The Toyota Production System
Applying the concept of waste in real estate management

Jylhä, T.E.

DOI
10.1201/9781003128786-13

Publication date
2021

Document Version
Final published version

Published in
A Handbook of Management Theories and Models for Office Environments and Services

13

THE TOYOTA PRODUCTION SYSTEM

Applying the concept of waste in real estate management

*Tuuli Jylhä**

1 Background

Use of resources is one of the greatest challenges globally in sustainability development. Overall, the built environment is responsible for a great part of energy consumption, emissions, and waste generation (Van den Dobbelsteen, 2004; Remøy, 2010; Remøy & Wilkinson, 2012). Both the construction and the use phase of a building consume natural, technical, and social resources and create emissions. For example, around 80–85% of a real estate's total energy is consumed during its use phase (Sharma et al., 2007) which creates up to 90% of all its life-cycle emissions (Junnila et al., 2006). In addition to natural and technical resources, the use phase requires plenty of intangible human capital (Lehtonen & Puhto, 2004); for example, in managing, planning, procuring, and controlling. A considerable amount of this human capital is wasted (Jylhä, 2013). The World Economic Forum (2017) has drawn the same overall conclusions by stating that almost 40% of the human capital is wasted.

Circular economy (CE) aims at efficient and effective use of resources. Circularity is based on the idea of reducing resource input into the system and eliminating leakages out of the system (Geissdoerfer et al., 2017). In the built environment, the one-sided interest in elimination of leakages out of the system, for example through looping and re-looping, has gained some criticism (e.g., Kyrö, 2020; Ness & Xing, 2017). Taking into account the long life cycle of buildings, the slow renewal of the building stock, and the amount of resources consumed in the use phase of a building, resource reduction in the built environment becomes highly relevant. Here, the focus is on resource reduction in the use phase of a real estate. An extended concept of waste is adapted from the Toyota Production System in the field of real estate and workplace management (REM and WM) to reduce the use of resources and to manage for long-term circularity.

1.1 Extended concept of waste

The concept of waste is typically associated with the Toyota Production System (TPS) and the related lean management movement, which has introduced the concept to a wider audience in

*t.e.jylha@tudelft.nl

DOI: 10.1201/9781003128786-13

the management field since the 1980s. The term 'lean' was introduced by Krafcik (1988) and later used, for example, by Womack et al. (1990), Womack and Jones (2003) and Liker (2004) in the mainstream literature. Although the waste concept has provided a long-term competitive advantage to Toyota, the history of the concept started, according to Koskela et al. (2012), at the end of the 18th century. They stated that in 1880–1930, waste of resources had its flourishing period. For example, in 1911, Taylor called after 'greater national efficiency' referring to the resource-efficiency and effectiveness of both tangible and intangible resources (Taylor, 1911, p. 7; Koskela et al., 2012, p. 5):

> We can see and feel the waste of material things. Awkward, inefficient, or ill-directed movements of men, however, leave nothing visible or tangible behind them. . . . [E]ven though our daily loss from this source is greater than from our waste of material things, the one has stirred us deeply, while the other has moved us but little.

The overconsumption of materials and labour force had a key role in production until around 1930. In the flourishing period of waste thinking development, the concept of waste was used not solely in production systems, but also to reduce waste in non-material environments such as governments, services, and engineering. After 1930, the concept of waste gradually re-emerged when the interest towards the Toyota Production System (TPS) started to rise and when the environmental movement highlighted the environmental side of the waste, for example, unwanted by-products and pollutions (Koskela et al., 2012).

The extended waste concept here refers to "the use of more than needed and unwanted output" after Bølviken et al. (2014). Taiichi Ohno, the father of TPS, wrote that "we have to start producing only the things we need" (Ohno, 1989, p. 18) using minimum resources, including natural and human resources. Lean thinking has been recognised as a resource-efficient philosophy that is applicable across industries (González Chávez et al., 2019). In this chapter, the concept of waste is used to re-create and release the available resources to avoid resource overconsumption and resource losses, including the tangible and intangible losses such as loss of human resources and time. Furthermore, the extended waste concept identifies value that is not needed as waste.

1.2 Waste in the TPS

The TPS recognises work and waste (Ohno, 1989). In the TPS, work refers to a series of processes and steps where value is produced or processed (Imai, 1997). For example, the product is given a feature, or needed knowledge is deducted and reported. The work in the steps and processes either adds value or does not.

In the TPS, waste – the (over)consumption of resources without increasing customer value – is categorised into seven types (Ohno, 1989; Imai, 1997): (1) waste of overproduction, referring to producing more that needed; (2) waste of time on hand, referring to waiting; (3) waste of transportation, i.e., unneeded movement of parts and material; (4) waste of processing itself, for example over-processing; (5) waste of excess inventory that ties up capital and resources in unused products; (6) waste of motion, for example in the search of a missing document; and (7) waste of making defective products, typically meaning unwanted output, rework, or value deterioration.

In the TPS, the fundamental idea to achieve efficient and effective use of resources is based on waste reduction. Waste reduction is done through continuous improvement (*kaizen*) at the workplace (*gemba*), where the value is added (Imai, 1997). To implement *kaizen* in *gemba*, two other waste aspects are needed (see Figure 13.1). The seven waste types presented are in Japanese

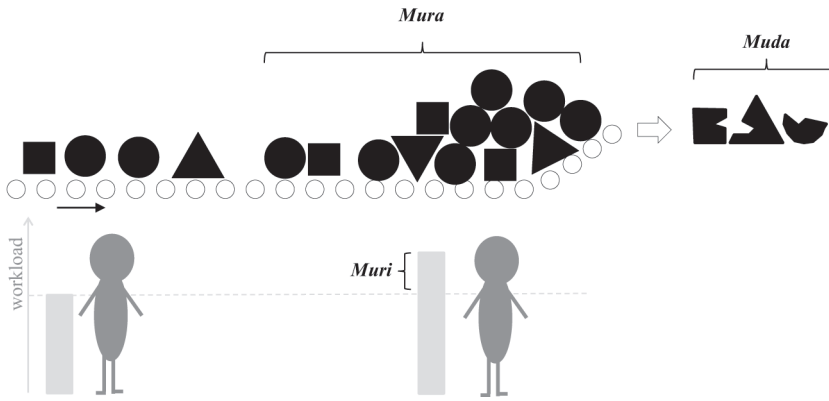

Figure 13.1 Illustration of muda, mura, and muri (partly adapted from Hohmann, 2014)

called *muda*. *Mura* and *muri* compose muda. *Mura* refers to the irregularities (Imai, 1997) or inconsistency (Ohno, 1989; Takeda, 1990) that prevent, delay, or interrupt the workflow. For example, a document waiting to be approved constitutes waste of time for the employees in the next process steps. *Muri* refers to the unreasonableness (Ohno, 1989) or strenuous work (Imai, 1997) in terms of work hours or demand. For example, too little time available, inappropriate machines, or improper training can lead to defective products and services.

According to Imai (1997), the reduction of muda is simple: stopping something that we are doing. This means holistic reconfiguration on the *gemba* level, i.e., on the entire process level, which might, especially in knowledge-intensive fields, include multiple *gemba*s (Jylhä, 2013, 2019) within and across organisations.

1.3 Making-do as waste

Koskela (2004) has introduced making-do as the eighth category of *muda*. 'Make do' means that something is done without all necessary input, or the quality of the input is lower than needed (for example, Cambridge Dictionary, 2020). Making-do is used frequently in the field of lean construction (e.g., Formoso et al., 2011; Emmitt et al., 2012; Fireman et al., 2013).

Originally, the idea of making-do is from operations management. Ronen (1992) explained it through the idea of a complete kit, i.e. a practice to 'do it right the first time and on time'. In operations management, the complete kit means that all needed input, such as assembly parts or components, documents and/or information, is ready for the "assembly, subassembly or process". Only when the kit is complete can the assembly be started in the process (Ronen, 1992). If this principle is not followed, waste is generated within that sub-process (i.e., in a *gemba*) and across the entire process (i.e., in multiple *gembas*) (Koskela, 2004). Ronen explained the waste as evils of an incomplete kit (Ronen, 1992; Jylhä et al., 2014).

The incomplete kit means that the job cannot be finished in the process. Instead, the object of a job remains in the process, when waiting for the missing part, information, or documents. Because fewer jobs are finished and more jobs are released due to an incomplete kit, there is (1) *more work-in-process*.

From the perspective of a single job, this leads to (2) *longer lead times*: an incomplete kit takes more handling time because some arrangements, operations, or set-ups need to be done more than once. This increases the entire lead time of the assembly. In addition to longer lead times,

variance of the lead times increases. In manufacturing, (3) *high variance* is one of the main causes of quality problems (e.g., Deming, 1982). By nature, the prediction of the missing part or information cannot be punctual. The quality of the finished product is also jeopardised, when the unfinished job waits for the missing information or component without the best possible storage facilities or needed maintenance. This simply (4) *deteriorates the quality and requires more rework*.

From the perspective of the production process, more work-in-process generates more waste. It (5) *declines throughput* when the unfinished job does not flow through the process but instead it is in the way of other jobs, resulting in waiting and longer lead times. It (6) *declines the overall productivity* when more resources are spent in handling and management due to double set-ups and operations – there is an overlap with the activities done before the waiting and after the waiting. More work-in-process also (7) *declines the manageability of the process*. The unfinished tasks do not fit or do not follow the principles of the controls in the process. This requires more resources to manage and control the unfinished task. Furthermore, (8) *the missing items are typically received with extra delay* because the non-suitable controls and decline in the manageability of the process do not support fast delivery. This is opposite to the illusion of making the process faster by starting to work with an incomplete kit. Finally, more work-in-process (9) *increases operating expenses* due to using more resources (especially human resources) than needed: double handling, double managing, rework, lower quality, and damaged parts, to mention a few examples.

Lastly, from the perspective of the workers, (10) *motivation declines*. Workers see and experience the waste, such as double work, rework, and lower quality, caused by the system failure. The workers' motivation is not supported when the system logic goes against their grain.

To summarise, the resource input is consumed for work and waste (Ohno, 1989). Lean thinking proposes efficient and effective use of resources by eliminating waste, i.e., *muda*, *mura*, and *muri*. This elimination is in line with the circularity idea of reducing resource input to the system and avoiding resource losses in the system.

2 Concept of waste for releasing and re-creating resources in corporate real estate management

The current mainstream CRE and workplace management research and practice do not acknowledge the extended waste concept. However, the dominant role of alignment theories in CREM provides readiness and fitness to accept and adapt the extended waste concept. Why? Because waste reduction provides greater alignment (Jylhä, 2019). CREM aims for greater alignment. This is highlighted, for example, in the definition of CREM: "the alignment of the real estate portfolio of a corporation or a public authority to the needs of the core business" (Dewulf et al., 2000). See also Chapter 9 on alignment theory.

2.1 Current alignment in CRE

Alignment constitutes several integrations within and across corporations (Kathuria et al., 2007). The alignment within a corporation includes vertical and horizontal alignment (summarised in Figure 13.2). In vertical alignment, often referred to as strategic alignment, the strategies, actions, and decisions between several corporate levels are harmonised (Kathuria et al., 2007). This type of alignment is well-studied in the current CREM literature (e.g., Weatherhead, 1997; Nourse & Roulac, 1993; Lindholm, 2008), which means that CREM can contribute to strategic corporate objectives (Jylhä, 2019).

Horizontal alignment is divided into cross-functional and intra-functional alignment. In general, horizontal alignment is acknowledged but studied less both in the general management

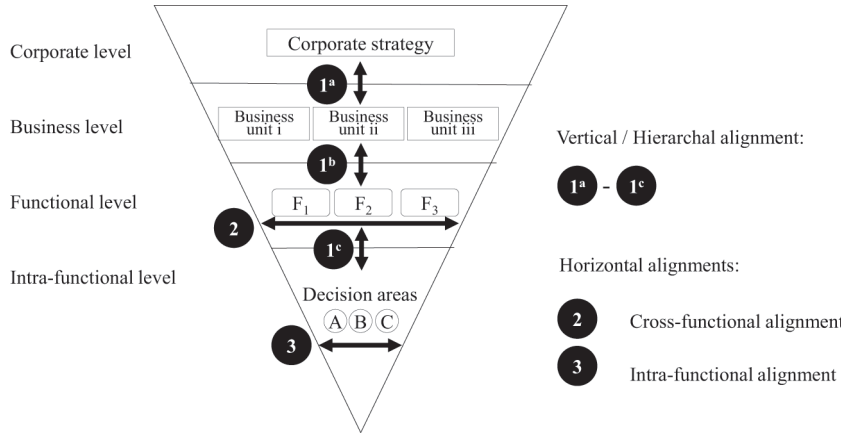

Figure 13.2 Summary of the current alignment in CRE (adapted from Jylhä, 2019)

literature (Kathuria et al., 2007) and in the CREM literature (Jylhä, 2019). The cross-functional alignment refers to the fit in decisions, planning, and operations between different corporate functions (Kathuria et al., 2007), such as HR, ICT, operations, and CRE (Jylhä, 2019). The intra-functional alignment identifies the fit between various decision areas within that function (Kathuria et al., 2007), for example, within the CREM function (Jylhä, 2019). In CREM, intra-functional alignment means, for example, that decisions, planning, and actions are aligned between financial, building, and user-oriented decision areas (Jylhä, 2019).

Horizontal alignment also covers the integration across corporations (Alagaraja et al., 2015) which is typically studied in supply chain and value chain management (Jylhä, 2019). In the field of CREM, this type of alignment has received less attention, although supply chains and the external service provider network play a crucial role in the value delivery (Jylhä, 2019).

2.2 Alignment to reduce waste in CRE

Waste reduction aligns especially horizontally (Schniederjans et al., 2010; Jylhä, 2019). From the circularity perspective, horizontal alignment reduces the resource input into the system and resource losses in the system. By following the concepts of *muda*, *mura*, and *muri*, horizontal CRE alignment can reduce waste on three levels: (1) on the work level (*muda*), (2) on the system level (*mura*), and (3) on the employee level (*muri*).

Waste on the work level (*muda*) refers to work steps that do not add value. (1) Waste of overproduction of information, products, or services refers, for example, to unnecessary data, unused square metres, or excess use of user or maintenance services. (2) Waste of time takes place when searching, working, and thinking the same twice, for example, in decision-making, planning, negotiations, or coordination due to the incomplete kit. (3) Waste of transporting information, people, or equipment is generated when, for example, excess RE information is delivered to decision-making or maintenance equipment is transported without a need. (4) Waste of over- and underprocessing happens, for example, when repairs are not planned in the budget or FM services are bought without knowing the user need. (5) Waste of inventory takes place, for example, in the format of non-needed plans, reviews, or negotiations. (6) Waste of motion is performed especially when searching for missing information (Jylhä & Suvanto, 2015), for example, in the search of an updated floor plan, a lease agreement, or a report.

(7) Waste of defects and unwanted value occur when, for example, a wrong decision is made, or the service or product is damaged or does not match the customer needs.

In terms of the TPS, waste reduction on the work level takes place at *gembas* in and between the CRE decision areas within the corporation. Reducing waste on *gemba* means horizontal alignment. In terms of circularity, tangible and intangible resources in the individual work steps are reduced and released to mobilise them into value delivery steps within the (CRE) organisation. This means that the (CRE) organisation is recreating its resource base through its processes and strategic routines, which are known as dynamic capabilities in management science (e.g., Eisenhardt & Martin, 2000; Teece et al., 1997; Jiang, 2014).

Waste on the system level (*mura*) refers to the interruptions that generate waste not solely within a process step but along the entire system. In terms of the TPS, waste is generated between *gembas* within the organisation and across organisations, covering a network of processes. Jylhä (2013) identified that the separate sub-processes are the root aggravation of waste generation. Unsynchronised sub-processes constitute *making-do waste* especially in the downstream. Waste reduction releases tangible and intangible resources and renews the resource base of the system. This resource base is then mobilised into long-term horizontal co-creation processes (e.g., Eisenhardt & Martin, 2000; Teece et al., 1997; Jiang, 2014) across the system.

Waste on the employee level (*muri*) refers to overload of work. The overload comprises the waste on the work and system levels (Jylhä et al., 2014). From the work level perspective, the employee uses resources for work that does not add value due to the lack of standardised best practices and rationalised work steps (Ohno, 1989). From the system level perspective, making-do waste overconsumes especially the human resources when more work-in-process declines the responsiveness and manageability of the process. By decreasing *muda* and *mura*, also the overload of work is decreased (Hines et al., 2011). This improves the social inclusion and performance of the workers, which is also relevant in circularity enhancement (Geissdoerfer et al., 2017).

To summarise, waste reduction aligns horizontally. Continuous waste reduction can be seen as a dynamic capability of an organisation. Dynamic capability means that the organisation modifies its resource base (Eisenhardt & Martin, 2000; Jiang, 2014) through its processes and strategic routines (Eisenhardt & Martin, 2000). When adopting the extended waste concept, the processes and strategic routines constantly identify, reduce, and release resources that lead to recreation of the resource base. From the circularity perspective, this type of horizontal alignment has the potential to enhance long-term circularity.

3 Methodology/research approach

The research approaches to study waste can be divide into two. By following the presentation of Lousberg and Van Stijn (NA), representionalist research aims to understand the waste concept in reality, in this case in the context of real estate and workplace management, by observing it. Interventionist research aims to understand the waste concept by engaging in it. In both cases, studying waste in reality requires a hands-on approach. The key distinction is whether the researcher remains as an observer or if the researcher takes a more active approach in the intervention(s). Value stream mapping (VSM) is a common lean technique to study flows and related waste, for example, in manufacturing (see e.g. Abdulmalek & Rajgopal, 2007; McDonald et al., 2002), in construction (see e.g. Arbulu et al., 2003; Yu et al., 2009), or in healthcare (see e.g. Henrique et al., 2016; Lummus et al., 2006). VSM visualises work processes. According to Lee and Snyder (2006), this visualisation process leads to enhanced mutual understanding of the flow and further supports its implementation. A Kaizen workshop is a special workshop to develop and implement value stream maps (Liker, 2004).

Depending on the research approach, the data collection methods vary from qualitative observations, interviews, workshops, and document gathering (e.g., Rahani & al-Ashraf, 2012; Jylhä, 2013, 2014) to analysing quantitative data typically related to processes and operations such as lead times, ratio of value-added times to lead times, work-in-process, set up times, and quality indicators, to name a few (see e.g. Arbulu et al., 2003; Yu et al., 2009; Abdulmalek & Rajgopal, 2007).

In the field of workplace and real estate management, flows and processes are mainly studied from the perspective of office (layout) and its impact on the office user (for example, Vischer, 2008; Haynes, 2008; Appel-Meulenbroek et al., 2014). Here the flows and processes are related not necessarily to the output of a service or product delivery and its impact on the office user, but on the workplace management-related processes and strategic routines (e.g., Jylhä, 2013, 2014) that make the workplace management organisation a learning organisation. Future research in the workplace management fields would benefit if both research streams, the impact of the office on users, and the resource-efficient and effective way of implementing that knowledge in the workplace management processes and routines would get more attention.

4 Limitations of the theory

The implementation of waste reduction requires a long-term approach. The concept of waste has shown both its power in the production systems of organisations (e.g., Ohno, 1989; Shingo, 1989; Koskela, 2000; Schniederjans et al., 2010; Mazzocato et al., 2010) and its limitations in implementation (e.g., Cusumano, 1994; Cooney, 2002; Rymaszewska, 2014).

Long-term waste reduction is not about adapting and implementing a selected set of tools and techniques from the TPS. This is mainly due to two issues. First, long-term improvements typically require changes on many levels of the system. In lean, according to Teece et al. (1997), the changes require synchronised improvements both on the shop floor and in higher-order managerial processes. Because of the multiple layers in the system, simply replicating a technique on one level does not bring long-term benefits.

Second, due to the dynamic environment, waste reduction is done constantly through continuous improvements in the TPS. Continuous improvement can be interpreted as an organisational learning process where "repetition and experimentation enable tasks to be performed better and quicker" (Teece et al., 1997, p. 520). The processes and managerial practices carry and implement the knowledge stock that exists in organisations (e.g. Besanko et al., 2013; Jiang, 2014). In the TPS, continuous improvement is implemented through the processes and practices of the improvement system. Without creating a coherent improvement system, the adaptation of individual lean tools and techniques might yield zero benefits (Hansen & Møller, 2016).

To summarise, the limitations of the extended waste concept lie in needed structural and long-term improvements in the organisational processes, which make the organisation a learning organisation. These processes are hard to replicate even when observed, as Teece et al. (1997) stated. This limitation can also offer a great benefit: when (C)RE organisations and systems adapt the extended waste concepts, it motivates organisations to improve their processes and strategic routines, resulting in structural and long-term advantage to sustain the transmission from linear economy to circular economy.

5 Theory relevance to practice

For real estate and workplace managers, learning to see waste and reducing it means doing the right things with as few resources as possible. This leads to resource efficiency and effectiveness

meaning, for example, lower costs, future-proofed allocation of resources, and contribution to the sustainability goals. In this section, a case is briefly presented to illustrate the excess use of intangible resources in the corporate real estate management context. The case has been originally presented by Jylhä et al. (2014). The case organisation was in the process of centralising its operations. The centralisation, which was a business-driven need, resulted in re-structuring the current real estate portfolio that included 10 properties in the same market in the Helsinki Metropolitan Area, Finland. In the case analysis, the focus was on the system level, including phases and steps to find a suitable property or properties to support the centralisation of the operations. The CRE organisation was an agent acting on behalf of the case organisation by following the service agreements. Heywood and Kenley (2010, 2013) called this the extended CREM organisation. The agent established a team on the intra-functional level to create a solution for its corporate customer. The work lasted approximately 3.5 years, starting in autumn 2009 and ending with a final solution in early 2013.

Value stream visualisation identified that most of the work done in the first 2.5 years was making-do. The work in the process was started with incomplete information resulting in several rounds of layout planning, bidding, property searches, analysis, and negotiations, which consumed lot of human resources and time. More work-in-process resulted in (1) longer lead times due to waiting for missing information; (2) variance in lead times because the same steps were done again after the waiting (e.g., arranging the same meetings twice or reworking with the schedule to fix an error); (3) decrease in quality because the missing information prevented delivering the right quality at the first time, for example, in terms of the office layout or location; (4) decrease in throughput when the work was not finished (e.g., unfinished layouts, negotiations, and other documents) but remained in the process; (5) decrease in the manageability of the process, which required more resources to control the inconsistency of disproportionate information or special arrangements; and (6) increase in the operational in-house expenses (the waste of human resources) and outsourced expenses (e.g., the final layout drawings were purchased twice).

The case especially illustrates the excess use of human resources and time. The wasted human resources would have had potential to be mobilised into value-adding work.

6 Further reading

Jylhä, T. (2019). Reconceptualising CREM alignment to account for waste. In C. Pasquire & F. R. Hamzeh (Eds.), *Proc. 27th Annual Conference of the International Group for Lean Construction (IGLC)* (pp. 1197–1206). Dublin, Ireland. doi:10.24928/2019/0126

Koskela, L. (2004, August 3–5). Making-do – the eighth category of waste. In S. Bertelsen & C. T. Formoso (Eds.), *12th Annual Conference of the International Group for Lean Construction*. Helsingør, Denmark. https://iglc.net/Papers/Details/312

Koskela, L., Sacks, R., & Rooke, J. (2012, July 18–20). *A Brief History of the Concept of Waste in Production*. 20th Annual Conference of the International Group for Lean Construction, San Diego, CA. https://iglc.net/Papers/Details/794

Ronen, B. (1992). The complete kit concept. *International Journal of Production Research*, *30*(10), 2457–2466. doi:10.1080/00207549208948166

7 References

Abdulmalek, F. A., & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *International Journal of Production Economics*, *107*(1), 223–236. doi:10.1016/j.ijpe.2006.09.009

Alagaraja, M., Rose, K., Shuck, B., & Bergman, M. (2015). Unpacking organisational alignment: The view from theory and practice. *Journal of Organizational Learning and Leadership*, *13*(1), 19–32. doi:10.1287/orsc.1090.0426

Appel-Meulenbroek, R., De Vries, B., & Weddeman, M. (2014). Layout mechanisms that stimulate innovative behaviour of employees. In K. Alexander (Ed.), *13th EuroFM Research Symposium, EFMC2014*. Berlin, Germany. www.researchgate.net/profile/Keith_Alexander4/publication/264695969_EuroFM_Research_Papers/links/53eb841a0cf202d087ccec43.pdf#page=14

Arbulu, R., Tommelein, I., Walsh, K., & Hershauer, J. (2003). Value stream analysis of a re-engineered construction supply chain. *Building Research & Information*, *31*(2), 161–171. doi:10.1080/09613210301993

Besanko, D., Dranove, D., Shanley, M., & Schaefer, S. (2013). *Economics of Strategy* (6th ed.). Singapore: John Wiley & Sons.

Bølviken, T., Rooke, J., & Koskela, L. (2014, June 25–27). *The Wastes of Production in Construction – a TFV Based Taxonomy*. 22nd Annual Conference of the International Group for Lean Construction (IGLC), Oslo, Norway. www.iglc.net/Papers/Details/1076

Cambridge Dictionary. (2020). *Make Do*. https://dictionary.cambridge.org/dictionary/english/make-do

Cooney, R. (2002). Is 'lean' a universal production system? Batch production in the automotive industry. *International Journal of Operations & Production Management*, *22*(10), 1130–1147. doi:10.1108/01443570210446342

Cusumano, M. A. (1994). The limits of 'lean'. *Sloan Management Review*, *35*(4), 27–35. https://sloanreview.mit.edu/article/the-limits-of-lean/

Deming, W. E. (1982). *Out of the Crisis*. Cambridge, MA: The MIT Press edition 2000, Massachusetts Institute of Technology, Center for Advanced Educational Services.

Dewulf, G., Krumm, P., & De Jonge, H. (2000). *Successful Corporate Real Estate Strategies*. Nieuwegein, NL: Arko Publishers.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they?. *Strategic Management Journal*, *21*(10/11), 1105–1121. doi:10.1002/1097-0266(200010/11)21:10/11<1105::AID-SMJ133>3.0.CO;2-E

Emmitt, S., Pasquire, C., & Mertia, B. (2012). Is good enough "making do"? An investigation of inappropriate processing in a small design and build company. *Construction Innovation*, *12*(3), 369–383. doi:10.1108/14714171211244622

Fireman, M. C. T., Formoso, C. T., & Isatto, E. L. (2013, July 29–August 2) *Integrating Production and Quality Control: Monitoring Making-Do and Unfinished Work*. 21st Annual Conference of the International Group for Lean Construction (IGLC), Fortaleza, Brazil. www.iglc.net/Papers/Details/899

Formoso, C. T., Sommer, L., & Koskela, L. (2011, July 13–15) *An Exploratory Study on the Measurement and Analysis of Making-do in Construction Sites*. 19th Annual Conference of the International Group for Lean Construction (IGLC), Lima, Peru. www.iglc.net/Papers/Details/1104

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017, February). The circular economy – a new sustainability paradigm? *Journal of Cleaner Production*, *143*, 757–768. doi:10.1016/j.jclepro.2016.12.048

González Chávez, C. A., Romero, D., Rossi, M., Luglietti, R., & Johansson, B. (2019). Circular lean product-service systems design: A literature review, framework proposal and case studies. *Procedia CIRP*, *83*, 419–424. doi:10.1016/j.procir.2019.03.109.

Hansen, D., & Møller, N. (2016). Conceptualizing dynamic capabilities in lean production: What are they and how do they develop? *Engineering Management Journal*, *28*(4), 194–208. doi:10.1080/10429247.2016.1238727

Haynes, B. P. (2008). The impact of office layout on productivity. *Journal of Facilities Management*, *6*(3), 189–201. doi:10.1108/14725960810885961

Henrique, D. B., Rentes, A. F., Filho, M. G., & Esposto, K. F. (2016). A new value stream mapping approach for healthcare environments. *Production Planning & Control*, *27*(1), 24–48. doi:10.1080/09537287.2015.1051159

Heywood, C., & Kenley, R. (2010). *An Integrated Consumption-Based Demand and Supply Framework for Corporate Real Estate*. Proceedings of 2010 International Conference of Construction and Real Estate Management (pp. 380–385), Brisbane, AUSTRALIA.

Heywood, C., & Kenley, R. (2013). *Corporate Real Estate Management: More than Clients' and Users' Procurement*. 19th CIB Building Congress, Brisbane, Australia. www.irbnet.de/daten/iconda/CIB_DC27166.pdf

Hines, P., Found, P., Griffiths, G., & Harrison, R. (2011). *Staying Lean – Thriving, not Just Surviving* (2nd ed.). Cardiff, UK: Cardiff University.

Hohmann, C. (2014). *Mura*. https://hohmannchris.files.wordpress.com/2014/01/bandeau_mura.png

Imai, M. (1997). *Gemba Kaizen – A Commonsense, Low-Cost Approach to Management*. New York, NY: McGraw-Hill.

Jiang, W. (2014). *Business Partnerships and Organizational Performance, The Role of Resources and Capabilities*. Heidelberg, Germany: Springer. doi:10.1007/978-3-642-53989-3

Junnila, S., Horvath, A., & Guggemos, A. A. (2006). Life-cycle assessment of office buildings in Europe and the United States. *Journal of Infrastructure Systems*, *12*(1), 10–17. doi:10.1061/(ASCE)1076-0342(2006)12:1(10)

Jylhä, T. (2013). *Creating Value or Waste? Evaluating the Production of Real Estate Services with Lean Thinking* (Doctoral dissertation). 148/2013, Aalto University. https://aaltodoc.aalto.fi/bitstream/handle/123456789/11195/isbn9789526053455.pdf

Jylhä, T. (2019). Reconceptualising CREM alignment to account for waste. In C. Pasquire & F. R. Hamzeh (Eds.), *Proceedings of 27th Annual Conference of the International Group for Lean Construction (IGLC)* (pp. 1197–1206). Dublin, Ireland. doi:10.24928/2019/0126

Jylhä, T., Rasila, H., & Karjalainen, A. (2014, May 21–23) *Making-do – Illusion of Effective Service Processes*. CIB Facilities Management Conference 2014, Copenhagen, Denmark. www.irbnet.de/daten/iconda/CIB_DC26919.pdf

Jylhä, T., & Suvanto, M. (2015). Poor quality of FM information – an analysis from lean management perspective. *Facilities*, *33*(5/6), 302–319. doi:10.1108/F-07-2013-0057

Kathuria, R., Joshi, M., & Porth, S. (2007). Organizational alignment and performance: Past, present and future. *Management Decisions*, *45*(3), 503–517. doi:10.5465/amp.2013.0025

Koskela, L. (2000). *An Exploration Towards a Production Theory and Its Applications to Construction* (Doctoral dissertation). Technical Research Centre of Finland, Espoo. www.vttresearch.com/sites/default/files/pdf/publications/2000/P408.pdf

Koskela, L. (2004, August 3–5) Making-do – The Eighth Category of Waste. In S. Bertelsen & C. T. Formoso (Eds.), *12th Annual Conference of the International Group for Lean Construction*. Helsingør, Denmark. https://iglc.net/Papers/Details/312

Koskela, L., Sacks, R., & Rooke, J. (2012, July 18–20). *A Brief History of the Concept of Waste in Production*. 20th Annual Conference of the International Group for Lean Construction, San Diego, CA. https://iglc.net/Papers/Details/794

Krafcik, J. (1988). Triumph of the lean production system. *Sloan Management Review*, *30*(1), 41–52. https://edisciplinas.usp.br/pluginfile.php/5373958/mod_resource/content/4/krafcik_TEXTO_INTEGRAL.pdf

Kyrö, R. (2020). How Can the Real Estate Sector Transition to Circular Economy? Approaches for Real Estate Management. In T. Jylhä (Ed.), *19th EuroFM Research Symposium, EFMIC 2020, 3–4 June 2020, Online Conference*. www.dropbox.com/s/yp4irmmnanw7fl1/Proceedings_EuroFM_2020.pdf?dl=0

Lee, Q., & Snyder, B. (2006). *The Strategos Guide to Value Stream & Process Mapping*. Bellingham, WA: Genesis of Manufacturing Strategy, Enna Products Corporation.

Lehtonen, T., & Puhto, J. (2004). *Productization of Facility Service Contracts* (Toimitilapalvelujen tuotteistaminen tarjoustoiminnan näkökulmasta). Espoo: Helsinki University of Technology, Construction Economics and Management Publications 223.

Liker, J. K. (2004). *The Toyota Way – 14 Management Principles from the World's Greatest Manufacturer*. New York, NY: McGraw-Hill.

Lindholm, A.-L. (2008). *Identifying and Measuring the Success of Corporate Real Estate Management* (Doctoral dissertation). A42, Espoo: Helsinki University of Technology.

Lousberg, L., & Van Stijn, A. (NA). Positioning interventionist research methods (manuscript in preparation). In L. Lousberg, J. Heintz & P. Chan (Eds.), *Interventionist Research Methods* (book in preparation).

Lummus, R. R., Vokurka, R. J., & Rodeghiero, B. (2006). Improving quality through value stream mapping: A case study of a physician's clinic. *Total Quality Management*, *17*(8), 1063–1075. doi:10.1080/14783360600748091

Mazzocato, P., Savage, C., Brommels, M., Aronsson, H., & Thor, J. (2010). Lean thinking in healthcare: A realist review of the literature. *BMJ Quality & Safety*, *19*, 376–382. doi:10.1136/qshc.2009.037986

McDonald, T., Van Aken, E. M., & Rentes, A. F. (2002). Utilising simulation to enhance value stream mapping: A manufacturing case application. *International Journal of Logistics Research and Applications*, *5*(2), 213–232. doi:10.1080/13675560210148696

Ness, D. A., & Xing, K. (2017). Toward a resource-efficient built environment: A literature review and conceptual model. *Journal of Industrial Ecology*, *21*(3), 572–592. doi:10.1111/jiec.12586

Nourse, H. O., & Roulac, S. E. (1993). Linking real estate decisions to corporate strategy. *Journal of Real Estate Research*, *8*(4), 475–495. http://pages.jh.edu/jrer/papers/pdf/past/vol08n04/v08p475.pdf

Ohno, T. (1989). *Toyota Production System – Beyond Large-Scale Production*. Cambridge, MA: Productivity Press.

Rahani, A. R., & al-Ashraf, M. (2012). Production flow analysis through value stream mapping: A lean manufacturing process case study. *Procedia Engineering*, *41*, 1727–1734. doi:10.1016/j.proeng.2012.07.375

Remøy, H. (2010). *Out of Office, a Study of the Cause of Office Vacancy and Transformation as a Means to Cope and Prevent* (Doctoral dissertation). Faculty of Architecture, Delft University of Technology. https://repository.tudelft.nl/islandora/object/uuid:9c24b779-1c61-4a88-921a-04d3e12a8e46/datastream/OBJ/download

Remøy, H., & Wilkinson, S. (2012). Office building conversion and sustainable adaptation: A comparative study. *Property Management*, *30*(3), 218–231. doi:10.1108/02637471211233738

Ronen, B. (1992). The complete kit concept. *International Journal of Production Research*, *30*(10), 2457–2466. doi:10.1080/00207549208948166

Rymaszewska, D. A. (2014). The challenges of lean manufacturing implementation in SMEs. *Benchmarking: an International Journal*, *21*(6), 987–1002. doi:10.1108/BIJ-10-2012-0065

Schniederjans, M. J., Schniederjans, D. G., & Schniederjans, A. M. (2010). *Topics in Lean Supply Chain Management*. Singapore: Mainland Press, World Scientific Publishing.

Sharma, V., Abel, J., Al-Hussein, M., Lennerts, K., & Pfründer, U. (2007). Simulation application for resource allocation in facility management processes in hospitals. *Facilities*, *25*(13/14), 493–506. doi:10.1108/02632770710822599

Shingo, S. (1989). *A Study of the Toyota Production System – From Industrial Engineering Viewpoint* (English retranslation). Cambridge, MA: Productivity Press.

Takeda, H. (1990). *The Synchronized Production System. Going Beyond Just-in-Time Through Kaizen*. Philadelphia, PA: Synchronized Production System.

Taylor, F. W. (1911). *The Principles of Scientific Management*. Milton Keynes, UK: Lightning Spurce UK Ltd.

Teece, D. J., Pisono, G., & Shien, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. doi:10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Van den Dobbelsteen, A. (2004). *The Sustainable Office, an Exploration of the Potential for Factor 20 Environmental Improvement of Office Accommodation* (Doctoral dissertation). Faculty of Architecture, Delft University of Technology. https://repository.tudelft.nl/islandora/object/uuid%3Ab96541bd-b4a9-4bab-b715-067c8a9078a3

Vischer, J. C. (2008). Towards an environmental psychology of workspace: How people are affected by environments for work. *Architectural Science Review*, *51*(2), 97–108. doi:10.3763/asre.2008.5114

Weatherhead, M. (1997). *Real Estate in Corporate Strategy*. Chippenham, UK: Macmillan Press.

Womack, J. P., & Jones, D. T. (2003). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. Groydon, UK: Simon & Schuster.

Womack, J. P., Jones, D. T., & Roos, D. (1990). *The Machine that Changed the World, How lean Production Revolutionized the Global Car Wars*. Groydon, UK: Simon & Schuster.

World Economic Forum. (2017). *The Global Human Capital Report*. Preparing People for the Future of Work, Insight Report. https://weforum.ent.box.com/s/dari4dktg4jt2g9xo2o5pksjpatvawdb

Yu, H., Tweed, T., Al-Hussein, M., & Nasseri, R. (2009). Development of lean model for house construction using value stream mapping. *Journal of Construction Engineering and Management*, *135*(8), 782–790. doi:10.1061/(ASCE)0733-9364(2009)135:8(782)