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Lean beyond waste

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CHAPTER 6

General discussion

6.1 INTRODUCTION

So far, in this thesis, we have reported on our investigation into Lean in healthcare environments and especially on the roles of buffers and variability. In Chapters 2 to 5, we looked into the link between Lean and throughput time performance, considered the focus of Lean interventions in practice and attempted to influence these interventions, researched projects with different flows to show the relationships between underlying variability and buffers, and finally made a theoretical exploration into the logic of an additional buffer type (quality). In all these chapters, the focus was primarily on the roles of variability and buffers within a Lean context.

In this final chapter, the findings of the individual research projects and the relationships between the different projects are discussed. First, the main findings of each individual study will be addressed, by shortly stating the most important messages to come out of each of the four research chapters. Following this, we will elaborate on the main theoretical contributions of this thesis and show where it provides new knowledge, challenges existing ideas, or supports earlier findings. In the subsequent section on the practical consequences, we translate our findings into

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implications for practice. We provide suggestions for professionals in the field that use Lean during the course of their work. Then, we will discuss the limitations of this thesis and indicate leads for future research. This concluding chapter finishes with final remarks related to our research findings.

6.2 MAIN FINDINGS

Chapter 2: Impact of Lean interventions on time buffer reduction in a hospital setting

Chapter 2 set out to relate performance changes to Lean interventions. The study showed that adhering to Lean principles resulted in changes in throughput time performance. However, contrary to our expectations, the continuous improvement process did not result in an observable uninterrupted pattern of incremental throughput time improvement. Rather, we identified an erratic throughput time pattern typified by three distinct periods.

The throughput time improvements seemed to be of a 'step' nature rather than a gradual progression. We identified one major performance improvement, and one major decline in performance. As such, our findings are at odds with the more common understanding of Lean, where incremental improvements over time result in superior results.

The study continued with semi-structured interviews that adopted the Event History Calendar methodology. The interviews revealed that two major Lean interventions could be identified as the causes of the changes in throughput time performance. We could relate the improvement in throughput time with the

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abandoning of batching and the adoption of production balancing. The original batching could be seen as a source of artificial variability, which had resulted in additional time buffers. The later setback in performance was the result of newly introduced machinery that was presented as being oriented towards one-piece-flow but resulted in an over-utilized resource.

Surprisingly, even though the laboratory was continuously initiating improvement projects, none of the projects focused on the degradation in performance after the introduction of the new machinery. Whilst the laboratory was aware of the additional waiting times after the introduction of the new machine, identifying and rectifying the exact causes of the performance decline was deemed too complicated a task for the people in the laboratory.

Chapter 3: Does Lean cure variability in healthcare?

Chapter 3 investigated Lean interventions in practice. We classified several interventions to establish their focus, and further tried to influence the focus of interventions through a field experiment. Most of the original interventions addressed reducing obvious waste, which is in line with other findings on Lean in healthcare. Very few interventions reported on variability or buffer reduction. Our results suggested that only a handful of interventions investigated variability and, based on our interviews, this seemed to be chance rather than deliberate attempts to reduce variability.

Whilst reducing waste seemed to be the clear target in most interventions, not all waste types seemed equally important. It

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seemed that reducing waste related to defects (or quality issues) grabbed the practitioners' attention. Thus, even if we disregarded variability and buffers, there still seemed to be a gap between the possibilities offered by Lean and its actual implementation in a healthcare environment. This expressed itself in an over-focus on quality-related issues and a lack of emphasis on variability-related matters.

The interviews confirmed our impression from the initial classification of the Lean interventions: that waste reduction was the predominant focus. When we asked practitioners about Lean, they immediately thought of waste reduction. Variability and buffers were never mentioned, either as their goals or as aspects of the Lean philosophy. This led us to suspect that it was a knowledge deficiency related to the roles of buffers and variability that resulted in the almost universal focus on waste. As an initial test of these suspicions, an exploratory field quasi-experiment was held in which we provided participants with knowledge on the roles of both buffers and variability. We then performed a similar classification to the initial one, but this time on interventions made after the experiment was held. Variability- and buffer-related interventions were still limited but the number of such interventions undertaken by those practitioners who had been provided with the relevant knowledge had grown substantially.

These results from our case provide a first indication that it is a lack of knowledge on the effects of variability that could hinder the adoption of a mature Lean approach in healthcare environments. As long as this remains the general situation, we should perhaps not expect major performance impacts from Lean in healthcare.

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Chapter 4: Exploring variability and buffers in Lean initiatives in healthcare

Chapter 4 investigated the complexities related to variability and buffers in flow improvement projects. Flow improvement requires the reduction of time buffers, and these buffers can be cut by reducing variability. To successfully improve flow in healthcare requires a good understanding of the relationship between variability and buffers. However, this is hampered by the roles and impacts of variability and buffers not being well established in the Lean literature. In our study, we investigated three hospital departments where Lean initiatives were employed in attempting to improve patient flows. The study showed that the interaction between variability and buffers is less straightforward than the literature assumes, and our research identified several complicating factors.

In our first case, a breast clinic, we obtained information on the inflow of patients from which we expected the effects of variability to be very limited or non-existent. However, when we took a closer look, the level of variability on a day-to-day basis was sufficiently high to require buffering. This resulted in waiting times for patients and idle capacity in terms of unoccupied physicians and radiologists. In an attempt to explain these occurrences, we looked at the performance goals set by the clinic. The clinic aimed to achieve access times of 24 hours and to also deliver test results within 24 hours. To achieve these targets required a very specific subset of patients, or patient mix, on a daily basis. This mix reflected the yearly inflow but day-to-day variability resulted in

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different daily patient mixes, some that meant that the initial goals could not be achieved. Here we observed that performance goals, such as access times and delivery times, and also performance agreements such as check-ups being with the same surgeon led to high levels of artificial variability.

In our second case, looking at the workflow of physiotherapists, we found that the interaction between buffers is not always obvious. The unavoidable recovery time for patients enabled a time buffer to be inserted during this recovery period without patients apparently waiting for treatment. In addition, we saw that, when under time pressure, physiotherapists were inclined to include fewer exercises in order to shorten consultations. This behavior could be considered as the use of quality buffers, a special form of buffer type that can be applicable in service environments and further studied in Chapter 5.

Our third case was a rheumatology unit that had tried to reduce access times. We showed that the reduction achieved through a temporary increase in capacity resulted in an undesirable vicious cycle. An increase in the number of newly diagnosed patients led to an increase in the number of follow-up appointments. These follow-ups essentially blocked new patients from entering the system. This mechanism resembled the service bullwhip effect in which limited information downstream of a process causes upstream variability. However, in our situation, it was not a lack of information but rather the availability of information that resulted in the increase in patients. The knowledge that the unit had changed referral strategies and shortened access times increased the number of patients selecting that unit for treatment. In the

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end, the temporary increase in capacity resulted in higher levels of artificial variability, and more variable access times than before the 'improvement'. At the end of Chapter 4, we presented a set of propositions. These propositions translated the individual case findings into more general theoretical contributions that could provide a basis for future studies.

Chapter 5: *Buffering by adjusting processing times in healthcare*
Chapter 5 focused on the quality buffers we had identified, a term originally coined by Hopp *et al*. (2007). Initially, our conceptual study suggested that it would be more appropriate to think in terms of processing time buffers since it is the processing times that are adjusted in a response to variability. We identified the underlying mechanism behind processing time buffers as adjustments to task speed and to the number of tasks. These adjustments are possible because a capacity resource has the freedom to decide which tasks to leave out and which tasks to speed-up. We further identified several empirical studies that provided examples of these behaviors in practice.

While increasing task speed and leaving out certain task elements can have negative effects on service quality, this is dependent on the way quality is defined in a specific environment. Here, this research offers a theoretical basis for the understanding of processing time buffers that is applicable in service environments. These buffers are especially helpful in explaining situations where patients do not appear to be waiting for treatment despite there being limited capacity and variable inflows.

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6.3 THEORETICAL CONTRIBUTIONS

This thesis has several implications for theory. Some of our results are in line with earlier assumptions, whilst other results differ from earlier findings. In some studies, the application of Lean in a service environment is considered defective because of an overuse of tools and a lack of understanding of the context and underlying Lean principles (Radnor and Osborne, 2013). Based on our own findings, we can provide insights into the status of Lean in healthcare. Whilst not all the underlying Lean principles are put into practice, our studied cases did apply the main Lean ideas and actively attempt to reduce waste through a process of continuous improvement. In addition, none of our studied cases ever showed an excessive use of Lean tools. When tools were applied, these were always part of the wider Lean approach. Whilst not all Lean aspects might enjoy the same amount of attention, those that had gained the practitioners' attention were applied extensively.

Lean and variability

The absence of a generally accepted Lean definition hinders the development of theory: a common concept is required in order to share ideas and new insights. Nevertheless, Samuel *et al.* (2015) note that, even without a formal definition, Lean has become a dominant operations paradigm. Moreover, most authors (e.g. Hopp and Spearman, 2004; De Treville and Antonakis, 2006; Shah and Ward, 2007; Browning and Heath, 2009) agree that waste, variability, and buffers are important aspects of Lean, and

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researchers seem to share common key concepts even though these are not always explicitly mentioned.

In this thesis, we adopted the definition of Lean by Hopp and Spearman (2004) since this focusses on minimizing buffer costs and thereby recognizes the importance of buffers, which are a major part of our studies. However, even here, the importance of both variability and waste is not explicit and has to be inferred by the reader. In addition, the focus on minimizing buffering costs could be interpreted as meaning that buffers do not need to be reduced in size, rather that the most cost-friendly buffer should be adopted. The minimization of buffers should ultimately go hand-in-hand with decreasing levels of waste and variability. Therefore, it is important to stress and explicitly address these Lean aspects.

Not only is there no accepted definition, there also appears to be no specific theory of Lean. Instead, Lean is made up of multiple theories (Boer *et al.*, 2014). For example, Lean relies heavily on concepts such as Total Quality Management (TQM) through its focus on continuous improvement. The Theory of Swift and Even Flow (TSEF: (Schmenner and Swink, 1998) is a more general theory that can be used to explain the link between Lean and productivity (Boer *et al.*, 2014). The TSEF holds that the swifter and more even the flow in a process, the higher the productivity in this process. As such, the importance of variability is reflected in the TSEF.

The findings in our studies also highlight the importance of variability. In Chapter 2, the Lean interventions that had the greatest impact on throughput times were those that influenced artificial variability. In addition, Chapter 2 provided a quantitative

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basis for such statements, thereby responding to the call by DelliFraine *et al.* (2010) for more rigorous designs and more detailed statistical reports. In Chapter 4, we saw that artificial variability resulted in added complexity when attempting to improve patient flows. Despite variability being an important aspect of Lean in healthcare, knowledge on the role of variability seemed to be largely lacking in the Lean practitioners interviewed in Chapter 3. Moreover, as we saw in Chapter 4, healthcare policies such as promising 24-hour access times can increase artificial variability which results in increased buffering requirements and puts a strain on both capacity and patients.

Towards Lean maturity

Toyota can be considered the original and a leading example of a Lean organization. In its early Lean stages, Toyota focused on reducing direct waste by addressing the practical and visible issues related to wasteful movements, inventories, over-processing, defects, over-production, transport, and waiting. Later, Toyota began to increase capacity buffers in order to be able to reduce inventories. This highlights an important buffering principle: buffers can be exchanged (Hopp and Spearman, 2004; Hopp and Spearman, 2008). The deliberate exchange of buffers in order to reveal hidden variability could be seen as a transition towards a mature Lean approach. Hopp and Spearman (2004) identified this pattern in the development of Lean at Toyota and distinguished various phases in Lean maturity as depicted in Figure 6.1.

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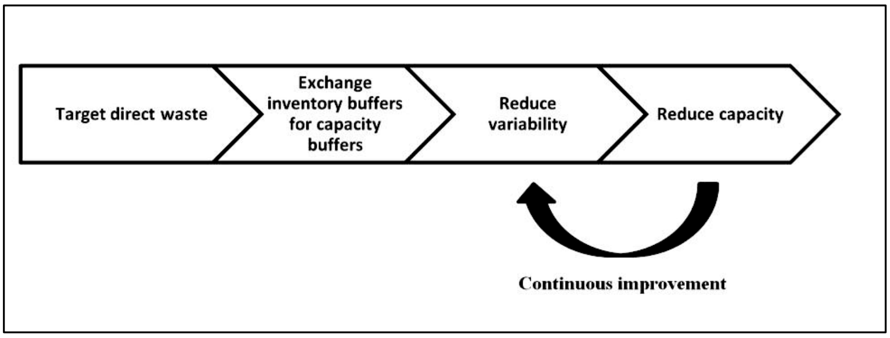

Figure 6.1. Phases in Lean adoption (Hopp, 2008)

The fact that inventory buffers can hide variability is a central theme in Lean theory (Hopp and Spearman, 2008). Problems caused by variability that would otherwise be exposed in the form of idle capacity or waiting clients can be dampened by inventories. Having reduced inventories, Toyota used added capacity to solve temporary issues occurring because of variability, and then successfully eliminated the causes of variability. This enabled the more obviously desirable reduction in capacity buffers over successive continuous improvement steps. Through this process of continuous improvement, an organization should eventually become Lean (as in the case of Toyota).

Buffer exchange in healthcare, introducing processing time buffers

As reflected in our own studies, healthcare has to exist without inventory buffers (Jack and Powers, 2004) in its primary process. This suggests that the variability in healthcare leads to a continuous trade-off between capacity and time buffers. Based on the phases identified at Toyota, one should expect to see an ongoing struggle in healthcare that tries to balance idle capacity and waiting patients. However, in our studies, we did not identify this continuous struggle, and we came across numerous situations where patients were not obviously waiting and capacity resources were not standing idle. It seemed that an alternative buffer type was able (at least partly) to take over the role associated with inventory buffers in healthcare.

Hopp *et al.* (2007) identified an additional buffer type that can be applicable in service environments: quality buffers. While some studies have acknowledged the presence of this quality buffer (e.g. Kostami and Rajagopalan, 2013; Kuntz *et al.*, 2014), there seemed a lack of research that had further investigated this concept. In Chapter 5, we therefore aimed to further develop the logic and theory for this buffer as it seems an important addition to the established buffering concept in service environments.

In our analysis of the quality buffer, we showed that, rather than thinking in terms of quality, we should think in terms of processing times. The actual buffering mechanism is making adjustments to processing times. Quality changes are a possible, but not necessary, consequence of using processing time buffers, the term coined for this additional buffer. Processing time buffers manifest themselves in increased task speed and/or a decreased number of tasks. Consequently, we suggest a formal definition for the concept of processing time buffers: *"Processing time buffering is the mechanism through which processing times are reduced by removing critical and/or non-critical tasks and/or increasing task speed in response to variability"*.

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The use of processing time buffers helps explain situations where throughput times do not deteriorate and capacity remains stable despite variability increasing. In addition, it suggests another buffer type to include in the earlier identified maturity model. Our analysis of the quality buffer concept shows that the original term ‘quality buffers’ is unfortunate since it gives the impression that quality will always suffer. However, as we argued in Chapter 5, the consequences for quality of this type of buffer are dependent on the way quality is defined and there indeed may be zero impact.

Lean maturity in healthcare

Before applying the earlier identified maturity model as presented in Figure 6.1 to healthcare, one should introduce some alterations. In place of inventory buffers, we should include processing time buffers and time buffers. Although similar to inventory buffers, time buffers and especially processing time buffers have the characteristic that they can hide variability. Processing time buffers hide variability through the continuous and hidden changes in task speed and task elements. As soon as time buffers arise, for example in the shape of waiting lists, this is a signal of variability in the related process. Figure 6.2 presents our revised development model, now suitable for the healthcare context.

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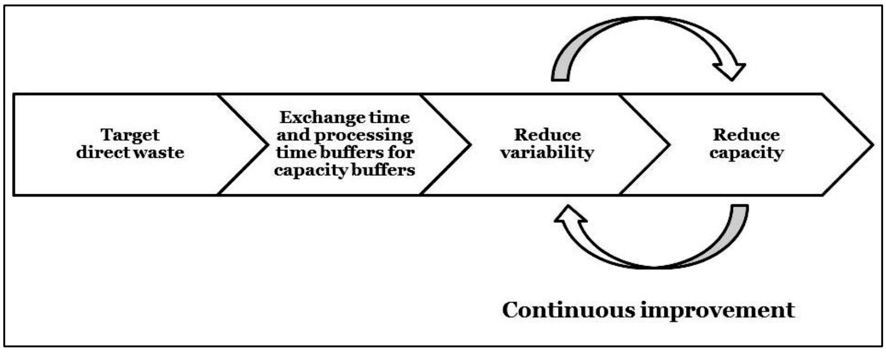

Figure 6.2. Phases of Lean maturity in healthcare.

We would expect healthcare organizations to move through the phases shown in Figure 6.2 over time. We had expected to see such developments in the case sites included in our research. Although all the case organizations that we studied did show a strong focus on waste in the early phases of Lean adoption, we could not identify patterns that indicated a move towards variability- and buffer-related Lean interventions.

Based on the findings in Chapter 3, it seems that a lack of knowledge on the roles of variability and buffers limits interventions focused on variability and buffering. This might explain why we did not observe a transition from earlier to more mature Lean phases in our case studies. In this respect, our study further showed that even a small investment in knowledge can influence the focus of interventions. While we failed to identify our healthcare cases moving through the development phases, this does not mean that the proposed Lean maturity phases are incorrect from a normative perspective.

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6.4 PRACTICAL IMPLICATIONS

Based on the findings from our studies, we can articulate several consequences for professionals responsible for the implementation of Lean in healthcare practice. First, our results underline the importance of variability and buffers in flow-oriented projects. If one accepts that flow performance is an important aspect of Lean — since it translates into low throughput times — then buffers and variability have a crucial role. In flow-oriented situations, rather than attempting to reduce obvious wastes, it would probably be more beneficial to attempt to determine where and why buffers arise. This should then allow an organization to focus on the underlying variability. A first step in determining where buffering takes place is to determine who of what is waiting (or idle). Are patients waiting for treatment, or is it capacity standing idle waiting for a patient to treat? Rather than continually striving for additional capacity, it could be more fruitful to give attention to the causes of waiting times and the reasons for sudden increases in the demand for care.

Further, our studies show that in order for practitioners to initiate projects that focus on flow, it may be necessary to extend their knowledge on the roles of variability and buffers. This could require Lean professionals to refresh their existing knowledge with advanced Lean classes that focus on the roles and uses of variability and buffers. Here, practice could benefit from additional support through relationships with universities, which are expected to include variability and buffers in their educational courses on Lean.

The results reported in Chapter 4 in particular indicate that practitioners are likely to underestimate the effects of artificial variability on performance. Small adjustments to the initial decisions made regarding patient flow could, relatively easily, reduce artificial variability. All the cases included in Chapter 4 showed that hospital policies were the cause of additional artificial variability. The same could easily be true in other healthcare organizations, suggesting that set policies could be the cause of considerable waiting times. Therefore, we would suggest, before a complete overhaul of a process is undertaken, that managers focus on analyzing the impact of decisions and rules within the current process.

Based on the findings in our final research project, we would like to emphasize the role of processing time buffers. Utilizing processing time buffers can avoid patient waiting time and excess capacity. However, on a note of caution, processing time buffers could be hiding variability and bring the risk of decreased service quality. We therefore think it is important that healthcare managers are sensitive to signs of processing time buffers. For example, if busy days do not lead to additional waiting times for patients, this could indicate that processing time buffers are being used. Ultimately, one would like to minimize buffers. Whilst processing time buffers might be difficult to identify, effort should still be put into minimizing the variability that creates the need for buffers. Here, we think that a useful diagnosis could start with questions to medical professionals about their routines and behavior to uncover if, and when, processing time buffers are applied. Identifying when processing times are adapted could

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constitute a first step in tracing the hidden variability at the root of this buffering.

6.5 LIMITATIONS AND FUTURE RESEARCH

As with all research, our individual studies have their limitations. The main concern regarding our studies, since we mostly relied on the case study approach, relates to the issue of generalizability. Whilst case studies offer a unique insight into the inner workings of organizations and allow a detailed view of theoretical phenomena, a case study methodology does not always allow statements to be made that apply at an industry-wide level (Voss *et al.*, 2002; Yin, 2009).

In our studies, we tried to limit the concerns related to generalizability through the selection of 'excellent' case examples. For example, through the selection of very experienced cases. Our single case studies, in Chapters 2 and 3, took place in what is considered one of the most advanced 'Lean healthcare' environments in the Netherlands. We reasoned that if we failed to establish effects of Lean here, studies at other healthcare providers would almost certainly not provide better insights. Expanding on our current studies, future research could consider cross-case designs, with a focus on differences between Lean environments. This would enable a comparison of different Lean approaches and help to clarify which type of approach results in the best possible outcome.

Another limitation relates to our theoretical lens, which was focused on variability and buffers, and where we generally followed the ideas of Hopp and Spearman (2004; 2008). In our

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research, we attempted to go beyond the reductions in obvious waste that are often the focus of studies on the application of Lean. We justified our focus on variability and buffers based on the Theory of Swift and Even Flow (Schmenner and Swink, 1998). As such, we focused on what we saw as the core of Lean: the reduction of buffers and variability. With this focus, we largely ignored other aspects of Lean, but this does not mean that waste reduction and other aspects of Lean are not important in healthcare. In healthcare, Lean is often applied as an approach for achieving continuous quality improvement. In future studies, a stronger focus on the role of continuous improvement processes in healthcare environments could provide valuable findings.

A more fundamental limitation, and not unique to this study, has to do with the way Lean is described in the current literature. The absence of a clearly stated and generally accepted Lean definition hinders Lean research. When reviewing studies investigating Lean and performance, one is never quite sure that Lean is being perceived in a universally applicable way. Whilst adjustments based on context are an obvious necessity, the basic concept should remain similar. We have tried to mitigate this problem by adhering to an established definition and focusing on underlying principles (variability and buffers) for which generally accepted theory is available. Nevertheless, the fact that Lean still relies on a fragmented theory hinders scientific progress. There is a danger that discussions become bogged down over questions regarding whether Lean is really the topic being addressed. We would suggest that future research focuses on those elements of Lean that can provide organizations with operational benefits and

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advance our current knowledge. This should become easier if future studies purposefully adopt existing Lean definitions and think in terms of similar underlying mechanisms.

6.6 FINAL REMARKS

In this thesis, the focus has been on Lean in healthcare environments. Nevertheless, some of our findings should be relevant for scholars interested in Lean in service industries in general. The results of Chapter 2 show that a reduction of artificial variability results in improved throughput time performance. There is no reason to believe that this principle, of reducing variability to improve throughput time performance, is not applicable in other service contexts.

In Chapter 3, we identified an excessive focus on waste and this may also be the case in other service environments. In the reports we read on Lean in other service contexts (e.g. Allway and Corbett, 2002; Piercy and Rich, 2009), it seemed that the variability and buffer relationship was not always considered. Similarly, our suggestions on the use of processing time buffers may also be applicable in other service environments.

In general, where Lean is concerned, there is only limited attention to buffering issues in service environments. This is especially true regarding the roles of variability and buffers, and this thesis adopted a novel approach and provides new insights. Each of our research projects links with the roles of buffers and variability within Lean, and we have provided an empirical basis to demonstrate the importance of these issues.

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Our overarching objective was to further current understanding of Lean and to aid practitioners in their daily decisions over Lean initiatives. In this context, we hope that both science and practice can use our work to give artificial variability the attention it warrants, both in Lean research and in practice when working on Lean interventions. Despite our focus, it was never our intention to downplay the role of waste but we would urge others to try to look beyond waste to other aspects of Lean as well. Ultimately, we need practice to progress to the more mature stages of Lean applications in order to obtain the performance effects that are so often desired.

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