

DESIGN-BUILD CONTRACTS IN NORWEGIAN ROAD PROJECTS

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ABSTRACT

The use of design-build (DB) contracts are increasing in the Norwegian infrastructure market, but the method is still new. Both contractors and project owners lack experience and knowledge of how these contracts can be carried out in the best possible way. The purpose of this research is to explore and document experiences from the use of DB contracts.

In addition to literature reviews, two cases are studied using interviews and document studies to present experiences from Norwegian road projects. The results show that the two projects are different from the early phase. An additional contract written in one of the projects has caused a lot of disagreement and mistrust between the contractor and the project owner and has been a damaging element in the project execution. It is also pointed out that because of the lack of experience and knowledge on the use of a DB contract and method from all parts, the projects are characterized by disagreements between the project owner and the contractor. Lastly, the results show that the early phase of the projects should have been utilized in a greater degree to define the scope and responsibilities of both the project owner and contractor.

KEYWORDS

Design-build contract, lean construction, infrastructure, road projects

INTRODUCTION

For Norway to have a modern transport system that can satisfy future transport needs, the government will invest up to NOK 1000 billion for the period 2018 to 2029. Currently, the public clients responsible for carrying out road projects – Norwegian public roads administration and Nye Veier AS (New roads) do not have sufficient capacity to follow up these major investment plans in detail. One of their solutions is to move from the traditional DBB contracts to DB contracts. This means that these two public clients have started to contract one contractor to perform both the design of the project as well as building it, in comparison to the traditional DBB method, where the project owner contracts separately with a designer and a contractor. In addition, traditional contracting based on the lowest price as only award criteria has caused conflicts in the Norwegian construction industry. A result is that public clients have moved from accepting tenders

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with the lowest price towards awarding the most economically advantageous tenders, i.e. they are now using more criteria than just price.

The trend with using DB contracts in combination with the most economically advantageous tender in road projects is relatively new, but with the low capacity within the public client organisations and enormous future investments in road projects and DB they will be more and more used. Therefore it is important to fill this knowledge gap as fast as possible. However, it will take time to standardize the execution method as well as the contract's layout, the room of maneuver, and the responsibility of the different organizations. DB in road projects is new and the government is planning

There is limited coverage of lean thinking in public procurement and DB projects in Norway and a lack of research in the IGLC community in the area of this paper studies. There is a lack of documented experiences from the use of DB contracts with most economically advantageous tender, causing a knowledge gap that should be reduced as soon as possible because of the enormous future investments. This paper contributes to addressing this issue and will answer the following research questions.

- How was the DB contracts executed?
- What are the experiences from the DB contracts?

To answer these research questions, two cases with DB contracts from different project owners – but the same contractor – are studied. Document studies and 12 interviews were used for data collection. The two Norwegian road projects that will be compared and studied are, E6 Helgeland North and E18 Rugtvedt-Dørdal.

METHODOLOGY

The research methods used in this study are literature study and two case studies. The cases are studied based on interviews and document studies.

A theoretical framework was developed based on a review of literature on DB contracts and early contractor involvement. The literature that has been chosen and used is reviewed to be trustworthy, accurate, and suitable for this study. The methods' validity is secured by a clear context between the research questions, theory, and analysis, as described in Blumberg et al. (2011). Keywords like “design-build”, “road projects” and “public procurement” have been used on Google Scholar and IGLC's online repository.

Semi-structured interviews with an interview guide have been conducted, as described by Blumberg et al. (2011). The study first started with interviewing the contractor of the two projects. When analyzing these results, it became clear that it would be interesting to interview the project owners as well, due the different execution methods used. The interviewees spoke freely and included what they thought relevant and necessary for the study. The interviewees were people in the contractors' (6 persons) and project owners' (6 persons) organizations that have managerial positions in the case projects. The interviews lasted on average for about 45 minutes – 75 minutes each. All the questions were qualitative of nature, and the interviews were carried out face to face with the interviewees. All interviews were audiotaped and a transcript was sent to the interviewees for approval to increase the reliability before the data was analyzed.

CASE DESCRIPTION

Through two case studies of the two projects, it has been possible to gain insight into the contractor's and the project owners' experiences with DB contracts and how they want future projects to be executed.

E6 Helgeland North

The Norwegian Public Roads Administration (NPRA) is project owner, and they have used the procurement method competitive dialogue. The NPRA is organized under the Norwegian Ministry of Transport and Communications. The contractor is responsible for design, building, maintenance and operation of the road until 2030. The design and build part had to be completed within five years, while maintenance and operation lasted for fifteen years. The road was originally designed for a speed limit of 80 km/h, but this was changed to 90 km/h in an additional contract signed after approximately one year.

Table 1: Description of the project E6 Helgeland North

Project	Description	Budget	Proj. Start-finish
E6 Helgeland North	62 km new two fields European highway	1,92 bill. NOK	07.2015 – 08.2030

E18 Rugtvedt-Dørdal

The project owner of this project is Nye Veier AS (“New Roads”), and the procurement method used was Best Value Procurement (BVP). Nye Veier AS is a fairly new organization organized under the Norwegian Ministry of Transport and Communication. Operation and maintenance is not included in this contract.

Table 2: Description of the project E18 Rugtvedt-Dørdal

Project	Description	Budget	Proj. Start-finish
E18 Rugtvedt – Dørdal	16,8 km new four field highway, 110km/h	2,1 bill. NOK	05.2017 – 12.2019

THEORY

CONTRACT STRATEGY

The project and contract strategy will to a certain extent determine the scope and room of maneuver for the contractor and project owner. This will also be affected by when in the project the contractor is involved, and how much the project owner has already decided and planned. The opportunity to influence the project is bigger in the early phases and will reduce as the project develops.

Choosing the most appropriate contract strategy often depends on the project type, project owner, and procurement method (Chen et al., 2015). The project owners’ choice of contract strategy largely determines to what degree the contractor or contractors need to be followed-up (Lædre et al., 2006). The specific project and the project owners’ overall project strategy defines to a great degree what kind of contract strategy is optimal. Both projects in this study have public project owners. This will affect both project strategy and contract strategy, since public project owners in Norway must follow certain rules. In addition to rules, there are also standards as well as the NPRA’s handbooks that are based on traditional DBB contracts and experience. Aandahl et al. (2017) concludes that it is challenging to apply these in DB projects. The study also addresses problems concerning the NPRA executing DB contracts with a DBB mentality, as well as not using DB contract strategy enough to extend their competence and knowledge. The study recommends executing more DB delivery systems to gain competence in the Norwegian market (Aandahl et al., 2017).

Kalsaas et al. (2018) have found that the clients' change in contract strategy will radically change the working conditions for the consulting design and engineering companies, as well as for the head contractor. In this study, it is also found that a strong relationship between contractor and consulting engineers is especially important for success in the execution of the project.

DESIGN-BUILD

DB is a project delivery system where the project owner signs a contract with only one contractor that has total responsibility for both the design and construction of the project. This contract is called a DB contract. By transferring the responsibility for both the design and construction through one contract with one contractor, the project demands another kind of involvement from the project owner (Lædre et al., 2006). DB is growing to become a delivery system of choice for public agencies (Lee et al., 2010, Molenaar et al., 1999). This is also becoming clear in the Norwegian infrastructure market. Lee et al. (2010) suggest several lean practices that can minimize waste and maximize efficiency, and proposes a hypothesis that lean design management can improve the design and estimating process of the project studied. The suggestions include systematic design constraint analysis, choosing by advantages, set-based design and cross functional teaming.

Kraakenes et al. (2019) concluded that the use of DB strategy can be improved by adopting suitable elements from the partnering approach in Lean construction. DB contracts have integrated the design and construction element, but they lack the inclusion of a structured way to ensure better collaboration in the projects.

Project owners' most important reason for choosing DB is the possibility to reduce the schedule (Puerto et al., 2008). It is found that big infrastructure projects in the USA executed with DB contracts have noticeably reduced the delivery and building time compared to similar projects executed with DBB contracts (Shrestha et al., 2012). It seems that DB is a more reliable and faster delivery system, which leads to a slightly lower claim rate (Plusquellec et al., 2017).

EARLY CONTRACTOR INVOLVEMENT

Both competitive dialogue and best value procurement cover some of the elements of Lean production by involving contractors in the early phases (Wondimu et al., 2018a). In addition, these approaches give the project owner and the opportunity to meet the possible contractors and discuss the projects before the contract is signed. This is early contractor involvement and is a way of integrating knowledge and experience at an early stage of the project (Song et al., 2009). Early contractor involvement can give several positive implications to a project, like improved cost estimation, planning constructability, and risk management (Sødal et al., 2014). On the other hand, contractors do intervene in the design process which used to belong to only designers and architects. This can lead to challenges of interests due to different viewpoints and focus.

(Wondimu et al., 2018a) claim that competitive dialogue and best value procurement – two approaches where the most economically advantageous tender win – give the best results when used together with a DB contract rather than a DBB contract. In addition, these approaches give the clients the possibility to adjust the projects together with the contractors before signing the final contract. These early contractor involvement approaches opens for early contractor involvement, where construction knowledge and experience is integrated in the early phase of a project. Early contractor involvement is

defined as an important element of lean construction (Song et al., 2009). In a competitive dialogue, the awarding method is always the most economically advantageous tender (Hoezen and Doree, 2008). In best value procurement the client will use other award criteria than just bid price in the evaluation and selection of the contractors (Elyamany and Abdelrahman, 2010). Examples of such award criteria are building time, quality of products, HSE (health, safety, and environment at work), environmental considerations and technical solutions.

The BVP method is a procurement method first introduced in the Netherlands in 2004. This method wishes to increase the efficiency of the project process by involving the contractor and sub-contractors in an early stage of the project. The goal is to increase the opportunity to utilize the expertise (Narmo et al., 2018).

CD is a different procurement method first introduced by the EU for complex projects, to give public clients a more flexible procurement phase (Wondimu et al., 2018b). CD is especially much used in big, complex projects, where there is a need for research and development in the clients' needs. The method is also flexible and secures competition and dialogue.

RESULTS

The results from the case studies are presented chronologically. First, the findings from the procurement and contracting phase come, then from the execution and completion phase, and lastly the first results from operation and maintenance. The findings from E6 Helgeland North come first, and then comes those from E18 Rugtvedt-Dørdal.

E6 HELGELAND NORTH

Procurement and contracting

This was the contractor's first project with a DB contract. The project owner NPRA used competitive dialogue as procurement method. In the pre-qualification for this project, the involved contractors delivered solutions that were evaluated with four award criteria; technical solutions, traffic management, HSE and environmental consideration, and lastly building time. In addition, the contractors had to solve specific challenges, for example related to the design of intersections and fillings. Through this phase, the contractors had continuous contact with the owner in dialogue meetings. After the pre-qualification, the contractors' priced their tender and NPRA signed up with the best tenderer.

After the design phase had started, the NPRA expressed that they wanted a higher speed limit. In addition, the contractor wanted to move the new road away from the existing road, allowing them to use bigger machines and get a better capacity. The client saw this as a win-win-situation and the result was an additional contract, new design solutions, and a total re-zoning process with the local municipalities.

Both the contractor's and the client's experiences from the competitive dialogue was good. They expressed that the phase was constructive, all involved parts were solution-oriented and there was a lot of positive engagement. This was a phase where both the contractor and project owner had the opportunity to influence the solutions, and the contractor described this as a productive phase. However, after the contractor priced the the new design solutions, they expressed that they felt trapped since they unexpectedly lost all possibilities to continue development of their solutions. The positive solution-oriented atmosphere stopped. The project owner expressed that the designed solutions at the time for pricing was what the contractor had to build. The project owner did not accept

new solutions that impaired the quality of the road. The contract owner experienced that the contractor realized during the execution phase that they were losing money, and started making unrealistic demands.

The contractor expressed a wish for better descriptions in the contracting phase of their influence on the design solutions as well as their room of maneuver after they priced the new design solutions. The interviewees from the contractor expressed that there were substantial misunderstandings and disagreements over what was described in the contract and the responsibility distribution. The contractor felt trapped throughout the project, with no opportunity to implement solutions that benefitted productivity. Many of their originally suggested solutions could be simplified – so the project could save time and money – but the project owner demanded them to be executed as they were first described. The interviewees from the project owner had a different perception. They would be happy to implement new solutions that benefitted the contractor, as long as the quality of the project was not decreased.

It was observed that the contractor felt that rather than working towards a common gain with a solution-oriented communication, the project parties worked against each other towards their own gain. The project owner evaluated the project as a success, and that the overall communication was good. They did highlight that contractors should make money and realized that this was not the case in this project, which was negative for the business in general.

Execution and commissioning

The DB contract in this project is very detailed, and every part of the road work is thoroughly explained and priced. In addition, the NPRA has handbooks and manuals stating how work should be performed attached to the contract. The contractor did not realize – before pricing the changed design solutions – that they had to follow the detailed prescriptions in the handbooks and manuals and that there was no room for maneuver. Problems occurred in rapid succession, and the additional contract was blamed for this.

The contractor is positive to project owner involvement in the execution phase, but in this project they felt overrun by the NPRA. The project owner made unreasonable requests, often directly to the craftsmen on site, instead of having an open communication with the contractor. This is pointed out to depend on the people working in the project organization, and is not believed to be caused by the contract. Nevertheless, it has been destructive for the cooperation between the contractor and the project owner.

In the execution and commissioning phase, the contractor would have appreciated a more flexible project owner and a more solution-oriented atmosphere. The contractor wanted more room of maneuver, so they could simplify their design solutions. The contractor was left with a feeling of the project owner acted as in a DBB contract – where the owner is in charge of the details – rather than a DB project – where the contractor is in charge of the details. This was believed to be a result of a lack of experience with DB contracts in road projects and was highlighted by both the client and the contractor as a main cause of the problems that occurred.

Operation and maintenance

In Norwegian road projects the normal warranty time is 3 or 5 years, but in this project the warranty time was 15 years plus a 3 years warranty that starts after the maintenance and operation phase. This increased the contractor's risk, and decreased the project owner's risk. If the contractor choose a bad solution, it will eventually backfire. Both the

client and the contractor believed this was positive, because it made the contractor design and build a high-quality road that will last during the prolonged warranty time.

The contract made contractor responsible for operation of the road in 15 years, starting at the time of contract signing. The contractor was not experienced with maintenance and operation of roads, and they had no interest in operating the road many years after construction. The contractor has delegated the responsibility for maintenance and operation to a sub-contract, but they still kept responsibility. It became clear through the contractor interviews that they wished that operation was not a part of their contract. The client was happy with this solution and wanted to repeat this in future projects. It took responsibility off their shoulders, which is one of the intentions with a DB contract.

E18 RUGTVEDT-DØRDAL

Procurement and contracting

The project owner Nye Veier AS used pre-qualification and best value procurement, and the winning contractor's tender consisted of six A4 pages. Two pages gave the achievement description, two pages presented the risks of the project owner, and the last two pages presented additional value contributing to the project goal. Interviews with representatives from the competing contractors are used as an award criterion. Representatives from the contractor are interviewed by the project owner and their specialists, and must answer all questions asked. The interviews were audiotaped, and the transcripts were included as part of the contract.

After owner had identified the – so far – best tender, the clarification phase began. The project owner and contractor sat together, planned the details for the project and made sure it followed what the project owner has envisioned. All the technical details of the project were revised to find a correct price for the project. During the clarification phase, the contractor had to decide which subcontractors to use.

Both the contractor and the client were positive to best value procurement, as it allowed the contractor to apply their expertise productively. The contractor participated in the planning and design of the project, and benefitted from that later on during execution. However, the interviews were brought up as questionable because, because the evaluation of them are influenced by the contractor representatives' ability to speak for themselves. The interviews did not necessarily reflect the knowledge and experience of the representative.

Execution and commissioning

The DB contract was detailed, like it was on the project E6 Helgeland North. The project owner Nye Veier AS had to build according to NPRA's handbooks and manuals, which are detailed and absolute. The room of maneuver in these types of projects are to a great degree managed by these handbooks.

The contractor agreed that the project owner needed control in a DB project and that they should be just as much involved as in DBB projects, but with different roles. Even though Nye Veier AS is a new organization, it has mainly sprung out from the NPRA and it was clear that the ways of thinking partly were as before. Even with a desire to optimize and innovate, the NPRA's handbooks and manuals held back the development. It was pointed out that to fully benefit from a DB contract, as well as from the early contractor involvement, the project owner needed, to some degree to be able to deviate from the handbooks. This would have made it easier for the contractor to optimize and innovate.

The road had to be safety approved for traffic before it was allowed to let the traffic on. The contractor had to document and get all solutions approved from the Directorate of public roads. In DBB contracts this has been the responsibility of the project owner, but in the DB contract the contractor had this responsibility.

The contractor points out that cooperation in the commissioning phase has been extremely productive, and they are happy with the project owner's interest and involvement. The project owner is also happy with the cooperation in the project. The contractor has had the opportunity to benefit and learn from the project owner's experiences, and such cooperation was new to them.

The contractor's experiences with NPRA's handbooks are both positive and negative. On the negative side, the handbooks restrict the room for maneuver in a DB project. The contractor felt that they did not get paid for all the responsibility they took. When the handbooks indirectly decided technical solutions, the DB contract gave the contractor responsibility for the quality of the solutions forced on them by the owner. If the solutions did not work, the contractor would have had to fix it without any extra compensation. Beside this, the handbooks restricted the contractor's opportunity to optimize and innovate. On the positive side, the handbooks challenged the contractor to use their expertise and optimize solutions within the functional requirements.

On the project E18 Rugtvedt-Dørdal the contractor wanted a low level of details in the contract. The perception was that the more details, the more risk they took. The contractor wanted to avoid a greater risk than reasonable. The project owner presented it as a goal for future projects to have as low level of details as possible in the contract. Their perception was that the more details they put in the contract, the more responsibility would fall back on them.

The contractor experienced that the interaction between the project owner and themselves was productive. Confidence and trust were necessary ingredients for the project success.

Operation and maintenance

On the project E18 Rugtvedt-Dørdal, the contractor had no responsibility neither for maintenance nor operation of the road after the execution and commissioning phase. The owner had an option to include maintenance for 20 years, but decided recently not to use it. The contractor has given a 20 year warranty for the road and has to repair damages caused by poor quality. The owner and contractor have agreed on basic annual inspections and main inspections every 5 years. The owner will accept normal wear and tear, and maintenance outside of the warranty will be taken care of by an operating contractor.

It was pointed out that since the maintenance part of the contract was optional, that caused unclear interfaces between the warranty responsibility and the maintenance of the road. This led to a need for clarification of where the responsibilities of the contractor stopped, and the responsibilities of the operating contractor started. The contractor did not accept to be responsible for quality if the operating contractor did not operate as agreed on. Therefore, it was agreed on maintenance and operation instructions that describes the road's condition after 20 years.

DISCUSSION

The procurement method in a project will in many cases set the scope and the basis for the cooperation between project owner and contractor. For both projects, it was clear that the procurement methods were a positive experience for both the clients and the

contractor. It led to a very productive design phase with open and positive collaboration. After the price was decided and the contract signed, the contractor felt, mostly in the project E6 Helgeland North, like the room of maneuver and the positive cooperation disappeared. It came forth in both projects that the scope and responsibility distribution in the project should have been discussed more. The project owner and contractor should have come to a common agreement before the execution phase started. How much of this that should be explained in the contract is hard to properly answer. Both the contractor and the clients clearly expressed that the DB contracts itself were good, and that they did not want to make substantial changes in future projects. This indicates that the contractor and the client should clarify risk distribution and room of maneuver early, and that they should make sure that they start the project with a common understanding.

According to Kalsaas et al. (2018), a DB contract is normally considered a specific contract, but the findings in the two projects show that there are different approaches to application of DB contracts in projects. The DB contracts gave room for maneuver in the projects, and the contractor believed the contract itself had many positive aspects and opened for a good project performance for both parts. In the projects, it is often specific individuals that are barriers for productive collaboration, and not the contract. This means that the contract itself can open for successful cooperation, while the individuals can be barriers. Since a characteristic of DB contracts is that the contractor is responsible for both the design and construction, it has throughout the two project been unclear what the project owner can demand and not during the construction phase. It seems like the project owner has the perception that, since this is a DB contract, the contractor will have to deliver everything that is asked for, even if the demanded changes appear after the design phase, and when the price already is set. The contractor does not agree with this perception, and this has caused miscommunication and disagreements. One solution to this could be to discuss and clarify this during the early phases of the project. It is a common experience that involving the contractor in the early phase is both productive and contributes to a good start for the project and the cooperation. It might be helpful to use this time to decide scope and room of maneuver for both contractor and client during the executing phase.

Both projects have a long warranty time after the project is delivered and the roads are opened. This is reviewed as positive because it challenges the contractor to design sustainable and lasting solutions and choose good materials. In the future, every part gains on this.

CONCLUSION

This paper has studied Norwegian DB projects, but it is believed that the experiences are transferable and relevant to an international context. It is pointed out in both projects that the contractor believes that a project owner organization should be structured in approximately the same way as the contractor organization. This would lead to a higher level of cooperation as well as an understanding of every field in the project.

The infrastructure industry loses a lot of money these days, and both project owners and contractors have negative results. This may be a result of the industry trying out new contract terms, including DB contracts. Both contractors and project owner needs to gain experience and adapt to a new contract type because the use of DB contract is increasing. The lack of experience in both the execution and the interpretation of a DB contract can lead to misunderstandings between the contractor and the project owner. This can in some

cases lead to distrust, making it more difficult for the specific organizations to cooperate in the future.

HOW WAS THE DB CONTRACTS EXECUTED?

The project E6 Helgeland North is a very unique project considering the additional contract concerning the road having a higher speed limit. Additionally, it is the very first road project the contractor has executed using the DB contract. The project owner, the NPRA, also lacks a lot of experience in the field. The contractor has therefore throughout the project felt that the project owner has executed a DBB while all the responsibility and risk lies on them as a DB contractor. This distribution has been uneven and has led to disagreements and conflict between the contractor and the project owner. The responsibilities, scope, and room of maneuver have not been well enough defined in the early phases of the project, and the consequences of this have followed throughout the project execution.

The project E18 Rugtvedt-Dørdal has from the procurement phase been characterized by trust and positive cooperation between the project owner and the contractor. The trust has been identified as necessary for success for both parts. The contract is detailed and descriptions are based on the NPRA's handbooks, which are absolute and to a great degree decide the room of maneuver in the project. The authority of the project owner Nye Veier AS is limited by the handbooks, even though the contract itself opens up for a bigger room of maneuver for the DB contractor. The cooperation has all in all been very good, but it is pointed out that the project owner lacks knowledge about what can be demanded and not during the execution phase, without giving economical reliefs or additional payment to the contractor. The common understanding of this has not been good enough and the contractor and project owner have had different opinions on the topic.

WHAT ARE THE EXPERIENCES FROM THE DB CONTRACTS?

There is a general agreement that the problems in the project E6 Helgeland North are not caused by the contract itself, but the additional contract as well as the lack of experience and knowledge concerning this contract method and execution. The contractor was not well enough prepared for this type of project and contract method. They failed to make the right demands and gain the proper knowledge about what the project owner expected and envisioned for this project in the early phase, and the project owner has utilized this to his advantage.

The project E6 Helgeland North has as experienced by the contractor been executed more or less like a DBB project but where the project owner has made unreasonable requirements saying it should be included in the project, without extra payment or other financial reliefs, because it is a DB contract and the DB contractor has all responsibility. This comes in the end back to both parts not having the experience or knowledge required before executing a project like this.

The general experiences in the project E18 Rugtvedt-Dørdal are good, the contractor has been allowed to use their expertise, as well as learn from the knowledge of the project owner. The client is overall very happy with the result and would like to continue using DB contracts in future infrastructure projects. The contractor wants a clearer scope and distribution of responsibilities in the project. It is pointed out that having a rather long maintenance responsibility after the project execution is finished, is positive for the contractor. This challenges the contractor to make sustainable and good choices and

designs. However, the scope on this part as well is unclear and it has taken time and resources to agree on the terms and responsibilities. The contractor is positive about both the procurement method and DB contract, but it is clear from the experiences that there is a need for better knowledge.

In both projects, it is pointed out that the early phases in the projects should have been better utilized. The scope and responsibilities should have been planned and discussed more in detail and project owners and the contractor should to a greater degree agree that they have the same understanding of the execution and room of maneuver for both parts in the project. One project owner applied a rather strict approach close to traditional DBB with little room for maneuver for the contractor – but still transferring the responsibility for uncertainty related to design to the contractor. The other project owner gave the contractor much room for maneuver since the contractor was allowed to do small design changes during execution – and therefore the contractor accepted the responsibility for uncertainty.

The results from this study will be interesting, not only for the involving parts but for all organizations that will have to perform similar projects with a DB contract in the future, to find out how the use of DB contracts, as well as the procurement methods competitive dialogue and best value procurement, can lead to successful road projects, based on the experiences from the two road projects.

LIMITATIONS AND FURTHER RESEARCH

This research is limited to studying only two Norwegian public road projects. The study has also only acquired information from the projects' own (Statens Vegvesen, u.å.) owner and contractor, and do not cover experiences from other involved parts and organizations.

This study is limited and there will be a need for further research on the topic. Information from other aspects, like from the designers and architects' point of view would be interesting to explore. In addition, further research should cover more project cases, both road and other construction projects, as well as compare experiences from projects in different countries.

REFERENCES

- Aandahl, S. H., Wondimu, P. A., Lohne, J. and Lædre, O. 2017. "Managing the Room of Maneuver in Design Build Contracts – A Comparative Study of Norwegian Road Projects." *Procedia Engineering*, 196, 187-194.
- Blumberg, B., Cooper, D. R. and Schindler, P. S. 2011. *Business research methods*, London, McGraw-Hill Higher Education.
- Chen, Q., Xia, B., Jin, Z., Wu, P. and Hu, Y. 2015. "Choosing Appropriate Contract Methods for Design-Build Projects." *In: Journal of Management in Engineering*, 32.
- Elyamany, A. and Abdelrahman, M. 2010. "Contractor Performance Evaluation for the Best Value of Superpave Projects." *In: Journal of Construction Engineering and Management, ASCE*, 136, pp. 606-614.
- Hoezen, M. and Doree, A. G. 2008. "First Dutch competitive dialogue projects: a procurement route caught between competition and collaboration." *In proc. 24th ARCOM conference, 1-3 September 2008, Cardiff, UK*, Dainty A. (ed.), pp. 535-543.
- Kalsaas, B. T., Hannås, G., Frislie, G. and Skaar, J. 2018. "Transformation from design-bid-build to design-build contracts in road construction." *In: Proc. 26th Annual Conference of the International Group for Lean Construction (IGLC)*, González, V.A (ed.), Chennai, India, .

- Kraakenes, E., A., T. and Johansen, A. 2019. "Comparing Lean Construction with Experiences from Partnering and Design-Build Construction Projects in Norway." In: *Proc. 27th Annual Conference of the International Group for Lean Construction (IGLC), Dublin, Ireland*, Pasquire C. and Hamzeh F.R. (ed.), pp. 937-946.
- Lee, H. W., Tommelein, I. and Ballard, G. 2010. "Lean design management in an infrastructure design-build project: A case study."
- Lædre, O., Austeng, K., Haugen, T. and Klakegg, O. 2006. "Procurement Routes in Public Building and Construction Projects." *Journal of Construction Engineering and Management, ASCE*, 132.
- Molenaar, K. R., Songer, A. D. and Barash, M. 1999. "Public-Sector Design/Build Evolution and Performance." *Journal of Management in Engineering*, 15, pp. 54-62.
- Narmo, M., Wondimu, P. and Lædre, O. 2018. *Best Value Procurement (BVP) in a Mega Infrastructure Project*.
- Plusquellec, T., Lehoux, N. and Cimon, Y. 2017. "Design-Build and Design-Bid-Build in Construction- a Comparative Review."
- Puerto, C., Gransberg, D. and Shane, J. 2008. "Comparative Analysis of Owner Goals for Design/Build Projects." *Journal of Construction Engineering and Management, ASCE*, 24, 32-39.
- Shrestha, P., O'connor, J. and Gibson, G. 2012. "Performance Comparison of Large Design-Build and Design-Bid-Build Highway Projects." *Journal of Construction Engineering and Management*, 138, 1-13.
- Song, L., Mohamed, Y. and Abourizk, S. M. 2009. "Early Contractor Involvement in Design and Its Impact on Construction Schedule Performance." 25, pp. 12-20.
- Statens Vegvesen. u.å. *E6 Helgeland* [Online]. www.vegvesen.no. Available: <https://www.vegvesen.no/Europaveg/e6helgeland> [Accessed].
- Sødal, A. H., Lædre, O., Svalestuen, F. and Lohne, J. "Early Contractor Involvement :Advantages and Disadvantages for the Design Team." In: *KALSAAS, B. T., KOSKELA, L. and SAURIN, T. A., eds. 22nd Annual Conference of the International Group for Lean Construction*, 2014/06/25 2014 Oslo, Norway, 519-531.
- Wondimu, P. A., Klakegg, O. J., Lædre, O. and Ballard, G. "A Comparison of Competitive Dialogue and Best Value Procurement." *26th Annual Conference of the International Group for Lean Construction*, 2018/07/18 2018a Chennai, India, pp. 13-22.
- Wondimu, P. A., Lohne, J. and Lædre, O. 2018b. "Competitive Dialogue in Norwegian Public Infrastructure Projects." Dept. of Civil and Environmental Engineering, Norwegian Univ. of Science and Technology, Trondheim.