An actor–network theory perspective for "Lean" interventions in manufacturing firms

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Abstract

Purpose – This paper tracks the network of actors participating in the initial implementation of a "Lean management" system, in order to identify associations between human and non-human participants conducive to successful adoption of the system.

Design/methodology/approach – The perspective of actor–network theory (ANT) helps reveal the complex dynamics at play in a "Lean" intervention at a manufacturing firm. It allows to identify key actors (human and non-human), as well as the possible associations between them, and helps produce network diagrams to track the changes in actors' roles and in network coherence over time.

Findings – Through a network analysis, the study charts the complexity of the process of Lean intervention, by accounting for the distinct possibility that actors' roles may shift over time, as they engage and disengage with the proposed intervention, until they fully cohere into a new system. Based on this, it derives a conceptual model to describe relevant factors for successful implementation of Lean improvement projects.

Originality/value – The ANT perspective affords new insights into Lean Management systems implementation, by highlighting associations between human and non–human actors. This novel focus suggests corresponding management guidelines and reflective practices for successful intervention.

Keywords Actor–network theory, Organizational change, Lean management, Lean manufacturing

Paper type Research paper

1. Introduction

In the face of ever-increasing competitive pressures, organizations must strive continuously to improve their performance (Anholon and Sano, 2016). The principles of "Lean management" ("LM" or "Lean") aim to enhance competitiveness and improve operational performance in firms (Bhasin and Burcher, 2006) by reducing waste and costs, which is often the most cogent motivation for organizations to implement Lean systems. The latter's success has been described precisely in terms of cost savings (e.g. through a reduction in labor time), decreased lead time, and increased productivity (Papadopoulou and Özbayrak, 2005). Still, a Lean production system may take time before improvements in operational performance carry over to the net income of a firm, for instance until an optimal inventory system has been established (Meade *et al.*, 2010). LM has become recognized as a major approach for continuous improvement. Moreover, Marodin and Saurin (2013) report that, since it was first introduced for process optimization, it has evolved from a set of standard practices into an adaptable business system.

The central principle of LM is continually and methodically to shift a firm's operations through a set of productivity improvement concepts and techniques (the "technical components" of a Lean system). For this purpose, it is crucial fully to harness the potential of

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those people, in the target organization, who are called to integrate the technical aspects of LM in their work routines. Hence, Lean systems implementation has been described as a *socio-technical* intervention for organizational improvement, presupposing the integration of social and technical innovations (Marodin and Saurin, 2013). Many of the challenges and barriers besetting Lean interventions are precisely of such a socio-technical nature. On the one hand, treating LM purely as a toolbox for eliminating non-value adding activities, in pursuit of quick productivity gains, has spawned a tendency to overlook the role that people play, leading to poor implementation outcomes for Lean systems (Sim and Chiang, 2012; Keitany and Riwo-Abudho, 2014; Chen and Meng, 2010; Basu and Ahmed, 2012). On the other hand, it remains unclear when and how, during the implementation process, social dynamics shift and technical adaptations break in, and whether the network of human and non-human participants to a Lean intervention evolves over time. This study takes up these questions by investigating the complex relationships between the technical adaptations demanded by Lean principles and the employees undertaking them, with a view to generating insights that might help ensure greater success of Lean improvement interventions.

The theoretical framework of actor–network theory ("ANT") offers a particularly useful methodology for furthering this level of inquiry. The primary challenge experienced by the focal actor(s) tasked with implementing a Lean system in an organization is reluctant involvement from employees. ANT helps clarify the complex interdependencies between human actors and the Lean system, which are activated by an organizational change intervention. Indeed, the underlying philosophy of ANT is that a phenomenon does not exist as a stand-alone, but is created by actors in the process of continuously re-negotiating their associations (Latour, 2005). ANT has already gained currency in different contexts to help understand a variety of project types (Broer *et al.*, 2010; Langstrand and Elg, 2012; Cresswell *et al.*, 2010; Hedström *et al.*, 2010; Sarker *et al.*, 2006). Such a trend motivates this study's attempt to devise an exploratory research design, inspired by ANT and focused on a qualitative case study, for gaining new insights on Lean systems implementation, with a specific focus on manufacturing firms.

The following sections present a literature review on LM and ANT, and subsequently describe the research methodology used in this study. The results section applies the ANT approach to the selected case study to track the dynamics of a Lean intervention. Case study findings are reviewed, in dialogue with literature on Lean implementation, in the discussion section. Finally, the conclusion lays out the implications of our findings for managerial practice.

2. Literature review

2.1 LM as a process improvement approach

LM is a set of operating principles for yielding the highest value output with minimum wastage (Bortolotti *et al.*, 2015). A Lean system is not limited to the operations side, but it nurtures an organizational structure and values that can shift firm culture and behavior as a whole. Originating from the Toyota Production System ("TPS"), the LM approach combines continuous optimization of processes, with waste minimization and quality improvement techniques (Womack and Jones, 2003).

Womack and Jones (2003) are credited with the first formulation of "Lean Thinking," namely that elimination of operational waste generates value for customers. Based on this insight, they derived five core principles of Lean Thinking: value stream mapping, flow, value, pull and perfection. Value describes a firm's capability to provide the right product, at the right time, for the right price, to the customer. Value stream mapping subsequently identifies three kinds of activities in the production flow: non-expendable core activities, activities that add no value but cannot be eliminated, and expendable non-value adding

activities. The flow principle highlights the removal of stoppages or hindrances along the production line. Lastly, the principles of pull and perfection focus on delivering a product/service as and when required, and with minimum waste.

Successful Lean interventions have occurred largely in the manufacturing sector, yielding such favorable outcomes as cost reduction, operational efficiency and adequate inventory management (Papadopoulou and Özbayrak, 2005). Adding to the improvement in processes, manufacturing companies have accrued quantifiable profit increases of up to 50% (Alves *et al.*, 2011). In the service sector, LM has been adopted primarily in healthcare for nurturing process improvements in such areas as waiting time for emergency care, length of stay, diagnosis of illness and preparation for treatment, among others (Vermeulen *et al.*, 2014; Kovacevic *et al.*, 2016).

Despite its established advantages, LM has faced several barriers to implementation (Achanga *et al.*, 2006; Camagu, 2010; Eroglu and Hofer, 2011; Sim and Chiang, 2012; Glasgow *et al.*, 2010). Studies conducted by Sohal and Egglestone (1994) and Jadhav *et al.* (2014) report oft-occurring resistance among top management, who might experience as challenges the opportunities a Lean intervention provides for new learning and increased task efficiency. In turn, the lack of strategic direction from reluctant top managers hampers Lean intervention success (Houshmand and Jamshidnezhad, 2006). Moreover, support required from top management is not limited to intellectual assistance, but includes material involvement in the changes (Tracey and Flinchbaugh, 2006; Wong *et al.*, 2009). Finally, top managers can also be found lacking in follow-up resource allocation, decision-making, and communication (Worley and Doolen, 2006); something that also applies to SMEs (Hu *et al.*, 2015). Another barrier to Lean systems implementation, described in a study of Indian SME's, is the withholding of managerial knowledge and practical expertise for identifying and eliminating important sources of waste (Kumar *et al.*, 2018). On the employee side, resistance to adoption of Lean techniques occurs for fear of job loss (Wong *et al.*, 2009; Eswaramoorthi *et al.*, 2011). Beyond this, re-training for shifting employees' ingrained habits is difficult: they often revert to traditional ways of working if they fail to comprehend the new techniques (Kumar *et al.*, 2018; Chay *et al.*, 2015; Su, 1994; Sirkin *et al.*, 2005; Radnor and Boaden, 2008; Rich and Bateman, 2003). Sometimes, implementing too many Lean techniques at once can backfire, by scattering employees' energies and focus (Bateman *et al.*, 2014). The lack of a knowledgeable human resource department can be another barrier, by failing to address employees' lack of training and poor awareness of Lean concepts (Eswaramoorthi *et al.*, 2011). The quality of a firm's machinery and equipment also matters: scant attention paid to facility layout and to minimizing movement by both people and raw materials can feed follow-up issues such as high inventory, high materials holding cost and low equipment utilization (Wong *et al.*, 2009). Another major hurdle to Lean systems implementation comes, according to Wilson (2010), from suppliers' lack of involvement in meeting Lean schedules.

In view of the foregoing criticalities, this study suggests that an ANT approach can provide a useful means for addressing such factors as human resistance or technical bottlenecks to Lean implementation.

2.2 Actor-network theory

Latour's theory of actor–networks (Latour, 2005) posits symmetry between human and non-human actors, and describes their entanglement into networks, held together by actors' iterative associations. One of the major empirical foci of ANT is to trace the emergence of networks and provide a viable explanation for this phenomenon. Networks become stable and aligned with the interest of a focal actor by means of adequate translation and enrollment to maintain the network and to lead other actors to act in a particular way (see Table 1). If

Actor (actant)	An actant is a human or non-human actor (such as a policy maker, a user, or an information system) that takes shape through its relations with other actors (Hedström *et al.*, 2010)
Black box	A network, and its participating elements, that has been "frozen", often with properties of irreversibility. The associations between actors are locked and the network acts as a single unit
Translation	The activities through which heterogeneous actors associate with one another and by which they constitute, order and dissolve actor-networks. They comprise problematization, interessement, enrollment and mobilization
Problematization	When an actor undertakes an effort to make other actors subscribe to his/her own description of reality, by establishing that (s)he has the "right" solutions to outstanding problems
Obligatory passage point	A situation that has to occur, for all actors to be able to achieve their interests, as defined by a focal actor (Olla *et al.*, 2003)
Interessement	When an actor attempts to impose on other actors identities and roles defined in the problematization stage, thereby locking actors in the roles proposed for them, assembling them into a new network (Papadopoulos *et al.*, 2011)
Enrollment	Actors in the network accept (or fall in line with) interests defined for them by the focal actor(s) and yield to their defined roles (Papadopoulos *et al.*, 2011)
Mobilization	During this stage, the solution suggested by the focal actor(s) gains wider acceptance and becomes taken-for-granted and black-boxed (Papadopoulos *et al.*, 2011)

Table 1.
Definitions and theoretical concepts in ANT

networks become unstable, ANT can help ascertain failure factors (Walsham, 1997) with a view to uproot the underlying causes of their unraveling.

In connection to organizational change, ANT has been used specifically for describing how processes evolve in tandem with changes in the relevant actors, during the integration of a new system in an organization (Sage *et al.*, 2011). The ANT approach highlights how many of the problems faced in the course of new process implementation can be traced to social and technological interactions between participants (Mitchell and Nault, 2003). Moreover, by bringing into focus the role played by non-human actors, ANT helps understand how their dynamic, interdependent and emergent stabilizations and negotiations add to the complexity of projects (Hedström *et al.*, 2010; Sage *et al.*, 2011). ANT has already been utilized for tracking organizational interventions from the healthcare sector (Broer *et al.*, 2010; Papadopoulos *et al.*, 2011), to the implementation of IT infrastructures (Cresswell *et al.*, 2010; Díaz Andrade and Urquhart, 2010), down to business process changes (Sarker *et al.*, 2006) and social networks (Poell *et al.*, 2014). However, the use of ANT for tracking processes in the manufacturing and production industry is still in its infancy. Finally, ANT's focus on the negotiations between human and non-human actors resonates with the view of change – as emergent from operational and social/technical innovations – current in LM (Joosten *et al.*, 2009).

3. Research methodology

A qualitative approach is particularly suited to track actors' involvement in a Lean implementation network, since it allows the collection of rich information on network emergence and change, as well as tracking the context surrounding the phenomenon under consideration through triangulation of data from multiple sources. Relevant literature (Cresswell *et al.*, 2010; Elgali and Kalman, 2010; Gao, 2005; Papadopoulos *et al.*, 2011; Tatnall and Burgess, 2002) confirms this, stressing that qualitative studies afford the opportunity for participants to express their lived experience of events, and advises this research protocol when the intervention being investigated has no clear or single set of outcomes (Yin, 2017), as in the case considered here. On top of this, the ANT approach adds a specific focus on the

socio-technical negotiations underpinning the introduction of a Lean system. The research approach was carried out into two phases as illustrated in Figure 1 and discussed in the following sections.

3.1 Phase 1

This study unfolded in two phases. During phase one, semi-structured interviews with managerial personnel belonging to five different organizations (see Table 2) were undertaken, to map recurring factors of Lean implementation failure. This was followed by a subsequent case study centered on a single organization, to enable depth of understanding of Lean implementation within a *particular* context.

3.2 Phase 2

The case study focuses on purpose on a manufacturing organization ("ManuEast"), which was chosen because it was implementing Lean, and for ease of access in following the Lean implementation over time.

ManuEast manufactures custom-made parts since 2008 in its UAE-based facility, acting as the tier-one supplier to leading international manufacturers. In the assembly hall, all products undergo final fitting of metallic parts and seals, and any other sub-assembly procedures. Technicians are responsible for drilling, assembling and interchangeability checks to ensure that manufactured parts will fit onto the final product. ManuEast has devoted considerable energy to implement Lean manufacturing principles, hoping to reduce non-value adding downtime, while still ensuring a user-friendly environment for technicians.

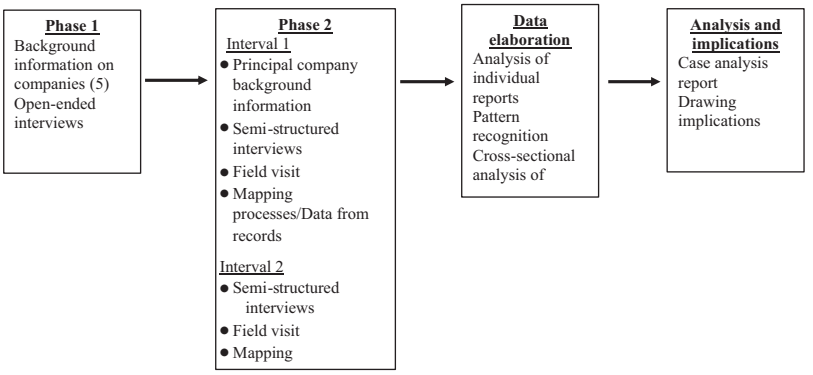

Figure 1.
Single case study: research protocol

Company	Industry	Interviewed personnel	Duration of lean implementation (years)
1	Healthcare	Risk manager	8
2	Public service	Strategic planning and performance management analyst	5
3	Public service	Supply manager	4
4	Military MRO services	Supply chain manager	4
5	Public service	Strategic planning and performance management analyst	5

Table 2.
Company demographics

The unfolding of events during the Lean implementation process demanded an adaptable and emergent research protocol to guide the case study (Asmussen and Creswell, 1995). This involved following several key actors to track their associations in the context of the Lean intervention. Data was collected over the span of a year, in two installments, and it included semi-structured interviews. The interviews were approached with the focus suggested by ANT, consolidating the theoretical direction of this inquiry (Creswell *et al.*, 2010; Sergi, 2012; Packendorff *et al.*, 2014).

Five participants from upper-level and operational management were interviewed more than once; each had previous experience of, and was deeply involved in, the implementation of Lean. Open-ended questions were used to identify associations between actors, to chart the translation process, and to gather the experiences of participants to the Lean intervention. Each interview lasted approximately two hours, was audio taped, transcribed *verbatim* and prepared for subsequent analysis. In addition to the interviews, the study also involved direct observation of actors on the shop floor, participation at meetings, and informal interaction with staff over the course of one year.

After one year, another extended visit to the manufacturing firm took place. More interviews were undertaken to follow up on the progress of the Lean improvement initiative, and to focus more closely on understanding the role of non-human actors. On this occasion, interviews were conducted in a group session with the same participants recruited the previous year, and they were audio taped and transcribed.

Finally, all interview transcripts were formatted and imported into *QDA Miner*, a qualitative data analysis software.

4. Results

This section first presents results from phase one, followed by findings from the single in-depth case study (phase two).

4.1 Phase 1: survey of five organizations

The Lean implementation process in the selected firms ranged from three to eight years. Despite extended implementation periods, managerial challenges were ongoing. All five participants agreed that human participation was always critical to the implementation of a Lean system. A constant success or failure factor hinged on whether employees had received adequate training and support to accompany the Lean intervention:

> The main challenges are to train the people and the staff: after 2012 we found this problem so we ask [sic] the training department to introduce some training, the level of training is beginner and intermediate (Company 2; Quality Assurance Manager)

This was closely related to other factors, such as top management support, communication, mentors' experience and expert knowledge, and – as emphasized by all five participants – clear definition of roles. The latter captures how well employees are acquainted with the requirements of their work and the expectations attached to it, as defined by quality managers.

In addition, the long-term consolidation of Lean outcomes requires internalizing a culture based on Lean principles. Failing this, Lean projects would end up being resisted by employees, because they re-engineer work systems and require extra time and energy of them for understanding and adopting new tools and practices. Employees can be reluctant to view this as a process improvement change, delaying the practical benefits of Lean adoption. This is why employees must be trained and repeatedly motivated to accept change and participate effectively in the project implementation. Interviewed participants offer a glimpse into this challenge:

> Employees saw [that] this improvement to efficiency can make their jobs unnecessary so they started to resist the change, but this was then solved by execution of policies to redeploy them in [a] productive manner (Company 4: Supply Chain Manager)

Phase two sought to delve into the reasons for staff resistance to Lean implementation, after phase one revealed it as one of the most persistent failure factors.

4.2 Phase 2: in-depth case study (ManuEast)

At ManuEast, implementation of the Lean improvement project was spearheaded by the Chief Operating Officer (COO), who had previous experience at General Motors, USA The production manager, who was interviewed in this study, led the initial discussions on implementing Lean in 2011. The actual process begun in 2013, after a two-year discussion. At this point, the Kaizen Promotion Office (KPO) was established, employing four persons that directly reported to the Senior Vice President (SVP). The KPO was tasked with facilitating engagement by production department heads for integrating lean tools and techniques in the production flow (Figure 2). Like other comparable manufacturing firms, ManuEast "went lean" in pursuit of cost reduction and of process improvement goals However, once the Lean implementation started, cost reduction became dominant. This was dictated by the fact that major customers had an office within ManuEast's facility, and demanded reduced prices.

Expertise on LM within the company was found primarily with the production manager and the production supervisor (Figure 2). Because employees were largely alien to the LM concept, the implementation initially focused only on basic Lean tools, with limited use of jargon. Furthermore, an external consulting firm was hired to design a proper structure for the implementation process. With the integration of the consulting firm, employees at ManuEast showed greater involvement.

4.2.1 Translation process and network diagram. ANT distinguishes four fundamental moments that punctuate the translation process (see Table 1). These are described below with reference to the case study.

Stage 1: Problematization. Key actors define the "problem" that has occurred and come up with proposed solutions. At ManuEast, the COO knew, from past experience, of the benefits

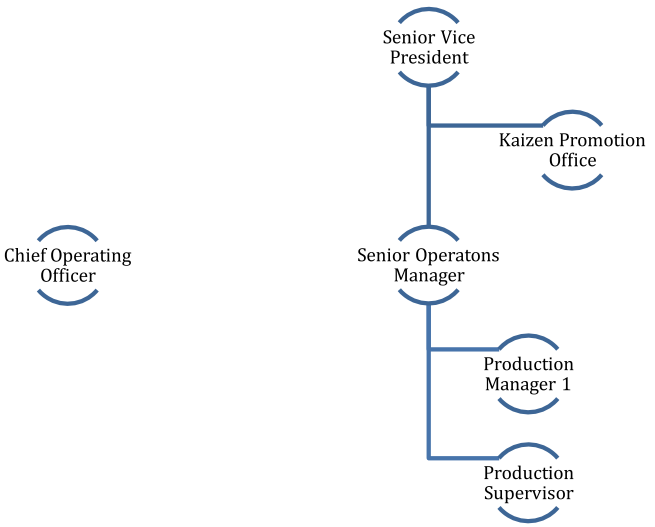

Figure 2.
Chain of command for initiating the Lean improvement project

that Lean holds for manufacturing firms. Cost reduction was already a major issue at the firm, so this became a key driver of Lean intervention in the production department.

The COO proposed the concept of Lean intervention to production managers, because the production department was thought to have a lot of downtime, e.g. from sorting tools and cutting materials. As a newly established company in the UAE, ManuEast had yet to lay down a standardized work process: the Lean process implementation was deemed capable of providing guidance for that as well. Subsequently, the Kaizen department was set up, specifically to tackle internal (culture change, process standardization) and external factors (cost reduction, competitiveness and supplier pressure) impinging on the Lean implementation process. It also became clear that cost reduction through Lean process improvement was an Obligatory Passage Point for the company; in the words of the production manager:

> We are in a very competitive marketplace and whilst we get offset, which says we have a guarantee of a volume of work, . . . there is no guarantee that our partners will pay us whatever we want, if they can find [. . .] the product that we make today to be made cheaper elsewhere.

Hence, the actors initially at work in identifying the "problem" were the COO, production managers, and production staff

Stage 2: Interessement. After key actors emerge in the problematization stage, their roles get further defined and stabilized. Non-human participants are introduced as possible technical solutions, so that their interaction with other human and non-human actors can be observed. At ManuEast, the major actor identified after the problematization stage was the Kaizen department, formed by employees with prior knowledge of Lean selected by the COO and the production managers. The company also appointed an external consultant to act in concert with the Kaizen department to implement Lean tools and techniques. At this stage of translation, the Kaizen department became actively involved in altering processes in the production department, as well as implementing standardized forms and reporting tools at the middle management level, such as a checklist on the kind of tools used in the production site that, along with matching shadow boards, was meant to prevent them being misplaced. The Kaizen department also set up an assembly line that provided materials cut to the required size and quantity.

Still, it was clear that integrating Lean thinking was more important than implementing individual Lean tools. With this goal, ManuEast adopted the basic 5S, SQCDP and other standardization tools of Lean. Support from the COO and the Kaizen office, which reported directly to the production manager, was generous at this stage.

Several human and non-human actors sprung into action at stage 2, such as the COO, production managers, production staff, the Kaizen department, external consultants, and the Lean system, which included such non-human participants (e.g. physical devices or conceptual blueprints for directing other actors) as Andon, Gemba, Kaizen, Kanban, Elimination of Waste, SQCDP, Standardized Work and Visual Factory (Table 3).

Stage 3: Enrollment. At this stage, actors that appeared during the interessement phase are locked into place and accepted. The actors are now aware of their new roles and have started to accept them as a new way of doing things. This stage witnesses strong correlation, integration and voluntary participation of actors towards the achievement of a new network of collaborative activity. For instance, once the checklist forms at ManuEast were set up, the production staff signed off twice a day to make sure all tools were in place. The production department also set up an inventory stock update system that kept a minimum requirement of replacement tools. All these adjustments led to a slight cost reduction, which benefitted actors not directly enrolled in the Lean implementation, i.e. stakeholders. For example, labor hours decreased due to the reduction in waiting time, giving ManuEast a slight margin to push down costs in response to stakeholders' pressure. For this reason, the major customers

Lean tools	Description
Kanban	A Japanese word describing the rationing of production to match requests, which is as central to Lean as the nervous system. It needs to be in place for effective system management (Bhasin and Burcher, 2006)
5S	Seiri (sort and eliminate), Seiton (set in order), Seiso (shine/clean), Seiketsu (standardize) and Shitsuke (sustain)
Elimination of waste	A blueprint for addressing seven Lean sources of waste: transport, inventory, motion, waiting, over-production, over-processing and defects
SQCDP	A panel for circulating updates under the following headings: Safety, Quality, Cost, Delivery and People
Standardized work	Documenting manufacturing procedures as best practices that can be edited later on
Kaizen	Japanese word describing improvement activities in Lean implementation initiatives
Andon	Derived from the Japanese word for "paper lantern," it describes a visual control system that uses an electric light board (or other signaling device) hung inside a factory, so that a worker can call for help and stop the line (Li and Blumenfeld, 2006)
Gemba	A Japanese word meaning "real place." In Lean, this indicates where the "real action" takes place, i.e. where the value-adding activities for the customer are carried out (Imai, 1996)
Visual factory	Visual signboards or indicators that are used around a factory to improve information and communication

Table 3.
Description of the Lean tools deployed

of ManuEast, who also held an office within the company facility, formed part of the Lean implementation network, even though they did not engage directly with the translation process.

Stage 3 revealed a network comprising the following actors: the COO, production managers, production staff, the Kaizen department, external consultants, the Lean system (see Table 3), and – finally – stakeholders of ManuEast (as non-enrolling actors).

Stage 4: Mobilization. In the final step, the network for Lean implementation becomes established as the new routine in the company. For this to happen, it needs to be accepted by other actors so as to widen its membership. Moreover, roles predefined for human and non-human actors need to be carried out as intended, in order to stabilize the functioning of the network. At this point, the network reaches a certain stability, and any new Lean tools introduced henceforth will more easily fit in, because the Lean implementation network now benefits from a shared understanding of problems to facilitate adaptation. Human and non-human actors are in place, and acting as required, but more work is still needed to increase the stability of the network. A final network diagram (Figure 3) pictures the actors' entanglement at ManuEast. The following statement of the production manager provides evidence of established gains from the Lean implementation:

> When I arrived here, there were 32 people on two shifts making 10 [product x] a month. Today we still built 10 [product x] a month and it takes us about 22 [staff] with very limited night shift. Big thing on the night shift is that it costs money because you pay people to work night[s]. So if you can reduce the night shift burden, you can reduce and save.

This indicates that some stability was achieved in the Lean implementation network at this point. However, the concept of Lean was unfamiliar to much of the staff, which led to setbacks. Resistance to change was registered most strongly at this stage, requiring further training. Moreover, ManuEast was only able to implement Lean at the production level, and not firm-wide as wished. On this matter, the involvement of actors from different departments was postponed till after successful implementation of Lean in the production department. For this purpose, black boxing the network established in the production department could help its integration within a larger network of different departments. The dotted lines in Figure 3

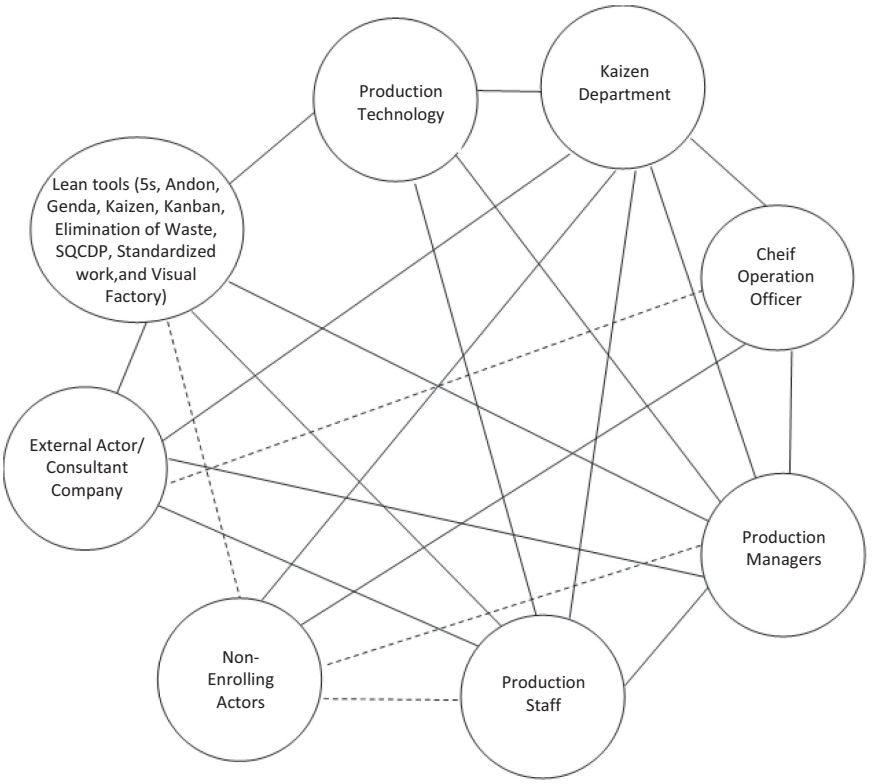

Figure 3.
Network diagram for the introduction of Lean in the production department

indicate the indirect involvement with lean tools. For instance, the non-enrolling actors do not directly get involved in the implementation of Lean tools. They only provide the approval required to implement them.

ANT stresses that network configurations are ever-changing, so that every actor is bound to shift positions and engage in new interactions. Follow-up interviews a year later revealed precisely that such shifts had taken place in the Lean implementation network, compared to its depiction in Figure 3.

For example, the network at ManuEast was enriched by additional non-human participants such as FIFO systems, CNC machines, SQCDP (Safety, Quality, Cost, Delivery and People), and Visual Factory boards, among others. External consultants were no longer supervising the Lean improvement initiative. The involvement of production managers (as evidenced in Figure 3) had also shifted, as they no longer actively impacted the Lean implementation network. Instead, new actors had joined, such as other departmental leaders, as shown in the updated network diagram (Figure 4). Another observed network shift was the re-distribution of responsibility from the Kaizen department, with the Kaizen head having remained the only one directly in charge of the Lean process improvement.

5. Discussion

5.1 Initial network assemblage

While both human and non-human participants are crucial to the successful completion of a project, human co-ordination is a particularly crucial challenge for managers (Verma, 1997),

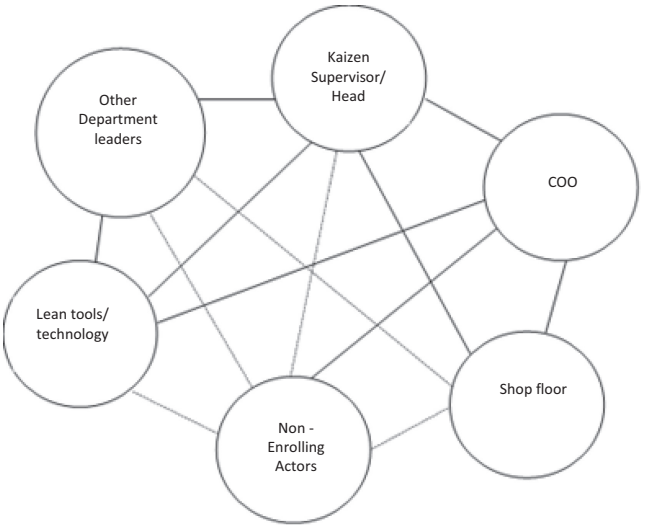

Figure 4.
Network diagram for the introduction of Lean in the production department, one year on

especially in projects that require a discretionary effort from members of a team (Rigby *et al.*, 2016), like Lean improvement initiatives.

For this reason, senior level actors involved in the Lean implementation provided the most active support for it. In contrast, the network formation phase faced reluctant contributions from staff and their limited comprehension of Lean: most of them appeared to disengage from this incipient network due to workload pressure or to their unfamiliarity with the long-term benefits of Lean. Reverting to established routines during the implementation process is a common occurrence (Sim and Chiang, 2012; Saurin and Ferreira, 2009): many companies have an internal culture that is resistant to change. In order to reassure staff on the benefits of Lean, leaders from each sector of ManuEast were identified, in order to take ownership of Lean practices within their respective area of work. A study of Kenyan companies (Keitany and Riwo-Abudho, 2014) clarifies that human resources constitute a major challenge to Lean implementation, also because people with Lean implementation experience might be difficult to locate. This particular issue, which is true of Lean projects in general (Bhasin, 2012; Parker, 2003), was confirmed in phase one interviews. At ManuEast, it took eighteen months to move from the problematization to the interessement phase, since different departments struggled to achieve clarity on the essence of Lean: Lean takes time, enthusiasm and skilled activity, and is not an instant fix to management problems (Rahbek Gjerdrum Pedersen and Huniche, 2011).

The study at ManuEast also illustrates how heterogeneous actors associate (or fail to associate) with one another during the Lean implementation process, and how their roles shift over time. The notion of "association" points to actors' interdependency, which demands commitment and trust for actors to coordinate successfully: a lack of trust has the potential to render ineffective the project manager's leadership (Blake and Mouton, 1978). At ManuEast, reassurances to staff by project leaders occurred precisely to build such trust. Ensuring trust among project participant provides a sense of confidence as team members all work towards one objective (Buchanan, 1999). The five organizations initially examined in phase one of the study also confirmed trust-building as an issue occurring during Lean implementation.

To counter these sources of drift towards previous styles of work, ongoing reaffirmation by top management is required for keeping all involved actors focused towards the Lean

project's intended outcomes (Sarker *et al.*, 2006), or their restraint risks being interpreted by other team members as lack of commitment.

5.2 Network assemblage after one year

Analysis of the Lean implementation network diagram after one year (Figure 4) reveals that the network shrunk over time due to changes in the roles of the actors involved. The main reasons for attempting the implementation of Lean at ManuEast had been cost reduction and process improvement: these still held one year on. Moreover, Lean tools had been well received, to the point of becoming standard procedures. For example, within one year, the basic SQCDP model had been adopted as a daily routine in various departments, whereas initially it had been used only in the production department. A new "Lean ideas" portal had also been introduced to encourage employees to put forward ideas on how operations could be improved, so as to contribute to cost reduction. Selected ideas would be progressively refined before implementation, and employees would be rewarded quarterly and annually for their contribution, depending upon their assiduousness. These initiatives are essential to harness employees' full potential, since it is they who are best positioned to locate process improvement opportunities (Taylor *et al.*, 2013).

Concerning non-human actors (Figure 4), ManuEast underwent significant technical adaptations in handling their production units. For example, the introduction of the First In First Out (FIFO) method in the shop floor area reduced lead time by 70%, whereas, earlier, employees would wait for their supervisor to assign them to a task. With FIFO in place, they were able simply to pick up the first part in their respective rack and start working on it. This reduced takt time as well. Moreover, a "pull" system ("Kanban") was established in the shop floor area, in order to reduce over-production and defects in the final unit. One more example of successful human and non-human integration leading to improved efficiency is the alteration of the set-up time for the CNC machine. The CNC machine at ManuEast consisted of two-halves, so that when one-half was running, employees could not set up the other half for safety reasons. Through improved safety measures, employees found a way to set up the other half of the CNC area simultaneously, increasing efficiency by up to 55%. Finally, ManuEast measured this increase in efficiency using Lean tools such as capacity tables, standard combination sheets, cycle times and takt time, among others.

Another interesting area of focus deals with the shifting roles of actors involved in the Lean implementation. In particular, a marked shift in the role of focal actors could be observed as the Lean implementation progressed. The kaizen supervisor, along with the COO, took on the leading role on the Lean project as time progressed. Other actors disengaged from the network due to a change in the nature of the implementation work. Further, focal actors (the COO and Kaizen supervisor) appointed "Kaizen champions" in each department, in order to facilitate the implementation of Lean in their respective areas of competence. This was planned from the start, but carried out after one year. Kaizen champions would be expected to practice basic Lean techniques to motivate people in their area of work, and report improvements to the supervisor and COO. In turn, a Plan-Do-Check-Act ("PDCA") cycle was followed by the two focal actors, in order to make sure that Lean tools were being integrated and understood by ManuEast employees. The enrollment of human and non-human actors also shifted between the first and second visit at ManuEast. For one, employees had become more accepting of Lean concepts, which was encouraging, since Lean has to be adopted as a systematic organizational philosophy, rather than as a set of individual tools, in order to become truly embedded in the culture of an organization Cheng and Meng 2010). Another finding was that the care that went into the choice of appropriate Lean tools, and their patient implementation over time, helped ManuEast reap their intended benefits.

In contrast to shifting roles for human participants, non-human actors turned out to be relatively stable over the observed interval. This was chiefly because technical changes at ManuEast required prior approval from various authorities and non-enrolling actors. These restrictions were called for by the nature of ManuEast's production, with the consequence that any amendment would require multi-layered approvals. Despite this, the observed associations between human and non-human actors in the network turned out to be more tightly coupled than before, with focal actors being able to direct other network participants without encountering much resistance.

Phase two of the study delivered a key finding, namely that, when actors in the Lean implementation network don't form strong associations with other human and non-human participants, they disengage and this can lead to the project schedule being delayed. Once disconnections were identified, efforts at ManuEast focused on strengthening the association between the loosely coupled actors. In consequence, follow-up interviews in phase two revealed associations between actors to have become stronger. This is in agreement with Mähring (2004), who suggests that stronger connections and locked positions between actors help undertake changes without fear of failing, fostering agility in the project team. The shifts in network configuration, as evidenced by a comparison of Figures 3 and 4, elucidate the dynamic nature of process improvement projects, where human and non-human connections may disperse, become coupled again and locked together in even stronger associations. Actors' *direct* impact on Lean projects has already been described in the literature (Esain *et al.*, 2008; Radnor, 2010), whereas this study contributes to the understanding of actors' *indirect* impact, mediated by the strength of associations in a Lean implementation network.

In view of this, one key to the success of Lean improvement projects appears to lie in fully embracing the Lean principle of prioritizing people's creativity over compliance with process blueprints. Organizational improvement initiatives need to be built around motivated individuals, with the freedom and support for identifying and addressing process improvement issues in their area of influence. To this end, the ultimate responsibility for creating a supportive environment lies with the organizational leadership (Rigby *et al.*, 2016), to make sure that any practices that might undermine worker empowerment and team morale are eliminated. Figure 5 (below) summarizes this study's findings in a conceptual framework

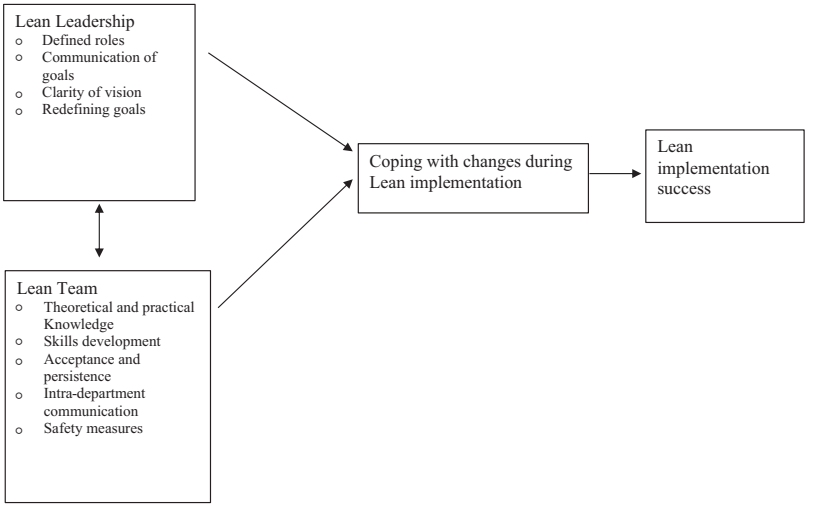

Figure 5.
Conceptual model identifying critical factors for the success of improvement projects

that outlines critical factors for successful completion of organizational improvement projects.

5.3 Critical factors for the success of organizational improvement projects

The overarching principle of Lean is fully to harness the potential of employees by enabling them to suggest and implement new ideas for process improvement. Empowering the project team in identifying and prioritizing the tasks involved in their work is one of the key steps linked to Lean implementation success (Marin-Garcia and Bonavia, 2015; Basu and Ahmed, 2012). For this reason, Lean interventions demand an *ad hoc* approach for managing organizational improvement projects, instead of traditional "command and control" structures. Namely, top management and the project manager must take responsibility for catalyzing associations, within the project team, which will foster a spirit of creativity and collaborative work. The ANT perspective helps one see this first hand, by explicitly identifying the role of different actors and tracking the strength of association between them. In our case, an ANT-inspired analysis revealed that associations between human actors were often weak in the early stages, due to the ingrained tendency towards disconnection from the project aims and objectives. Hence, the role of the project manager in creating associations during the initial implementation phase cannot be underestimated. By a clear definition of roles for the team, (s)he can help establish a clear understanding of the skills and expertise required by the project tasks. This, in turn, helps recruit suitable personnel as team members so that the project team will be more likely to have the collective intelligence and experience necessary to complete the project successfully. The early articulation of project goals also focuses team members' skills development, making them aware of what will be required of them as part of the Lean intervention. When team members can envision themselves making tangible differences in the achievement of organizational objectives, project activities become more engaging, which is likely to optimize individual contributions (Mir and Pinnington, 2014). Communication of project goals that isn't just effective, but also updated on an ongoing basis, builds focus in the project team, as confirmed also by the phase one interviews in this study.

Strong knowledge management (Todorović *et al.*, 2015) by the project leaders can help with effective communication of Lean goals, as it occurred at ManuEast by capitalizing on insights from the first phase of Lean implementation to guide corrective action by the project manager. In the initial phases, project managers were not successful in conveying to the other participants the overarching horizon of their intervention. Team members did participate by learning skills and giving implementation to the Lean intervention, but kept relating to it purely as a short-term project. Further, during the initial phase of Lean implementation, the network at ManuEast showed signs of disconnection in carrying out tasks as instructed by the focal actors. This was because the Lean system introduced new ways of doing things, which were resisted by employees, and project team members were slow to trust the project manager (Rezvani *et al.*, 2016). In such situations, top management support has been identified as instrumental in providing clarity of vision to the project team (Berssaneti and Carvalho, 2015). This holds also with respect to the case study at ManuEast: once a vision was clearly articulated by the project leadership during the second stage of Lean implementation, team members proactively contributed to the project goals with appropriate acceptance of the roles, goals and vision of the project, and with persistence in carrying out the tasks as assigned.

One additional finding of this study is that the association between the project manager and other team members alternated between phases of engagement and disengagement. Initial disengagement was overcome when the focal actors came up with clearly defined roles, forthright communication and a clearly articulated vision in the second phase of Lean

implementation. The project team reciprocated with acceptance of and persistence in the assigned roles, subsequently leading to closer association between focal actors and other members of the Lean implementation network.

6. Conclusion and managerial implications

This article presents a case study that uses an ANT perspective to understand the integration of social and technical innovations in Lean improvement projects, and how those projects evolve over time. ANT, specifically brings into focus the process-related aspects of Lean implementation. Although ANT focuses on the continual assembling of as-yet-unformed networks, it can also be used as a guide to depict, by a network diagram, the Lean implementation network at discrete points in time. This turned out to be a useful instrument for noticing disparities, in order to facilitate corrective action by focal actors. This application makes ANT relevant as a method of reflective practice to document and standardize successful Lean implementation processes.

In this paper, a manufacturing firm's production department was studied to track the emergence and transformation of the network of actors involved in the Lean intervention. Through this network perspective, the complexity of the process was shown to revolve around the possibility that actors' roles keep shifting throughout the course of the implementation, engaging with – and disengaging from – the Lean improvement initiative, before they align into a new, stable system. The application of ANT for understanding Lean implementation rejuvenates the extant set of theoretical tools for identifying gaps and challenges during projects of this kind. Indeed, it can help project managers dealing with diverse project participants, each with a varied set of personal skills, gain a footing for establishing stronger associations between them (Chua *et al.*, 1999; Cohen *et al.*, 2013; Creasy and Anantatmula, 2013)

Finally, a crucial highlight of this study is the usefulness and relevance of ANT for describing the contribution to Lean implementation coming from *both* human and non-human participants. In this way, issues and problems with network formation and stability can be detected early, affording project managers additional space for improvement. This can increase the influence of project managers' decisions for the purpose of aligning participants to the Lean implementation initiative through clarity of communication, ongoing information sharing, and the provision of rewards and task-specific training. Moreover, the study delivers insights specific to the manufacturing sector on how to track a system's evolution and the process dynamics of project implementation, in order to enable improved outcomes by addressing disparities while the project is still underway.

This article has broader implications for the literature both on Lean and project management. First, it reasserts the centrality of social interactions for the success of Lean improvement projects, by showing that network actors ultimately determine the outcome of improvement interventions. Second, it provides insights into which management practices can facilitate harnessing employees' full potential, particularly in the context of process improvement interventions initiated from the top down. Third, the ANT perspective allows to track associations between human and non-human participants over time, which in turn helps locate specific management actions that can shift employees' attitudes towards Lean tools and techniques. Fourth, the use of ANT for undertaking network analyses over the life cycle of the project can help project managers identify key actors and enable their intervention: by tracking each association, project managers can easily detect weak couplings and intervene on them before the final outcome is irremediably affected. In sum, this article makes the ANT perspective available as a reflective practice tool for organizational learning, with a view to helping organizations improve performance in connection with their change initiatives.

Despite the aforementioned insights into organizational change projects, a limitation of this study pertains to the restricted number of cases that were considered, most notably the focus on a single organization, and on a select number of participants within it, during phase two. Therefore, further empirical studies would be needed to contextualize across different industrial settings the process perspective afforded by ANT for understanding organizational change. This would help broaden the empirical basis for evaluating and possibly generalizing the findings of this study, in order to refine the conceptual model sketched here. Notwithstanding these limitations, this study offers an initial basis upon which to build, for achieving a more rounded understanding of the project dynamics of organizational change interventions.

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