Revista Ingeniería de Construcción RIC
Vol 38 Special Issue 2023
www.ricuc.cl
DOI: 10.7764/RIC.00090.21

ENGLISH VERSION

Lean in the public sector in Finland

Lean en el sector público en Finlandia

Pekka Petäjäniemi [*1]

[*] Finnish Transport Infrastructure Agency, Helsinki, Finlandia.

Fecha de Recepción: 01/08/23
Fecha de Aceptación: 18/12/23
Fecha de Publicación: 21/12/23
PAG: 51-57

Abstract
Finland is undergoing an immense change in the execution of real estate development and construction projects. Since 2011 nearly 100 projects have already been launched in the country with the Integrated Project Delivery (IPD) principle. The total value of the projects is close to 7.3 billion euros. The principles of integration are currently applied especially to project management contracts, but also to other traditional contract models with fixed content or fixed price. Implementation of the IPD models has triggered a change in work culture and practices across the whole construction field. Focus within the traditionally somewhat quarrelsome and fragmented industry has now shifted towards cooperation and continuous improvement – both important Lean principles. Experience from the integration of contracting authorities and service providers has shown the advantages to be achieved. The contracting authority can utilize the know-how of different parties from the start of the project, as designers and builders are planning ways of execution together. A joint development phase leads to better planning and more accurate budgeting as well as better commitment of different parties. The use of IPD models has also served as a significant basis for introducing Lean principles and tools in Finland. Without IPD models, especially the customers' awareness of the benefits of Lean methods would have remained low. Furthermore, the sharing of risks and benefits encourages the execution of projects with stricter adherence to budget and schedule. So far, all completed IPD projects have achieved the target schedule and budget. Despite minor shifts in the cost targets of the projects, all contracting parties have been satisfied with the achieved results.

Keywords: *LIPS; Lean Construction; Alliance Model; Public Sector.*

Resumen
Finlandia está experimentando un inmenso cambio en la ejecución de proyectos de desarrollo inmobiliario y construcción. Desde 2011, en el país ya se han lanzado cerca de 100 proyectos con el principio de Integrated Project Delivery (IPD). El valor total de los proyectos se acerca a los 7.300 millones de euros. Los principios de integración se aplican actualmente especialmente a contratos de gestión de proyectos, pero también a otros modelos contractuales tradicionales con contenido o precio fijo. La implementación de los modelos IPD ha desencadenado un cambio en la cultura laboral y las prácticas en todo el campo de la construcción. El enfoque en una industria tradicionalmente algo conflictiva y fragmentada ha cambiado hacia la cooperación y la mejora continua, ambas importantes principios Lean. La experiencia de la integración de las autoridades contratantes y los proveedores de servicios ha demostrado las ventajas que se pueden lograr. La autoridad contratante puede aprovechar el conocimiento de diferentes partes desde el inicio del proyecto, ya que los diseñadores y constructores están planificando formas de ejecución juntos. Una fase conjunta de desarrollo conduce a una mejor planificación y presupuestación más precisa, así como a un mayor compromiso de diferentes partes. El uso de modelos IPD también ha servido como una base significativa para la introducción de principios y herramientas Lean en Finlandia. Sin modelos IPD, especialmente la conciencia de los clientes sobre los beneficios de los métodos Lean habría permanecido baja. Además, el compartir riesgos y beneficios fomenta la ejecución de proyectos con una adhesión más estricta al presupuesto y al cronograma. Hasta ahora, todos los proyectos IPD completados han logrado el cronograma y el presupuesto previstos. A pesar de pequeños cambios en los objetivos de costos de los proyectos, todas las partes contratantes han quedado satisfechas con los resultados obtenidos.

Palabras clave: LIPS; Construcción sin pérdidas; Modelo de Alianza; Sector Público.

[1] ***Corresponding author:***
Finnish Transport Infrastructure Agency, Helsinki, Finlandia
Corresponding author: pekka.petajaniemi@vayla.fi

1. What is Lean

Lean is a management philosophy that aims to optimize the whole system by eliminating waste, improving flow and increasing value for customers. Lean thinking is considered a philosophy. In Finnish, lean means slim, thin or competitive. Lean thinking aims to improve the efficiency and profitability of the company's operations by reducing waste. The core of Lean thinking is to use the methods for each production process that can be used to make the process as efficient as possible. The process is constantly monitored during production and the method is constantly improved and modified. Lean thinking originates from the Toyota car factory in Japan in the 1950s. Toyota used a production system called the Toyota Production System (TPS). The purpose of the production system was to constantly improve the factory's internal process and strive for the most efficient production possible. (Koskenvesa and Sahlstedt, 2017). The concept of lean production was used for the first time in 1988 (Modig and Åhlström, 2012).

2. Challenges to start to use Lean

There are many definitions of the concept of Lean philosophy, and several definitions have started to take on a life of their own. Lean can be understood at many different levels of abstraction. The higher the abstraction level definition for Lean, the more general the definition is. If Lean is defined only as methods and tools, it becomes too narrow. In this case, it is only suitable for a certain environment and context. If Lean is defined at a low level of abstraction, there is a risk that many organizations will misunderstand Lean. In this case, one negative limitation is when Lean is applied in other industries. (Modig and Åhlström, 2012).

There have also been problems in the development of the Lean concept when goals and means have been mixed. The means explain how and the goals why. If Lean is defined as methods, the use of methods easily becomes the purpose itself. Problems arise when the method becomes the goal itself. Mixing goals and means causes organizations to forget why change work is being done. As an example, to open this, you can use gathering around the visualization board to have a breakfast meeting every day. When asked if Lean is applied in the organization, the answer is that every day we gather around the blackboard. In this case, the means has become the goal, if the goal behind the tool has remained unclear. It is important to understand what Lean is for. What goals need to be realized with the help of Lean and what not. (Modig and Åhlström, 2012).

Many organizations tend to start their Lean journey using methods and tools developed by Toyota. In this case, there is a danger that the most profound principles of Lean are not realized, but that the focus is on concrete actions. Lean is abstract and requires a lot of time and understanding. Many organizations may shelve Lean because their organization is not a piece-goods organization. In this case, it has not been seen how Lean's tools and methods can be useful in those environments. (Modig and Åhlström, 2012).

3. Lean in Public Sector

Finnish representatives have also been active in the Lean in Public Sector (LIPS) network, which is a network of practitioners and researchers who share their experiences and knowledge on applying Lean principles and methods in public sector organizations. LIPS congresses are concentrating Lean leadership, collaboration, project delivery, procurement and sustainability. It has been recognized, that benefits to use Lean in Public Sector are:

• Improved service delivery: Lean helps public sector organizations to identify and eliminate waste, streamline processes, and deliver value to customers and stakeholders. Lean also helps to improve quality, reduce errors, and increase customer satisfaction (Hansen and Stoner, 2009); (Isanians, 2023).

• Cost reduction: Lean helps public sector organizations to optimize their use of resources, reduce operational costs, and increase efficiency. Lean also helps to avoid overproduction, inventory, and unnecessary transportation(Isanians, 2023).

• Increased accountability: Public sector organizations can establish clear performance metrics and enhance overall transparency by implementing Lean Six Sigma. This fosters a culture of accountability, essential for public trust and confidence in government institutions. (Andersson et al., 2023).

• Improved staff morale and productivity: Lean helps public sector organizations to empower their employees, involve them in problem-solving and decision-making, and provide them with feedback and recognition. Lean also helps to improve communication, collaboration, and learning within and across teams. (Andersson et al., 2023).

Despite the many benefits, it is important to recognize the challenges of implementing Lean in Public Sector as well:

• Lack of proper training: Public sector organizations may not have sufficient resources or expertise to train their staff on Lean principles and methods. This may result in a lack of understanding, commitment, and skills among employees and managers (Maware and Parsley, 2022)

• Resistance to change: Public sector organizations may face cultural barriers and organizational inertia that hinder the adoption of Lean. Employees and managers may be reluctant to change their established ways of working, share information, or collaborate across silos. (Maware and Parsley, 2022).

• Insufficient financial resources: Public sector organizations may have limited budgets and competing priorities that constrain their ability to invest in Lean initiatives. Lean may also require upfront costs that may not be easily justified or recovered. (Maware and Parsley, 2022).

• Complexity of public services: Public sector organizations may have multiple and diverse stakeholders, goals, and regulations that complicate the application of Lean. Public services may also involve high variability, uncertainty, and interdependence that challenge the standardization and simplification of processes (Mando and Saleh, 2014).

• Lack of evidence-based solutions: Public sector organizations may lack reliable data and rigorous evaluation methods to assess the impact of Lean on their performance and outcomes. Public services may also have long-term and intangible benefits that are difficult to measure and attribute to Lean. (Neumann et al., 2015).

4. Lean in Construction

Lean construction was originally an application of lean thinking to the construction industry by Professor Lauri Koskela in the early 1990s. According to some interpretations, the roots of lean construction come from Finland. It is about minimizing the loss that occurs in projects and thus maximizing the value the customer receives (Koskenvesa and Sahlstedt, 2017).

Although the lean philosophy has been studied for a long time by researchers in universities and its benefits are indisputable, its practical application to construction in Finland started quite late: Lean Construction Institute Finland (LCI) was founded in 2008 and registered in 2016. LCI is a network of researchers and practitioners who share their knowledge and experience on Lean Construction. It supports the development and dissemination of Lean Construction methods and tools in Finland and abroad. It represents Finland in the international LCI network, which includes associations from various countries such as North America and Europe. LCI Finland organizes and supports research projects, seminars, workshops, and study trips related to Lean Construction. It is open to all stakeholders who are interested in Lean management in the built environment, such as clients, architects, designers, contractors, suppliers, consultants, and research institutes. (https://lci.fi/en/).

In Finland, the application of lean thinking in construction received a significant additional boost when public builders were the first to apply the use of the Integrated Project Delivery (IPD) - also as the Alliance Model nominated - in construction. It was soon noticed that the benefits of construction based on strong cooperation come to the fore most significantly when people are introduced to and trained to use lean tools.

5. Alliance model in construction – step to use Lean

The integration of construction projects in Finland has started because of project alliances launched in 2011– 12. Positive experience from the model has resulted in the adoption of the model already in 75 real estate development and construction projects. The total value of these projects is already around 7.3 billion euros. (Vison Oy: Alliance and IPD report – almost 100 IPD projects in Finland).

The principles of integration are currently applied to project management contracts, but also to other traditional contract models with fixed content or fixed price. These models are called integrated project deliveries (IPD), or collaborative project deliveries. Implementation of the IPD models has triggered a change in work culture and practices across the whole construction field. Focus within the traditionally somewhat quarreled and fragmented industry has now shifted towards cooperation and continuous improvement. Experience from the integration of contracting authorities and service providers has shown the advantages to be achieved. The contracting authority can utilize the know-how of different parties from the start of the project, as designers and builders are planning ways of execution together. A joint development phase leads to better planning and more accurate budgeting as well as better commitment of different parties. Furthermore, the sharing of risks and benefits encourages the execution of projects with stricter adherence to budget and schedule. So far, all completed IPD projects have achieved the target schedule and budget. Despite minor shifts in the cost targets of the projects, all contracting parties have been satisfied with the achieved results. Because of that, it is necessary to highlight

the basic principles of the Alliance model in this context. (Vison Oy: Alliance and IPD report – almost 100 IPD projects in Finland).

6. Alliance Background

Project alliance is a project delivery method based on a multi-party contract between the key to a project whereby the parties assume joint responsibility for the design and construction of the project to be implemented through a joint organization, including the owner, and where the actors share both positive and negative risks related to the project and observe the principles of information accessibility in pursuing close cooperation (Petäjäniemi and Lahdenperä, 2012).

The basic idea is that an operational model where risk is borne jointly, and reward is shared based on the success of the entire project makes the parties consider each other's views better and collaborate more efficiently for the best of the project. The method also allows combining a wide range of expertise needed to foster innovation and to make demanding ventures successful. That, again, necessitates early selection of the actors which makes offering services at a fixed price impossible. The solution to that challenge is selection based on a thorough review of team performance and capacity. (Petäjäniemi and Lahdenperä, 2012).

Project alliancing and its use have developed strongly in recent years, especially in Australia, from where the method found its way to Finland. The Finnish Transport Infrastructure Agency (FTIA) adopted it first for the renovation of the Lielahti–Kokemäki railway section and later on for the construction of the Tampere lakeshore road tunnel. Governed by public procurement legislation, the procurement was based on the stage-wise negotiated procedure where overall economic advantageousness was the selection criterion.

In the process, the competition entrants, who have been selected as tenderers, receive a request for a proposal. After tenders have been submitted, the number of tenderers is reduced based on an assessment including interviews. Thereafter, two competing teams continue to the stage involving workshop tasks that are evaluated which, forms the basis for the selection of the best tenderer. The cost viewpoint is reflected in the selection primarily through the proposed method for control of the economy, presented budget critique, and suggested development possibilities, but the concrete price criterion included is the mean of the percentage fees of the companies of the consortium weighted by their work inputs.

The member companies of the selected team enter into a 'development agreement' with the owner for the design of the project in order, for instance, that the project's target cost can be set and jointly agreed. Only thereafter the actual implementation contract is signed.

7. Three leading contracting parties (Vison Oy: Alliance and IPD report – almost 100 IPD projects in Finland)

In Finland, the leaders in the implementation of alliance and IPD models have been those who initiated the first projects: Finnish Transport Infrastructure Agency (Lielahti-Kokemäki railway renovation project), City of Tampere (Tampere tunnel) and University of Helsinki (Vuolukiventie Campus renovation). 10 cities currently belong to the authorities that initiate IPD projects. Other public authorities initiating IPD projects are Finnish airport operator Finavia, Helsinki City Transport municipal enterprise, the Hospital District of Helsinki and Uusimaa, and six other hospital districts as far as public energy companies and some universities. Non-public operators and Pension Funds have launched IPD projects also.

All the significant Finnish construction companies are already operating as principal executors in IPD projects. Respectively, almost all major design offices have been responsible for design in IPD projects. Besides the large enterprises, a growing number of smaller architectural firms and design offices are operating in IPD projects. All the major construction management offices have also operated in various roles in IPD projects.

8. The alliance model is used more widely than before.

Alliance models have spread rapidly from large infrastructure projects to building construction. Around 22% of the value of launched alliance projects is related to investments in infrastructure, around 71% in the construction of buildings and around 7% in other projects and services. The share of new construction in construction projects is about 75% and rebuilding or renovation around 25%. The alliance model has also been introduced in four road and railway maintenance contracts. The Finnish Transport Infrastructure Agency has two ongoing railway network maintenance contracts. Helsinki

has piloted the regional contract of Pakila, and Turku has launched a maintenance contract on the downtown street network, utilizing the alliance model. Comprehensive projects consisting of several individual projects have also been launched with the alliance model.

In terms of units, most projects launched with the alliance model concern the new construction or renovation of residential properties (12), schools or community centers (12), hospitals (12), or operating facilities (11). A special characteristic of these projects is the involvement of users and the large number of stakeholders, to whom the alliance model serves as a good foundation for integration.

By cost, hospitals and healthcare centers (3.1 billion euros) and tramway projects (1.6 billion euros) account for the largest share of alliance projects. In addition to alliance projects, the healthcare district of HUS in Helsinki and Uusimaa has launched practically all its projects in the form of collaborative contracts in recent years.

9. IT, Social & Healthcare, and other services

The alliance model has also proven its suitability for projects in other business fields. The Finnish Transport Infrastructure Agency has already completed two IT system and service projects with the alliance model. Other public clients of the cost accounting system of the new infrastructure procurements are the 6 biggest cities in Finland. In the city of Tampere, the social and healthcare service alliance Tesoma has started its alliance operations in the spring 2018 and is already offering services to customers. An exceptional feature of the Tesoma model is that the alliance comprises two service providers: the city itself as a service provider and Mehiläinen Oy. Moreover, the city has invited a tender for the operator's services of the new railway for approximately 90 million euros, using the alliance model.

10. Functional exit

Because of varying reasons, the infra-alliance project of the city of Kuopio in Savilahti and the lifecycle alliance of Järvenpää Comprehensive School have both been abrupted. The solar power plant project of Päijät-Häme Waste Management was suspended in mutual agreement when the project turned out to be financially unprofitable in the development phase. The alliance contract has been proven to be functional under these circumstances.

11. Collaboration during the corona epidemic

Because of varying reasons, the infra-alliance project of city of Kuopio in Savilahti and the lifecycle alliance of Järvenpää Comprehensive School have both been abrupted. The solar power plant project of Päijät-Häme Waste Management was suspended in mutual agreement when the project turned out to be financially unprofitable in the development phase. The alliance contract has been proven to be functional also under these circumstances.

12. Additional certainty to construction through risk management

The key principle in IPD projects - joint risk management - challenges the practices applied in the construction business. Transfer of risks to service providers or any other individual party has usually no positive effect on risk management. On the contrary, the transfer of risks usually tends to increase costs. The benefits achieved in IPD projects is based on the following key principles: early inclusion of parties, joint contractual grounds, and joint incentives. Joint management of risks and opportunities leads to better outcomes in the project. By nature, construction involves a lot of uncertainty, which evolves into concrete risks and related impacts during a project. Risk management contributes to preventing the materialization of risks and minimizing the impacts. Risks are often related to the objectives, budget, and timeline of the project. Similarly, positive risks should also be managed, by supporting their materialization and capitalizing on gained benefits. In projects that entail risk exposure due to uncertainty such as administrative or technical challenges, integrated forms of execution are preferred. For this reason, the significance of risk management in IPD projects is higher than customary, especially when risk management is integrated invariably into joint trade conditions and incentives. In IPD projects, risks are viewed as a risk reserve distinguishable from the rest of the cost estimate, contributing to higher transparency of the budget. Risk management should be started as early as possible, preferably already when setting up the project. The process should start with the identification of risks and opportunities, where all the parties review risks and opportunities jointly, openly, and transparently. Next, the risks should be sorted or classified, based on their type or properties. Risks could impact, for example, the planning of the project, technical execution, schedule, and usually also the costs. A risk analysis should also be carried out, which in practice often means drawing up either a qualitative or quantitative risk analysis. This is best achieved by combining the results of the qualitative and quantitative analysis of the risks: Impact of risk = likelihood x consequences Risk management in IPD projects should start from joint identification and management of all risks. In some cases, some of the risks should be allocated entirely or partly to the client, especially when preparing for such risks requires unreasonably high-risk reserves.

At the end of the development stage, risks should be divided as follows:
• Joint risks of the project
• Scope-affecting risks
• Client's risks

The risks of the project should be managed jointly, even if the risks are inevitably beyond the control of all parties concerned. The consequences of these risks are also shared in case that a risk had not been identified or had been entirely overlooked in the risk reserves.

At the end of the development stage, risk management should be made more conclusive, specifying and verifying the risk reserve included in the cost target. The risk reserve should also consider any changes in the project and management of these changes.

In the execution stage, the focal point in risk management is shifted to the management of their impact. In practice this entails the response to risks, attempting to avoid risks or mitigate the impacts of risks. Risk reserves also function as a buffer for risk control.

Risk management should be systematic and carried out as part of project planning, designing, and execution. In practice, risk management is part of the TVD process.

Systematic joint risk management supports the success of projects by maximizing the positive effects and minimizing the negative impacts of risks. Added value with a longer follow-up liability The alliance contracts used in Finland contain a five-year follow-up liability. The contractual meaning and essence of the follow-up liability still need some clarification. According to the new alliance contract, execution is followed by a follow-up liability stage, where the alliance monitors the realization of the objectives of the project and is responsible for contractual tasks of the follow-up liability period. In addition, the alliance is responsible for any repairs arising from the performance of the alliance as well as other possible tasks. Follow-up liability does not include maintenance or upkeep duties unless separately agreed. Follow-up liability as a concept has a broader meaning than warranty. The function of follow-up liability is to ensure that the alliance is responsible for all the tasks under their responsibility. These tasks include management and control as well as monitoring and reporting of follow-up liability. They also include amending any errors and deficiencies arising from the activities and decisions of the parties, and possible incomplete tasks and extra work transferred from the execution stage. The underlying principle of follow-up liability is that the alliance is responsible for its activities over five years. This should also include a five-year liability for errors. However, nothing stops the parties from agreeing otherwise as agreed by the "for the benefit of the project" principle. For example, in subcontracting based on YSE contracts, it may be reasonable to settle for a normal two-year warranty period instead. The follow-up liability should not limit the earlier commissioning of various parts of the project, which should always be the aim of the alliance. A project may be taken into use in stages, but the follow-up liability is a separate stage of the entire project, agreed upon separately by the parties. The tasks of the follow-up liability period should be included in the cost target of the project. Possible changes in scope are subject to separate financing by the client. If the goal of the alliance is a well-functioning project, it would be reasonable to set project objectives that also extend to the follow-up liability period. This could include, for example, the energy efficiency of the property, user satisfaction, or functioning technical solutions. Follow-up liability should therefore be planned as part of the implementation plan, specifying the reserves made for the follow-up liability stage and extending the incentive system into follow-up liability. Follow-up liability starts at the end of the implementation stage with acceptance by the client. At this point, the alliance should submit the final financial statement of the implementation stage and complete the payments and incentives of the implementation stage and reserves made from these for the follow-up liability period. The liability of the alliance ends in a final meeting held at the end of the follow-up liability period. Even after this, the parties remain responsible for matters regarding the accounting of the project.

13. Conclusions

Lean is a journey, not a destination. Through it, the organization strives for better quality with lower costs by utilizing the scientific method in the development of operations. Lean always starts with the customer and his needs and strives to produce better-added value for the customer. It is important to understand that the people who make the service or projects are the ones who create value for the customers. It is important also for the public sector to participate in international LIPS congresses, which concentrate on Lean leadership, collaboration, project delivery, procurement, and sustainability. The experiences gained from colleagues at international LIPS conferences gave a significant impetus to the implementation of an alliance model that strongly utilizes Lean thinking in Finland.

It seems obvious that alliance is commonly used as a general concept to describe collaborative arrangements in general: different countries have different meanings for ´an alliance´. Whenever such arrangements are applied in Europe nowadays it is most likely a question of some kind of a hybrid model instead of a ´pure alliance´ that was in use in the FTIA projects and also the target of the business arena discussions and this report.

Different countries have also different cultures, and, in some countries, the industry is more adversarial than in others. Consequently, this may hinder the introduction of alliance contracting in the said markets while in any case, it requires a lot of work. The change of the culture is a real challenge. Enough time and resources should be reserved, and the stakeholders should be trained to understand the alliancing philosophy. There cannot be too much communication and dialogue.

On these conditions alliance contracting offers a novel option for the owner. Yet, projects are different and alliance contracting is not for every project. Alliance contracting is, first and foremost, a procurement method for projects that involve a lot of challenge, uncertainty, and interfaces. These challenges make the integration of competencies profitable. Early team involvement emphasizing team competence is a major vehicle in this procedure besides the joint risk-sharing that aligns the interests of the parties for the best of the project. All in all, in broad terms it seems obvious that Alliance Contracting is applicable (also) for Public Owners, and with pertinent preparation, we may expect it to offer good value for money in challenging projects. At the same time, it offers a means to develop the culture and performance of the construction sector with Lean methods in general.

14. References

Adnan, Enajar; Ashraf, El Damatty; Ashraf, Nassef. (2021). *Solución semianalítica para techos a dos aguas bajo cargas de viento ascendente. Estructuras de Ingenieria, 229. 1-2*

Caracoglia, L.; Jones, N. (2009). *Análisis de mediciones de viento y presion a gran escala en un edificio de baja altura. Revista de Ingeniería Eólica y Aerodinámica Industrial, 97(5-6)157-173.*

American Society of Civil Engineers (2021). *Cargas mínimas de diseño y criterios asociados para edificios y otras estructuras. Reston: ASCE.*

Andersson, G.; Lynch, M. P. J.; Johansen, F. R.; Fineide, M. J.; Martin, D. (2023)*. Exploring perceptions of Lean in the public sector. Public Money and Management, 43(1), 64–72. https://doi.org/10.1080/09540962.2020.1847454*

Koskenvesa, A.; Sahlstedt, S. (2017). *Planificación temporal y control de proyectos de construcción. Rakennustieto. https://www.rakennustietokauppa.fi/sivu/tuote/rakennushankkeen-ajallinen-suunnittelu-ja-ohjaus/2741393*

Hansen, M.; Stoner, J. (2009)*. A leaner public sector. McKinsey and Company. https://www.mckinsey.com/industries/public-sector/our-insights/a-leaner-public-sector*

Isanians, V. (2023)*. The Importance of Lean Six Sigma Implementation in the Public Sector of Developing Countries. LinkedIn. https://www.linkedin.com/pulse/importance-lean-six-sigma-implementation-public-sector-verej-isanians/*

Mando, J.; Saleh, G. (2014)*. Overcoming the Challenges of Lean in Public Health - Lean Enterprise Institute. https://www.lean.org/the-lean-post/articles/overcoming-the-challenges-of-lean-in-public-health/*

Maware, C.; Parsley, D. M. (2022). *The Challenges of Lean Transformation and Implementation in the Manufacturing Sector. Sustainability 2022, 14(10), 6287. https://doi.org/10.3390/SU14106287*

Modig, N.; Åhlström, P. (2012)*. This Is Lean: Resolving the Efficiency Paradox. Rheologica Publishing, 172p.*

Neumann, S. L.; Mothersell, W. M.; Motwani, J.; Neumann, S. L.; Mothersell, W. M.; Motwani, J. (2015)*. The need for implementing lean in the public sector. International Journal of Business Excellence, 8(1), 104–121. https://EconPapers.repec.org/RePEc:ids:ijbexc:v:8:y:2015:i:1:p:104-121*

Petäjäniemi, P.; Lahdenperä, P. (2012)*. Alliance Contracting: How do we make it in Finland. 1st European Infrastructure Procurement Symposium, EIPS, Copenhagen, Denmark. https://cris.vtt.fi/en/publications/alliance-contracting-how-do-we-make-it-in-finland*