

# HOW RESEARCH CAN HELP TRANSFORM THE CONSTRUCTION INDUSTRY

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**Abstract:** According to its website, the International Group for Lean Construction is dedicated to the radical renewal of AEC practice, education and research. As is the way with academic researchers, that objective has been pursued with little explicit coordination. Without expecting everyone to become part of a big machine, this paper presents the benefits expected from collaboration on a high level research program aimed at removing the obstacles to radical renewal. Obstacles to that transformation are proposed, culminating in an appeal for collaboration to remove those obstacles.

**Keywords:** Lean construction, industry transformation, obstacles, paradigms, research.

## 1 INTRODUCTION

Construction is a project business, contracts have to be defined at a stage when the product is only projected. Handling of that complicated situation goes back as far as the famous "Stele of Law" by the Babylonian King Hammurabi. Whereas death was the penalty for a failed master builder, in the modern world we have more civilized contract models and public procurement rules. But they are no less belligerent. Each side is striving for its own advantage. Gaps in the description of the described works are used to create construction claims. Since those gaps are inevitable war is pre-programmed, resulting in disputes, delays and waste of time and resources. Profit maximizing of the contractor stands against budget discipline of the client. The Lean and collaborative approach is different. The selection process of contractors is based on quality and reliability. The contract is concluded at an early stage of the project bundling the experience and knowledge of the partners. Reasonable profit margins of the contractor are accepted by the client. Incentives are built into the contract with the aim to optimize the project as it develops.

Lean and collaborative contracting have generated their own power. To increase benefits to society, we want to encourage the Lean community to improve its methods of practicing, its ability to spread the results to society and reach the "next level" of performance. It is high time that this community openly and more publicly, in the face of

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the whole world, publish its views, aims and potentials. Lean research must play a major role.

Traditional regulations are not more than a sort of “Geneva Convention” regarding warfare. The absolute power of a king like Hammurabi has been replaced by the power of the administrator. Keeping files clean, adhering to rules, and lack of courage for better guide his behavior. Who can harm him when choosing the cheapest route? Who will reward him when choosing the best? Proof of the former is a simple table, the proof of the latter requires explanations, judgements and courage, rare commodities in the construction environment.

The “next level” for the Lean practitioners is, therefore, not only to spread success stories but also to develop help for the administrators in both public and private clients, to support them in developing judgement and courage, in making distinctions between the numbers in an offer, often not worth the paper they are written on, and true value. Researchers in the Lean Construction community can help to reveal potential for change and its underlying rationale. Specialization comes with the territory for academics, and as a result, there is a natural resistance to collaboration beyond their specialties. But that collaboration is what is needed for lean professors and practitioners to create and spread the knowledge of making a difference, of creating a construction world that encompasses progress for the better, to convince administrators and politicians of the potential of Lean.

## 2 LEAN RESEARCH AND NEXT LEVELS OF LEARNING

An earlier call for action in support of lean transformation was made by Koskela et al. (2003), where the authors noted, citing Papert (2000): “A systemic approach requires one to step back from the immediate problems and develop an understanding of how the whole thing works.” The “next level” of research must address prevailing paradigms and obstacles more intensively. To do so requires understanding the construction industry as a system. Numerous success stories and intelligent white papers have not generated a worldwide acceptance. We must do more to change the construction world for the better.

Some of the setbacks in Lean happen in different countries. National regulations and habits are hindering. We encourage the study of those factors. We want to bring forward the common interests of all countries. We solicit all researchers and practitioners to collaborate, to understand national particularities and to create models independent of all nationalities without neglecting their benefits. The “next level” should encompass all virtues of difference.

Lean is not only a personal power with regard to success in projects. It is a social power. Little has been done by the Lean family to make social power transparent and spread it to the construction stakeholders. The alignment of different interests is the great secret. It has not yet been made transparent to all, especially to the “traditionalist” opposition. The “next level” endeavours do not only have to reveal its advantages but also to show that it can be done.

It is widely understood that fundamental transformation of an industry takes a generation. Educating the next generation in research-generated Lean Construction theory and practice is a necessity. The “next level” practice has to form part of education and research. Whereas research is often a reactive science dedicated to explaining what has already happened, it also has power to shape the future. All participants are encouraged to foster collaborative practice through research results and to form the next generation. One of its many tasks will be to help generate sustainability

of progress achieved while it is constantly hindered by the human habit to fall into “inherited” habits.

The IGLC world is characterized by trying to add a scientific component to the practical Lean world. That is good. But we have to distinguish between what the world needs and papers that are presented in a context of giving the authors academic credit. While the latter should continue we need more research into removing obstacles and disclosing wrong paradigms and developing strategies for radical renewal. Corresponding papers should develop Lead Values, values that create new value. The present depth of the IGLC research can reach “next levels” along the following lines.

Sustainability -in the sense of maintaining the Lean journey- is one of them. Numerous are the cases where success in projects is not transferred to the next project or does not lead to a Lean transformation of the organization. More investigation and research is needed here. Lean Construction has developed its principles and methods by adopting, adapting and inventing. Some Lean production principles and methods have been adopted with little or no change; e.g., the principle to *Use Pull Systems to Avoid Over Production* (Liker, 2004). Others have been adapted to fit with the nature of construction as an industry; e.g., Target Value Delivery (Tommelein and Ballard 2016), which was adapted from lean manufacturing’s target costing. Yet others have been invented; e.g., the Last Planner System (Ballard and Tommelein 2016). The Toyota Production System has been the principal source and inspiration, and may yet inspire other adoptions and adaptations. But there are other sources as well that should be mined; e.g., current innovations (e.g. mass customization) that bring manufacturing closer to project-based industries, and further exploration of potential knowledge transfers across the boundaries of project production systems: construction, new product development, software engineering, shipbuilding (air and sea), and performing arts productions.

Is waste always a waste? Is there something good to be discovered in waste? Einstein said that God does not throw dice. If we look at evolution it rather looks like the opposite. Constantly dice are thrown into various directions. The right numbers are not defined by a certain face value but through their relation to a changing environment. Can we do more research into the value of waste? The Set Based Design method is going into that direction. Possibly more could be discovered.

The Last Planner System offers great opportunities for learning. Failures and mistakes are collaboratively made transparent. Root causes are unveiled with the aim to eliminate those and to create a learning platform. But learning does not only happen through failures. It is established that children learn through negative experience; they won’t touch a hot stove a second time. The Lead Value, however, is created by learning through positive experience: from their own behavior with feedback, from the encouragement of the parents, from positive role models, from everything they did and regard it as a success. Spitzer (2007) has given evidence of that. The hot stove is just a singular thing. Positive learning creates new values and shapes the future. The Lean learning from success can be systemized. Another field of research.

Lean has formed a successful marriage with BIM. Other technologies could be added like hand-held devices as I-Pads or augmented reality in head screens on site. What are the next levels of using IT and internet? The future design team might gather necessary input from the net. Is the Big Room outdated already? Imagine architects working for the net. An “app” makes the results available. The feeders could be rewarded like an UBER driver. What does a Lean app look like? Can we create a Lean internet university? The Lean construction future might be in the internet. Today, you have an idea and it can be

developed through the net, at low cost. In this context, are the five big ideas really big? Here is another huge research field that could be assigned to a Lean think tank for structuring and devising research topics.

### 3 OBSTACLES TO LEAN TRANSFORMATION

There are many obstacles to any kind of transformation. The first obstacle is unwillingness to change until forced. Fortunately for the human race, that characteristic is not uniformly distributed through the species. Some people and organizations tend to be early adopters of new ideas and tools. When that adoption leads to improvements, especially improvements that impact competitiveness in markets, it can compel others to change.

A related obstacle is what has been called paradigms: fundamental assumptions about the nature of reality (Kuhn, 1970). Paradigms in the construction industry that are obstacles to lean transformation include (Ballard, et al., 2011):

- Trust is for suckers;
- If you don't bid it, you pay more;
- Win-win is hogwash. All that matters is if I win;
- The best risk management strategy is shifting risk to someone else; and
- Project management does not include management of production.

Experience has shown that some people are unable to give up their paradigms—they just can't 'get their head around' new ways of thinking and behaving. However, a few do make the change, and new assumptions and operating principles can be embedded in younger generations. Old rules and regulations can be replaced by new rules that align with the new way of thinking and acting.

The existing way of doing and thinking about construction is well rooted in a multitude of practices and institutions. For a transformation such as lean to replace what appears to be an immovable object will require cutting every one of its roots. Among the strongest such roots is the education system, in which curriculum is controlled by successful practitioners through service on program assessment committees and on standards setting bodies. At the university level, it is the rare assistant professor who will carry the fight into the camp of the enemy when threatened with failure to be granted tenure. Change is coming, but slowly, in the teaching of architects, engineers and constructors.

Another fundamental obstacle to lean transformation is those who live off the waste in the current system. That waste ranges from claims consultants to unnecessary inventories to criminal practices. This obstacle cannot be overcome by persuasion and education. It must be overcome by force. How can research help with this problem?

### 4 THE NUMBER ONE OBSTACLE TO LEAN: CORRUPTION

The number one waste in construction is corruption. Little has been published or done to fight this in Lean research or practical Lean papers. Corruption is the main obstacle to progress especially in developing countries that need progress most. The Lean principles of transparency, honesty, openness, customer value, aligning of justified interests, etc. are bound to fail in an environment where special interests prevail. Special interests are those that will not contribute either to the project or to customer value. They are

designed to serve the interests of individuals who render their paid services for influencing the awards of contracts or for providing information.

It is beyond the scope of this paper to investigate all the reasons for corruption and its mechanisms. Numerous papers exist in the non-Lean context. One may be mentioned here: Zhang et al., “Causes of Business-to-Government Corruption in the Tendering Process in China”, an ASCE Case Study, 2016. Further references are included there. The reasons for corruption are given there in a one country context. Recommendations to overcome them are presented. As in many other countries the remedies proposed are concentrated around improving the existing system: To revise the flawed tendering system, establish a new code of conduct, introduce new laws to better an existing system, and establish more stringent penalties and supervision. Nothing of that nature has really helped yet. The truth is that the corruption environment usually has “better” rules and codes of conduct always being ahead of the tender regulations and that new regulations will open new possibilities to bribe its enforcer.

It is quite clear in this context that Lean principles must fail. To really operate an open Last Planner System (LPS) is close to impossible. Attempts of admirable young Lean researchers to investigate the possibilities of applying LPS or other methodologies like TVD or even IPD must remain futile in those environments because they are not connected to reality. Lean research should focus on how “special interests” create obstacles. But that is only one side of the coin. It should offer to the world that Lean principles do represent a possibility to overcome the special interests by showing that no new regulations within the old system will help. Only cultural changes will help.

Culture has mostly a positive denomination. But habitual negative behaviours are often derived from it. Bad habits become culture. Our brain functions like that. Repetitive actions are stored and become habitual, even if detrimental. So, if the Lean family wants to offer a better solution than increasing supervision and ever more stringent rules that would be corrupted anyway, it has to offer something else--its own philosophy. Bring people together to jointly develop the project. The remaining problem is how to develop a win-win situation with corruption-prone people who would see their gain drift away, a research question of highest importance. How can we lead them into a world where jointly developing a project and sharing of knowledge is better than making information a trade item to be paid through corruption?

Another item in the context of special interests is vanity. Rulers in developing countries are rather pleased to open a new road with golden scissors and under TV coverage. Nothing spectacular is connected with spending money to maintain public assets. The result is that, according to the World Bank’s (1989) *Road Maintenance Initiative*, for every Dollar spent in new road construction in Africa withdrawing it from maintenance, three Dollars are lost in the value of existing roads lacking maintenance. What is the answer of Lean to that? A research question.

Useful agents to influence the supreme decision-maker are deeply rooted in our culture (e.g. ask a Saint for help). Corruption emerges from the very inside of our cultures and behaviour. Therefore, it can only be fought from the inside through cooperative models. If the Lean family is convinced of its mission to change the construction world it has to be aware of cultural facts. Instead of accepting the demanding of ever stricter rules for a failing system it should offer and make more transparent its powers to change habits, at least in the construction world. In the context of this chapter, the transformation of the construction world, more research is needed. More action is required to show society that lean principles have the potential to reduce the negative effects of special interests. The action part should be to convince political

decision makers to give Lean/IPD a chance to prove that better projects will be the result and corruption could be fought more efficiently through open books, aligning of interests and collaborative contracting than through introducing more stringent rules within a failing system. The group dynamics of LPS and IPD have the power to work against corruption, automatically and inherently. One of the predominant research questions in this context is: How can we create win-win?

## 5 RESEARCH AREAS

A list of possible next level research areas is presented below. These are not meant to be comprehensive. They can be subdivided into a number of individual dissertations and/or actions. International coordination is recommended.

- How can IPD be made understood and accepted in various environments – worldwide?
- How can it be shown that IPD and correct administration are not in contradiction?
- How can public authorities be helped to develop new regulations and new behavior?
- How can a FAQ-list for newcomers and ‘traditionalists’ be elaborated and answers compiled?
- How can wrong or misleading paradigms be made more transparent and better understood?
- How can it be proven that the most economic project is one that creates the best value?
- How can it be shown that different interests can be aligned for the benefit of all?
- How can Lean country teams develop procedures incorporating national singularities?
- How can it be shown that Lean is much more than a mere collection of tools?
- How can Lean be expanded in the field through the use of augmented reality?
- How can Lean research be led to a next level by offering Lead Value?
- How can Lean learn from production systems other than the TPS?
- How can Lean be spread through education? Can a standard curriculum be developed?
- How can the experience from successful Lean projects be transferred into sustainability?
- How can the effort be intensified to lead young researchers into practical next level topics?
- How can it be shown that Lean offers the best way available to react to a changing world?
- How can Lean learning from success be systemized?
- How can obstacles against transformation be systematically identified and eliminated?

- How can wrong paradigms be addressed? Which role has education in this context?
- How can Lean contribute to convincing corruption infested societies that jointly developing a project and sharing knowledge is better than making information a trade item to be purchased through corruption?
- How can Lean be applied and transparency and win-win situations be created against the resistance of those who live off waste?
- How can Lean be extended to improve the maintenance field?
- How can Lean develop its potential for changing habits deeply rooted in culture?
- How can it be shown that Lean principles offer a better potential for the fight against corruption than ever more stringent regulations within a failing system?
- How can Lean contribute to overcome resistance to and fear of change?
- How can Lean become the norm in construction worldwide?
- How can the methods to disseminate the knowledge of Lean be improved?
- How can Lean make new-comers 'feel' something: excitement, curiosity, inspiration?
- How can Lean change the suspicion many people carry about Lean?
- Can the PDCA cycle be used by Lean on its next level to Plan (strategize) the transformation, to Do certain steps, to Check (create evidence and evaluation), and Act (create standards)?
- How can Lean be developed from offering new concepts into a force that drives change in industry and society? How can drivers for change be identified?
- Should gradual change be maintained or a revolution started?
- How can small and medium enterprises be addressed and included more intensively?
- What are the potentials for Lean on the internet?

## 6 SUMMARY AND CONCLUSIONS

This paper constitutes an appeal to IGLC researchers and practitioners to work together in applying research to advance the transformation of the global construction industry. Although Lean Construction enclaves are growing, traditional thinking and practice still dominate the construction industry. Lean transformation remains something that must be fought for--it will not happen by itself.

To cut the roots of the traditional culture of industry, many things need to be done, and research is only one of them, but a very important one. Education is a mighty weapon because it helps shape the framework within which future construction industry professionals think and act within the construction industry—and research provides the stream of knowledge, both know-that and know-how, that informs educational curricula. Further development and implementation of technology can be helpful; e.g., in supporting Lean Construction objectives to engage the minds and emotions of industry workers in continuous improvement.

Specific to their role as researchers, Lean Construction advocates can help by targeting the paradigms that are obstacles to lean transformation. To give just one example: what evidence is there to believe that ‘If you don’t bid it, you pay more’? A recent review of the literature by one of this paper’s authors found that most academic researchers believe this to be true, and counterpose this drive for ‘efficiency’ to the need for innovation in the industry. This is confused thinking, which targeted research can reveal as such. What evidence has been produced thus far against the claim that bidding reduces cost? One example is the recent publication of a report on Integrated Project Delivery projects entitled *Motivation and Means: How and Why IPD and Lean Lead to Success* (Cheng, 2016). This set of case studies is certainly a contribution to knowledge, but statistical confirmation of the correlation between awarding contracts on qualifications (not price) and lean management of projects, on the one hand, and on the other hand, project outcomes, including cost, remains to be done.

## 6 REFERENCES

- Ballard, G., Kim, Y.W., Azari, R. and Cho, S. (2011) "Starting from Scratch: A New Project Delivery Paradigm" Research Report 271, *Construction Industry Institute*, University of Texas, Austin.
- Ballard, G. and Tommelein, I.D. (2016). *Current Process Benchmark for the Last Planner System*. Lean Construction Journal, 2016. Also available at [p2sl.berkeley.edu](http://p2sl.berkeley.edu)
- Cheng, R. (2016). *Motivation and Means: How and Why IPD and Lean Lead to Success*. Lean Construction Institute ([www.leanconstruction.org](http://www.leanconstruction.org))
- Koskela, L., Ballard, G. and Howell, G. (2003) "Achieving Change in Construction." *Proceedings of the 11th International Group for Lean Construction Conference*.
- Kuhn, T.S., (1970) The structure of scientific revolutions. *International Encyclopedia of Unified Science*, vol. 2, no. 2.
- Liker, J.K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. McGraw-Hill
- Papert, S. (2000). What's the big idea? Toward a pedagogy of idea power. *IBM Systems Journal*, Vol. 39, No's 3 & 4, pp. 720 - 729.
- Spitzer, M. (2007) *Learning: The Human Brain and the school of Life*. Elsevier Science
- Tommelein, I.D. and Ballard, G. (2016). *Target Value Design: Introduction, Framework and Current Benchmark*. Lean Construction Institute, March 2016.
- Worldbank (1989). *Road Maintenance Initiative*. Internal documentation made available to governments in developing countries.
- Zhang, B., Le, Y., Xia, B. and Skitmore, M. (2016). *Causes of Business-to-Government Corruption in the Tendering Process in China*. American Society of Civil Engineers, also published in *Journal of Management in Engineering*, 05016022, Queensland University of Technology.