and Manley, K. (2004). "Key influences on construction innovation." *Construction Innovation: Information, Process, Management*, 4(3): 143-154.

Briscoe, G. H., Dainty, A.R.J., Millett, S.J. and Neale, R.H. (2004) "Client-led strategies for construction supply chain improvement." *Construction Management and Economics*, 22(2): 193-201.

Checkland, P. (2012). "Four conditions for serious systems thinking and action." *Systems Research and Behavioral Science*, 29(5): 465-469.

Decarolis, F. (2014). "Awarding price, contract performance, and bids screening: evidence from procurement auctions." *American Economic Journal: Applied Economics*, 6(1): 108-132.

El Asmar, M., Hanna, A.S. and Loh, W-Y. (2013). "Quantifying performance for the integrated project delivery system as compared to established delivery systems." *Journal of Construction Engineering and Management*, 139(11).

Hale, D.R., Shrestha, P.P., Gibson Jr, G.E. and Migliaccio, G.C. (2009). "Empirical comparison of design/build and design/bid/build project delivery methods." *Journal of Construction Engineering & Management*, 135(7): 579-587.

Howell, G. (2012). "Uncertainty and contingency: implications for managing projects." *Proceedings of the 20th Annual Conference of the International Group for Lean Construction*, San Diego, USA.

Jorgensen, B. and Emmitt, S. (2008). "Lost in transition: the transfer of lean manufacturing to construction." *Engineering, Construction and Architectural Management,* 15 (4) 383-398.

Jorgensen, B. and Emmitt, S. (2009). "Investigating the integration of design and construction from a "lean" perspective." *Construction Innovation: Information, Process, Management*, 9(2): 225-240.

Koskela, L. (1992). "Application of the new production philosophy to construction." *Technical Report No. 72*, Center for Integrated Facility Engineering, Department of Civil Engineering, Stanford University, Stanford, USA.

Koskela, L. (2000a). "An exploration towards a production theory and its application to construction." Ph.D. Dissertation, Technical Research Centre of Finland – VTT, Helsinki, Finland.

Koskela, L. (2000b). "We need a theory of construction." In: *Berkeley-Stanford Construction Engineering and Management Workshop: Defining a Research Agenda for AEC Process/Product Development.*

Koskela, L., Rooke, J., Bertelsen, S. and Henrich, G. (2007). "The TFV theory of production: new developments." *Proceedings of the 15th Annual Conference of the International Group for Lean Construction*, Michigan, USA.

Koskela, L. (2011). "On theory of production in economics and production management." In: de Valence, G. (ed.) *Modern Construction Economics: Theory and Application*, Spon Press, London, UK.

Koskela, L. and Ballard, G. (2006). "Should project management be based on theories of economics or production?" *Building Research & Information*, 34(2): 154-163.

Kumaraswamy, M.M. (1998). "Industry development through creative project packaging and integrated management." *Engineering, Construction and Architectural Management*, 5(3): 228-237.

Lahdenperä, P. (2012). "Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery." *Construction Management and Economics*, 30(1): 57-79.

Mossman, A. (2009). "Creating value: a sufficient way to eliminate waste in lean design and lean production." *Lean Construction Journal*, 5: 13-23.

Osipova, E. and Eriksson, P.E. (2011). "How procurement options influence risk management in construction projects." *Construction Management and Economics*, 29(11): 1149-1158.

Salvatierra-Garrido, J. and Pasquire, C. (2011). "Value theory in lean construction." *Journal of Financial Management of Property and Construction*, 16(1): 8-18.

Thomsen, C., Darrington, J., Dunne, D. and Lichtig, W. (2010). "Managing integrated project delivery." CMAA, McLean, VA.