Lean meeting buyer's expectations, enhanced supplier productivity and compliance capabilities in garment industry

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Abstract

Purpose – Investigate the potential of using 'lean' in garment supplier factories to enhance productivity and compliance capability, so as to fulfil a buyer's expectation of lower price, shorter lead time, and higher occupational health and safety (OHS) standards.

Design/methodology/approach – By means of an intervention, lean tools integrated with OHS elements were introduced in four Bangladeshi key garment suppliers of a Danish buyer. By employing a qualitative approach, both quantitative and qualitative techniques were used to collect data on productivity, OHS, and buyer-supplier efforts.

Findings – This study demonstrates that lean tools, integrated with OHS elements, can be used to improve the productivity and compliance capabilities of supplier firms which meet a buyers' changing demands for lower prices, shorter lead times, and higher compliance standards. This study suggests that the improvement of productivity and OHS in supplier firms through lean implementation could be a better choice for buyers than switching to new suppliers with uncertainties in productivity and delivery, as well as OHS compliance problems.

Practical implications – The findings of this study suggest that garment suppliers can benefit from implementing lean, thereby improving their capacity to meet buyers' expectations. Therefore, both suppliers and buyers have a mutual interest in the application of lean in suppliers' production facilities.

Originality/Value – By considering both buyer and supplier perspectives, this research is a unique attempt to investigate the possibilities of lean implementation at the shop-floor level to meet the market challenges in the context of a developing country.

Keywords Buyer-Supplier Relationships, Occupational Health & Safety, Sustainability

Paper type Research paper

1. Introduction

Shorter fashion life cycles and decreasing garment prices are two characteristics of the modern garment industry (Bruce *et al.,* 2004; Jeacle, 2015). As the fashion cycle is becoming shorter under competitive market conditions, buyers in the global garment supply chain are forced to secure product delivery within a short lead time, yet still with strong price competitiveness. This development ultimately affects the garment supplier firms in developing countries when they respond to buyers' expectations for developing production capabilities (Bruce and Daly, 2006). Moreover, large garment brands need to maintain their brand reputation by ensuring compliance with a code of conduct in the supplier firms (Oka, 2010). In this situation, buyers seeking the lowest price, shortest lead time, and highest level of compliance with those standards can put both productivity and compliance performance at risk (Niinimäki and Hassi, 2011). Therefore, the question is what possibilities exist to meet buyer expectations in relation to enhancing productivity and OHS compliance capability.

Limited research, so far, has been carried out on exploring how suppliers can meet these challenges. Some studies indicate that enhancing production capabilities through lean implementation can be a possible strategy in the garment industry to meet productivity challenges (Vijayakumar and Robinson, 2016; Wickramasinghe and Wickramasinghe, 2017). However, research suggests that although lean can improve productivity and shorten lead times, lean implementation may jeopardize OHS conditions (Jackson and Mullarkey, 2000; Lingam *et al.,* 2015; Hamja *et al.,* 2018). It is, therefore, an open question of whether lean implementation in supplier factories can meet the buyers' expectations of both productivity and OHS compliance. To answer our research question regarding the possibility of simultaneously improving productivity and compliance, we designed buyer-supported lean intervention initiatives with an integrated OHS focus in four supplier factories related to the buyer in the context of the Bangladeshi garment industry.

Bangladesh is the second-largest garment exporting country in the world and has a long tradition of working with leading garment brands (Gereffi and Frederick, 2010; Khan *et al.,* 2018). However, the industry in Bangladesh has faced increased competitive pressure, both globally and domestically, due to the reasons mentioned above (Khan *et al.,* 2018; Maalouf *et al*., 2019). Therefore, Bangladeshi garment manufacturers have begun to adopt new manufacturing systems,

such as lean, in order to increase productivity (Hamja *et al*., 2019). Therefore, Bangladesh is a relevant location for studying the garment industry and the possibility of implementing lean to meet buyers' expectations of both productivity and OHS compliance. Implementing these components can form the basis of a more sustainable buyer-supplier relationship. To answer our research question, we designed buyer-supported lean intervention initiatives with an integrated OHS focus in four supplier factories related to the buyer in the context of the Bangladeshi garment industry.

This study contributes to the operations management and buyer-supplier relationships literature by showing that suppliers have a good possibility of meeting buyers' demands by introducing lean with integrated OHS. However, lean implementation is not straightforward, as suppliers often lack competencies in the application of lean and face limited top-management commitment, as well as resistance from lower-level supervisors and workers who fear the loss of jobs due to increased efficiency. Therefore, in order to succeed, buyers need to support their suppliers in developing their capabilities. The benefit for buyers in doing so is that careful lean implementation will contribute to the reduction of production costs and lead times, while at the same time improving OHS conditions.

We start the paper with a discussion of the literature related to the current trends in the fashion and garment industry, the influence of lean on OHS, the buyer-supplier relational dynamics in the fashion/garment industry, and the supplier commitment to sustain lean. We continue with a presentation of the design of the intervention and the subsequent data collection in section three. Then we present an analysis of the results in section four, and a final discussion, with the conclusion presented last.

2. Literature Review

2.1 Recent trends in the fashion and garment industry

The fashion industry has recently experienced changing dynamics, such as retailers' increased expectations of lower cost, higher quality, less response time, and delivery flexibility (Bhardwaj and Fairhurst, 2010). Consequently, the success or failure of a retailer in a rapidly changing fashion market depends on its flexibility and quick response to market demands, such as short-notice delivery, the capability to adjust (increase/decrease) order volume, and the rapid inclusion of

consumer choices into the product design (Christopher *et al*., 2004; Storey *et al*., 2005). Therefore, fashion retailers create pressure on their garment suppliers to reduce production costs and lead times, and to improve the quality of products in order to be competitive in the market. They also demand an increase in OHS standards due to pressure from consumers and other national and international interests, such as NGOs, the media, and trade agreement demands from Western countries (Hoque and Rana, 2019; Hamja *et al*., 2019; Khan *et al*., 2018; Neu *et al*., 2014).

These fashion market trends force both buyers and suppliers to adopt new operational strategies rather than depend on a traditional structured mass production system (Christopher et al., 2004). Lean manufacturing system is one of the operational strategies used to tackle the current market challenges by improving supplier production and compliance capabilities (Li et al., 2017). Lean manufacturing system is built on the Toyota Production System, and it is suggested as a manufacturing strategy to make the American auto industry more competitive (Womack et al., 1990; Liker, 2004). Shah and Ward (2007:791) define lean manufacturing as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability." Some of the most common lean tools include Value Stream Mapping, Kanban, Just-In-Time, Total Productive Maintenance, 5S, Standard Operating Procedures (SOP), Kaizen, Single-Minute Exchange of Dies (SMED), and Multifunctional Teams (Bhamu and Sangwan, 2014; Hasle et al., 2012). Extensive research in lean found a positive link between lean manufacturing and organizational performance (MacDuffie,1995; Shah and Ward, 2003; Wu, 2003). The lean production system is adopted in many industries, and it has proved its effectiveness to improve efficiency, productivity, product quality, and reduce production costs and lead times (Liker and Wu, 2000; Hopp and Spearman, 2004; Bhamu *et al*., 2012; Arif-Uz-Zaman and Ahsan, 2014; Rampasso *et al*., 2017; Singh *et al*., 2018; Haerizadeh and Sunder, 2019). Although originally developed for the automotive industry, in the last decade lean has also been applied in the textile and garment industry and has shown a positive impact on productivity performance (Videla, 2006; Marudhamuthu, 2011; Smadi, 2012; Jabbour *et al*., 2014; Lingam *et al*., 2015; Gamage *et al*., 2017). Several lean tools have been found to have a positive effect, among others 5S (Agrahari *et al.*, 2015), kaizen (Quddus and Ahsan, 2014), SMED (Marudhamuthu, 2011), and quick response manufacturing (Locke and Romis, 2007).

2.2 Impact of lean implementation on OHS

The effect of lean on workers' health is a debated issue in research. Several researchers, especially in the early implementation of lean, point towards a detrimental effect on workers' health and safety (Harrison, 1994; Landsbergis et al., 1999; Conti et al., 2006). A later review showed that the adverse effects were, in particular, related to manual assembly tasks (Hasle et al., 2012). The possible consequence is that lean causes a higher intensity of repetitive strain injuries (RSI) (Buckle and Devereux, 2002; Muggleton et al., 1999). As sewing operations are highly repetitive, it is quite possible that there may be adverse effects. In particular, it has also been convincingly proven that the repetitive tasks of sewing machine operators carry a high risk of RSI (Öztürk and Esin, 2011; Sealetsa and Thatcher, 2011), especially in regard to repetitive movements and sitting postures (Delleman and Dul, 2002). Other studies report that garment workers in South East Asian garment factories suffer from musculoskeletal disorders of the upper body parts – neck, shoulder, arm, hand and back - as well as poor morale and high worker turnover (Chan et al., 2002; Sarder et al., 2006).

However, a review study indicates that the effects of lean depending on the actual application of lean (Hasle et al., 2012), and one recent study on the Bangladeshi garment industry indicates a short term positive impact of lean implementation on muscle fatigue and pain (Hamja et al., 2019). A parallel review of the lean in garment found ambiguous results regarding the health outcome but with a tendency towards positive effects (Brännmark and Håkansson, 2012). Furthermore, the literature suggests that suppliers tend to focus on lean as an opportunity to increase productivity and thus often neglect OHS in the garment industry (Raworth and Kidder, 2009). Thus, the effects of lean on workers' health in the garments industry are still unsettled, and the research also provides good arguments for paying particular attention to OHS during lean implementation.

By doing so, lean may be utilized to improve the ergonomic arrangement of the workstation, reduce equipment and materials, and remove obstacles that cause muscular strain. These changes have already been suggested in some studies of the garment industry (Marudhamuthu *et al.,* 2011; Vijayakumar and Robinson, 2016). For example, poor workstation design in the form of an inappropriate height or size of sewing table, seat, and workspace has been shown to have a negative

effect on productivity (Megeid *et al.*, 2011). The literature further suggests a number of measures that can improve the work environment. For the physical arrangement of the workplace, Parimalam *et al.* (2006) recommend improvements in the form of adjusting the height sewing tables for various operations, using appropriate lighting, employing noise control through routine maintenance of machines, utilizing earplugs and earmuffs, using local exhaust ventilation, equipping workers with dust protectors, having a standard distance between machines, redesigning blade guards and fabric cutting tools, and holding regular safety meetings with workers. There have also been suggestions for organizational changes such as task rotations, decreased work hours, and increased rest periods, modifications that may reduce upper body musculoskeletal pains (Wang *et al.*, 2007).

2.3 Buyer-supplier relational dynamics in the fashion/garment industry

The buyer-supplier relationship dynamics in the fashion and garment industry have long been investigated (Crewe and Davenport, 1992), and there are primarily two types of relationships that have been identified: transaction orientation and relationship orientation (Han *et al.,* 1993; Heide and Stump, 1995; Tangpong *et al.,* 2015; Hoque and Rana, 2019).

Transaction orientation is characterized by short-term discrete transactions, one-time relations, frequent switching of suppliers, limited communication, and only sharing legal contractual information (Benton and Maloni, 2005). Hoque and Rana (2019) defined the transaction-oriented buyer-supplier relationship as an adversarial, arms-length, and individual transactions-based competitive relationship to achieve short-term organizational objectives. Transaction-oriented relationships create opportunistic behaviour whereby the buyer-supplier relationship contains less trust and commitment than would typically exist (Campbell, 1997). In contrast, relational governance controls opportunistic behaviour through a written contract, and relies upon trust, commitment, cooperation and collaboration-based exchange relations (Hawkins *et al.,* 2008). The assumption is that the relational governance between buyer and supplier acts as a safeguard of the supplier's opportunism and facilitates long-term collaboration (Lee *et al.,* 2018).

The trend is for especially large international buyers to move towards a collaborative partnership relationship with suppliers with a focus on issues such as delivery time, quality, cost, and compliance (Soh *et al*., 2016). Studies show that the collaborative buyer-supplier relationship improves relationship outcomes, such as risk and reward sharing, joint-product development, and

business outcomes, such as market share, cash flow, and lead time (Cousins and Lawson, 2007). Close relationships have also been found to offer improvements at the operational level, such as in quality, delivery, and cost reduction (Kannan and Tan, 2006). A key point is that maintaining a collaborative relationship involves commitment and investment from buyers to develop and increase suppliers' capabilities, and this involvement is the focus of our discussion in the next section.

Supplier development is defined by Krause and Ellram (1997:21) as "any effort of a buying firm with its supplier(s) to increase the performance and/or capabilities of the supplier and meet the buying firm's supply needs." Supplier development can be summarized into four main strategies: 1) competitive pressure (giving more business to suppliers to motivate suppliers to improve performance); 2) evaluation and certification systems (helping suppliers understand buyers' expectations and thus improve their performance); 3) incentives (motivating by providing incentives such as recognition, cost-sharing savings, and assuring large future business volumes); and 4) direct involvement (making capital and equipment investments in supplier operations, partially acquiring the supplier firm, and investing in human and organizational resources) (Krause *et al.,* 2000). The direct involvement is the most relevant option when studying the possibilities of using lean as a tool to upgrade both productivity and OHS. It can involve activities such as frequent routine visits, easy communication with frequent information sharing, and sending experts who advise and train suppliers' employees (Sako, 2004; Krause *et al.,* 2007; Govindan *et al.,* 2010).

2.4 Supplier commitment to sustaining lean implementation initiatives

Direct involvement may be particularly relevant as the literature reports that applying and sustaining lean comprehensively is not straightforward (Abolhassani *et al*., 2016; Hopp, 2018). Therefore, buyers in other industries have supported lean development in their suppliers. This issue has in particular been studied in automotive industry suppliers (Jabbour *et al.,* 2014; Bhamu and Sangwan, 2014; Dyer and Nobeoka, 2000). Toyota is especially well known for collaborating systematically with suppliers, facilitating the transfer of lean technology and knowledge from Toyota to the supplier companies (Dyer and Nobeoka, 2000). On a less comprehensive scale, Bhamu and Sangwan (2014) suggest internal and external education and training programmes for learning lean tools and techniques in addition to hands-on training at the supervisory level for identifying and categorizing waste. Although the buyers' support of lean application in garment

suppliers has not yet been studied, it seems plausible, and moreover it should be expected, that supplier support is also important for the successful application of lean in this industry. The sustainability of any lean implementation initiative depends on the supplier firms' understanding of lean and its application, regular training of employees and workers, monitoring and controlling lean initiatives, and management and employee commitment to lean initiatives to deliver long-term benefits (Angelis *et al*., 2011; Mostafa *et al*., 2013; Jobin, 2015). Top management commitment and leadership play a particularly critical role in implementing and sustaining lean initiatives (Alefari *et al*., 2017; Sreedharan and Sunder, 2018, Netland, 2016).

Based on the literature, there are good arguments for applying lean in the garment industry in order to meet productivity and competition-related challenges and to ensure that buyers also benefit from lean. However, the literature is less clear about how OHS will be affected by lean and what the role of buyers could be in its introduction, in particular with improving supplier firms' sustainable capabilities and balancing productivity and OHS. This current study contributes to closing this gap in this literature.

3. Research Design

This intervention study is part of a larger DANIDA research project studying lean, productivity, and OHS (see the acknowledgements). The project is designed to investigate the possibilities of implementing lean with the aim of improving both productivity and OHS. We followed a qualitative approach using a multiple embedded case study method (Yin, 2014). We used both quantitative and qualitative data analysis techniques to investigate the impact of lean tools on productivity and OHS performance and why and how lean can transform and being sustainable in supplier factories to meet buyers' expectations of lower prices, shorter lead times, and higher OHS standards.

3.1 Intervention design

The intervention is divided into three phases: a) baseline study, b) implementation, and c) follow up. In the baseline study, the existing productivity and OHS conditions of the supplier factories were measured. In the implementation stage, the specific lean tools and OHS issues were implemented and measured. In the follow-up stage, the sustainability of the intervention project was observed (Hamja *et al*., 2018; Eira *et al*., 2015). One Danish buyer operating in Bangladesh

and its four key suppliers from the Bangladeshi garment industry were selected for this study. We selected the Danish buyer as it is the knowledge partner of the DANIDA research project, while its four key suppliers were chosen based on the following case selection criteria: a) key suppliers since they produce a large volume of goods for the buyer and the buyer maintains a long-term cooperative relationship with them, which is important when establishing new initiatives in supplier factories; b) large suppliers since they are more capable of implementing new initiatives than medium and small suppliers; and c) top-ranked key suppliers since these are more compliant and generally follow standard operating procedures, thereby facilitating the implementation of our intervention initiatives. The Danish buyer is denoted 'DB' and the four key suppliers are denoted 'S1', 'S2', 'S3', and 'S4' hereafter to maintain the anonymity of the buyer and suppliers. DB has been active in Bangladesh since 2005 and, currently, has around 80 suppliers from which it is sourcing. The main characteristics of the supplier firms are presented in Table I.

[Table I about here]

In each factory, the researchers, together with the factory management, selected a pilot sewing line for the lean intervention (see Table II).

[Table II about here]

Two teams were formed in each factory to conduct the intervention initiatives: a core team comprised of five members from top and mid-management and an operational team comprised of five to seven members from the top, middle, and first-line management. The operational team members received three-day training sessions, which covered lean tools and OHS improvement techniques. The operational team subsequently introduced the same lean and OHS learning to the workers and other colleagues in their respective factories, and worked on lean and OHS improvements in the selected line. In addition to conducting the three training sessions, the researchers frequently visited the supplier factories to assist with the implementation of lean and

OHS improvements. Together with the core and operational teams in each factory, we monitored and controlled the selected pilot line so that it was unaffected by the other lines on the same floor.

Four lean tools and two OHS issues were selected as the most important and realistic items in which the operational teams could achieve sufficient competence to apply in practice (see Table III).

[Table III about here]

3.2 Data collection and measurements

Both quantitative and qualitative data collected concurrently from multiple sources, including first-hand data from shopfloor workers, personal interviews with key management personnel, direct observation, and reviewing documents (Bryman and Bell, 2015). Quantitative data was collected through four main lean measures, namely value stream mapping (VSM), 5S, defects per hundred units (DHU), single minute exchange of die (SMED) (see Table IV), and the two OHS assessments of machine safety and ergonomics (see Table V).

[Table IV about here]

For OHS, we used four machine safety items and four ergonomic (sitting position) items as a proxy for the work environment and the risk to workers' health and safety (see Table V).

[Table V about here]

Qualitative data was collected by interviewing managers and workers in the buyer and supplier firms (see Table VI) through face-to-face, personal, in-depth interviews with key informants in multiple settings (Yin, 2014). While the buyers' data was collected from their Dhaka office and headquarters in Denmark, the suppliers' data was collected from their factories.

[Table VI about here]

An interview guide was used for the in-depth interviews, which at the supplier firms were conducted partly in Bangla and partly in English, since one of the authors is a native speaker of Bangla; and the buyer's interviews were conducted in English. Some of the interviews were audio-recorded with the permission of the interviewees and supplemented by written notes; and rest of the interviews were only recorded in written notes as interviewees were not comfortable in audio recording. The interviews lasted 30-90 minutes with every manager and 10-30 minutes with every worker. Only relevant and necessary quotes were transcribed. Secondary data was collected from the buyer and suppliers' websites and different online sources. In addition, various documents were collected, such as line layouts, committee lists, meeting minutes, policy papers, audit reports, DHU reports, and compliance reports.

3.3 Data analysis

The basic analysis consisted of comparing before and after data in order to assess the outcome of the intervention. For the quantitative data, the researchers compared before and after measures and then used the qualitative data to support and further elaborate the quantitative findings. In particular, the researchers compared high and low performers – polar cases (Yin, 2014). We summarize the results in an assessment of suppliers' commitment to lean as well as an assessment of the expected sustainability of the lean changes. The criteria of the assessment are described in Table VII. We also analysed the buyer's current role in the suppliers' productivity and OHS improvements, and their requirements for sustaining the implemented lean initiatives. The data validity is enhanced by using multiple sources of evidence in the data triangulation and by sharing a draft case report with the respondents to receive their comments (Yin, 2014).

[Table VII about here]

4. Results

4.1 Outcome of the intervention initiatives

After implementing the lean tools, most of the suppliers experienced positive changes, although some changes showed relatively small improvements (see Table VIII). However, for VSM, 5S, DHU, and SMED there were also a few cases where the development was either unchanged or negative. Overall, however, results were higher productivity with a potential for shorter lead times and thereby also more flexibility and faster delivery.

[Table VIII about here]

After implementing the OHS initiatives, the assessment shows that all suppliers experienced positive changes, although some of the changes were rather small; however, it was mainly the suppliers with the greatest problems that made the largest changes (see Table IX). All suppliers used belt covers on their machines, making it unnecessary to depict this result in the table.

[Table IX about here]

4.2 Buyer involvement in supplier productivity and OHS capability development

The Danish buyer (DB) follows a policy of developing trust-based cooperative long-term relationships with its suppliers. The DB's country manager stated: "We treat our suppliers as our family members." This cooperative relationship helps the DB understand the necessary productivity and OHS support requirements of suppliers. The DB believes that only close long-term relations can ensure its suppliers are responsible for productivity and OHS initiatives.

The DB rates its suppliers' according to their performance, based on their on-time delivery and expected quality, and also regularly audits its suppliers, sometimes using its own team and sometimes using an independent third-party auditing firm. Based on the issues identified in each audit, the DB sets a corrective and preventive action plan (CAP) for each supplier to improve

productivity and OHS KPIs within a given deadline. The DB not only identifies problems but also assists suppliers in solving them. The DB has its own health and safety guidelines, which act as an instructional tool in identifying and solving health and safety problems in supplier factories.

The DB motivates its suppliers to achieve new milestones and appreciate new achievement. For example, DB suppliers have achieved various certificates, such as Worldwide Responsible Accredited Production (WRAP) and the Business Social Compliance Initiative (BSCI), which approve suppliers' productivity standards and compliance excellence. The DB believes that its suppliers' certificate achievements are indicators of developing their greatest ability. The sustainability manager of the DB stated: "Before selecting a supplier, we check how many certificates and memberships they have, and after selection, we continuously motivate them to achieve new certificates and to get new memberships."

It is furthermore the policy of the DB to provide necessary support for the development of its suppliers, including supporting training programmes and offering expert advice. This support covers both supplier productivity and OHS development. Due to supplier demand, the DB occasionally sends its local and foreign experts to the key supplier factories to solve problems. For example, the DB's design development teams and its suppliers work together to develop new designs. The DB has dedicated teams that regularly follow up on productivity and OHS development activities as well as track improvement in supplier factories. The sustainability manager of the DB stated: "Our sustainability team regularly visits our supplier factories for process improvement, quality checks, and [to] improve compliance standards." If the DB sets any corrective action plan for its suppliers, it follows up on their progress. If suppliers fail to follow the set time frame, the DB helps them to achieve the target, such as working together with suppliers in their factories to solve problems, and sharing new ideas and technological know-how.

The DB considers this intervention project to be in line with its strategy for the development of the capabilities of its suppliers. When the researchers shared the intervention project objectives with the DB, it happily accepted the offer. As the chief representative of the DB mentioned: "We think it is a great opportunity for our suppliers to improve their productivity and compliance condition without any cost." The DB provided the researchers with their full support of the project objectives (lower product prices, shorter lead times, and higher compliance standards) and found that they were similar to their own objectives for supplier development. The sustainability manager

of the DB added: "This project would help our suppliers since they need to improve productivity and reduce lead time to be competitive in the market and maintain standard occupational health and safety (OHS) as per our own, plus local and international, codes of conduct (COC)."

The DB assigned a team comprising of one project manager, one sustainability manager, and two corporate sustainability coordinators to continuously support the researchers either at their office or at the supplier factories. The intervention initiatives in each supplier factory began with an introductory meeting at the DB's office, in which the top management of both the DB and the supplier firm participated. In the introductory meeting, the DB gained the consent of the suppliers to provide all manner of support to the researchers. The DB's team accompanied the researchers on the first factory visit at each of the four supplier factories. Moreover, the DB regularly took follow-up inquiries from the researchers regarding the progress of the intervention initiatives. When researchers faced a challenge, the DB intervened and secured the necessary support from the factory management. For example, when the researchers struggled to receive cooperation from S1, DB's team visited the factory and assured full support through discussion with the supplier's top management. When researchers did not receive cooperation from S4's top management, the DB called the supplier's top management and accused them of non-cooperation. After that, S4 fully cooperated with the researchers. The DB's management recommended that the suppliers' management take the intervention initiatives seriously and suggested them to learn the tools so that they could continue the same practices after the completion of the intervention to reduce production costs, lead times, and improve OHS standards. As the country manager of the DB stated: "We told the suppliers to learn from the intervention project and implement the same tools in all lines of the factories." The DB was already running an initiative, named the HER Project, in the four supplier factories, a programme intended to empower female workers and make them aware of health-related issues. As the researchers' OHS initiatives were in line with the objectives of the HER project, the intervention expedited the project. Moreover, the DB started a quality improvement programme called Accredited Quality Controller (AQC) during the project intervention in order to develop a quality team in each supplier factory that could identify and independently solve quality problems. The quality assurance manager of DB stated: "We are very happy with your intervention project as we think that lean implementation not only has a positive impact on production cost and lead time reduction, but also has a positive impact on product quality improvement." Throughout the entire duration of the intervention, the researchers shared regular

updates on the intervention progress with the DB's responsible team. In addition, the researchers shared their final intervention findings, future possibilities, and the DB's necessary future actions to sustain the initiatives. The DB's support not only helped in the implementation of the lean initiatives, but also became critical to sustaining the implemented lean initiatives.

4.3 Supplier commitment and sustaining initiatives

During the intervention process, the four suppliers demonstrated different levels of commitment and capability in regard to implementing lean. In addition, it was observed that the employees did not know who was responsible for what, or which section was responsible for which tasks. For instance, the production department thought that productivity improvement was the responsibility of the industrial engineering (IE) department, and the IE department thought that the production department was responsible for these tasks. Moreover, supervisors and workers were in fear of losing their jobs if they proved to be insufficiently qualified to work with the lean changes. The line supervisor of S2 stated: "If our company implements lean in this factory, we will lose our jobs as we do not have the academic qualifications." Likewise, one worker for S4 mentioned: "We know from the workers in another factory that many of them lost their jobs due to lean implementation."

Based on the above experience, we conducted an assessment of the suppliers' commitment to lean and OHS implementation. The assessment was, as outlined in the methodology, based on the interviews and observations conducted during the entire intervention process. The results revealed that none of the suppliers demonstrated a high level of commitment (see Table X). Three suppliers reached a medium level of commitment, whereby their top and mid-management were much more involved in the intervention initiatives than the low level observed in S2. These suppliers also had some experience from prior lean initiatives in their factories and their industrial engineers had some lean knowledge. Furthermore, their top management was directly or indirectly involved in the lean implementation initiatives. For example, a director, a general manager of quality, a general manager of planning, and a production manager of S3 were all directly involved in the intervention initiatives. The general managers of quality and planning developed their own teams in conjunction with our operational and core teams so that their teams could capture the intervention process and implement the same process in other lines after completion of the intervention. The director always followed up on the progress of the intervention initiatives and directed others to

provide the necessary support. The three suppliers also proved that they were able to secure a certain, although far from perfect, level of cooperation and coordination between top management and lower-level management and workers.

In the case of S2, they did not show the necessary commitment, and neither their top management nor their senior managers were involved in the implementation of the lean project. We observed that from the very beginning, the top and mid-management of S2 transferred their responsibilities to the first-line management. The operation head of S2 stated: "We are prepared to provide all sorts of support to the researchers and operational team." However, in practice, top management's support and involvement were insignificant during the intervention. The low level of commitment manifested itself in the intervention project's poorest overall productivity outcome.

[Table X about here]

It is well established that it can be difficult for companies to sustain their lean implementation. In this study, the four suppliers showed great variation regarding their commitment to sustaining the initiatives. Of the four suppliers, S3 undertook the most significant sustainability initiatives. Their highly competent and experienced top and mid-management were open to receiving new knowledge, were fully involved in our intervention initiatives, and started to implement the same lean tools in all lines in the plant. The general manager of S3 stated: "Already we have formed a kaizen team for lean tools and OHS implementation, and the team is responsible for providing training to workers and line supervisors and for assuring a continuous process and OHS improvement." S1 and S4 took small-scale initiatives, such as the application of 5S, DHU, machine safety, and ergonomic implementations, in a few additional lines. The IE manager of S1 shared: "Our industrial engineering and compliance teams have started to implement some of the lean and OHS tools in some lines, and we are thinking of gradually expanding the same initiatives to other lines so that we can satisfy buyers' demand of lower product cost, higher OHS standard, and shorter lead time." The HR, administration, and compliance manager of S4 stated: "We are very interested in the training on productivity and OHS that our staffs have received from your

intervention, and our management is thinking of providing the same training to other staff so that they can produce more by maintaining higher OHS standards." In contrast, S2 showed low levels of interest in sustaining lean implementation. According to our observation in the follow-up stage, no workers or first-line managers at S2 received any lean training before starting the lean intervention initiatives. Furthermore, since the intervention project ended, the supplier stopped its lean initiative and did not plan on implementing any future lean training to improve its capabilities to capture lean benefits, e.g. lower production costs through higher productivity, shorter shipment lead times, and higher OHS standards. Its top management had no follow-up plan for the lean initiatives.

One of the important barriers to the sustainability of suppliers' lean application is the widespread job switching tendency of mid and first-line management, and workers at all suppliers. However, this tendency was lower in S3, which showed the best results of all suppliers.

5. Discussion

This study shows that a lean intervention with a shared focus on both productivity and OHS leads to improvements in both issues. All four suppliers achieved improvements during the relatively short time of intervention, although the improvements are in some cases relatively low and do not constitute a large jump in productivity or OHS. However, this result is based on changes to a single pilot line in factories with limited or no prior knowledge of lean. Therefore, the intervention initiative is a small first step in lean transformation and may bring confidence to supplier management to extend the same initiatives to the whole factory.

There can be several reasons a larger jump in productivity and greater OHS improvements can be constrained. One reason is the suppliers' limited experience and qualifications in lean and in introducing organizational changes in general. The difficulties in coordinating between departments and the uncertainty among first-line managers and workers were the other reasons. Another reason was the insufficient direct involvement from the top management in the intervention initiatives. The DB realized this and tried to emphasize the need for substantial involvement from top management by requiring the owners to participate in meetings at the buyer's office, but as the results show, only three suppliers achieved moderate top management support. Hence, the study shows a variation in the percentage of productivity and OHS improvement across the suppliers due to the variation in lean orientation, top management

involvement, and commitment across the cases. The results of the intervention were achieved by involving the buyer. Therefore, it is questionable whether there would have been the same levels of factory managements' commitment and cooperation in implementing the initiatives had the buyer not been involved or been only minimally involved.

The above-mentioned problems with limited top management commitment, generally low competence in lean changes, and role uncertainty may explain the limited achievements by some suppliers; and also, the apparent constraints for the further expansion of lean in the suppliers. These results are in the same line of previous research findings (Lodgaard *et al*., 2016; Netland, 2016; Nordin *et al*., 2012; Turesky and Connell, 2010; Worley and Doolen, 2006). For suppliers to fully benefit from the lean application and to secure both productivity and OHS improvements, they must take a series of initiatives:

- Increase top management knowledge about lean in order to achieve stronger interest and thereby commitment to changes.
- In-depth training of core staff in middle management and specialists in lean and OHS tools and their application.
- Basic training of supervisors and workers on the lean approach and how these approaches are related to OHS.
- Implement organizational changes that clarify roles and secure cross-functional collaboration, such as through incentive systems that promote collaboration.

The previous literature supports similar initiatives on lean (Abolhassani *et al*., 2016; Lodgaard *et al*., 2016; Netland, 2016; Jadhav *et al*., 2014; Turesky and Connell, 2010).

Considered from a buyer's perspective, this study shows that not only suppliers but also buyers can benefit if suppliers are able to develop their capabilities. As suppliers are producing products for the buyers, the higher productivity and better compliance capabilities of suppliers indicate higher value creation for those buyers. Thus, the buyer in this study was highly involved in the project by recruiting the firms and putting pressure on the owners and top managers to commit to the lean implementation process. Nevertheless, the suppliers in this study had difficulties in extensive lean implementation even with strong assistance from the researchers. There is,

therefore, a need for buyers to be involved in a lean transformation to achieve the potential benefits fully.

Our results indicate that buyers need to work on two levels. First, they should support the development of a supplier's top management's motivations and understanding because top management must understand the perspectives and benefits of lean and its connection to OHS improvements, and also to be motivated to implement it. Second, buyers need to provide the necessary support for the actual lean implementation, which most likely involves two elements, namely training and following up with advice and support. Without such buyer support, it is likely that even though the suppliers have trained staff, they will run into problems and if these problems are not addressed, they will eventually terminate the implementation.

6. Conclusions

Research on the potential to utilize lean to improve productivity and OHS for the benefit of both suppliers and buyers has so far been limited. In this study, we demonstrate that lean implementation with a focus on integrating OHS has a positive impact on both productivity and OHS. Therefore, lean can be a valuable tool to improve suppliers' production and compliance (OHS) capabilities, thereby meeting buyer expectations. The findings contribute to the understanding of how buyer-supplier relationships could be improved in the garment industry. Both buyers and suppliers could benefit from implementing lean, and there is potential for developing stronger buyer-supplier relationships with less opportunistic behaviour, which would assure the future sustainability of their business relationship. This research prescribes solutions for suppliers who are concerned about their survival and growth, as well as for buyers who are thinking about other outsourcing options due to Bangladeshi garment suppliers' limited capabilities.

However, lean implementation is not a simple task. It is difficult for top management to commit sufficiently to lean transformation, while lower-level management generally lacks both qualifications and incentives. It is, therefore, pertinent that buyers become involved in the process by supporting the development of their suppliers' production capacity. There are several possibilities for such support. The basis is an extended relationship and the key elements are

support not only through incentives and audits but also directly through lean capability in the supplier production facilities.

This study considers only a single pilot sewing line on the shop floor of four supplier factories. Thus, the findings represent only a part of the whole scene in each of the supplier companies and in the industry as a whole. Moreover, it was difficult to isolate and control the line fully as workers in the line are somewhat affected by workers in other lines on the same shop floor. Therefore, it would be important to use longitudinal studies covering the entire lean transformation process to demonstrate what is needed to achieve its full benefits. This study only considers a single buyer from the Nordic region, whereas every supplier works for several buyers. It would, therefore, be relevant to examine the relationship modes between a supplier and its different buyers. Taking into consideration how the variations in these relationships affect their lean implementation initiatives in supplier factories would also be beneficial. It would also be relevant to study national differences and compare Bangladesh to other garment exporting countries where suppliers may have different conditions and interact differently with their buyers. It could furthermore be relevant to study the possibilities for further development of lean implementation in the garment industry into the more advanced approaches such as lean six sigma.

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Table I. Characteristics of the supplier firms

Name of Supplier	Year of Establishment	Size	Number of Total Lines	Employees	Product Type	Monthly Capacity (pcs)	Supplier Rating by the Buyer*	Length of Relationship with the Buyer (year)
S1	2006	Large	24	3,145	Woven	6,00,000	Yellow	10
S2	2005	Large	18	2,286	Woven	2,50,000	Yellow	11
S3	1999	Large	110	8,424	Knit	3,640,000	Yellow	13
S4	2013	Large	14	1,500	Woven & Knit	3,20,000	Yellow	6

*Supplier rating: red (unacceptable critical non-compliant, and high risk), orange (serious non-compliant and considered risky), yellow (acceptable minor non-compliant and very low risk), green (no non-compliance issues and no risks), and blue (new factory with minor non-compliance and low-risk issues, with temporary approval obtained).

Table II. Summary description of the selected pilot lines

Supplier Firms	Selected Line	Product Type	Duration of Intervention (Weeks)	No. of Workstations	No. of Workers	No. of Supervisors in the Selected Line
S-1	23	Long-sleeve shirts	24	57	57	2
S-2	F	Trousers	24	53	53	2
S-3	B5	Round-neck T-shirts	26	28	28	1
S-4	10	Ladies tops	26	49	49	2

Table III. Selected lean and OHS tools

Selected tools	Implemented initiatives	Objectives
VSM	Solve bottlenecks, remove unnecessary motions through motion study, reduce bundle size, fix work-in-progress (WIP), assure dynamic maintenance support in the specific line in each of the factories.	Increase value addition
5S	Provide hands-on training to the operators, helpers, and line supervisors; make changes such as reorganizing input racks, label input racks to use specific racks for specific styles; organize necessary worker tools at each station; remove unnecessary thread cones, electric wires, extra fabrics, and standard operating procedures (SOP) of previous styles; make the line neat and clean, keep chairs and workstations within aisles; remove workers' sandals, food boxes, and water bottles from the line.	Improve housekeeping and OHS
DHU	Calculate quality defects, identify possible root causes, and introduce possible solutions.	Defect reduction
SMED	Introduce a six-day plan and assign teams to follow the plan.	Reduce changeover time
Machine safety	Train and motivate line operators and helpers to use belt covers, needle and eye guards, and machine lights.	Improve safety conditions
Ergonomics	Correct motion problems of workers, re-design some workstations, and change sitting posture of operators based on standard head, arm, back, and leg positions.	Enhance ergonomics

Table IV. Productivity measures

Lean Initiatives	Description	Measurement
VSM	Identification of value-added and non-value time in a product's production process.	% of ratio value-added time divided by total time.
5S	Housekeeping conditions of a production shop floor.	% of the average score on a 100-point scale. This builds on the same approach as a 5S score sheet in Quddus and Ahsan (2014).
DHU	Identification of product quality defects per hundred units.	% of defects per hundred units from line quality inspection sheets.
SMED	Converting a manufacturing process from running its current product to running its next product.	Changeover time calculated before and after following the proposed changeover plan.

Table V. OHS Measurement

OHS Initiatives	Description	Measurement
Machine safety	Machine safety based on the use of belt cover, needle guard, eye guard, and machine light.	% of workers using and not using belt covers, needles and eye guards, and machine lights on the production line. Every worker received 1 for using and 0 for not using a belt cover, needle and eye guard, or machine light.
Ergonomics	Sitting position based on head, arm, back, and leg standards set by ILO (2010).	% of acceptable and unacceptable worker sitting positions. Every worker received 1 for acceptable and 0 for an unacceptable head, arm, back, or leg position.

Table VI. Interview details

Supplier & Buyer	Top Management	No. of Inter views	Mid- and Lower-level Management	No. of Inter views	Workers	No. of Inter views
S1	Head of Production; General Manager of Planning; General Manager of HR, Admin & Compliance; Deputy General Manager of Admin & HR; Head of Industrial Engineering; Manager of Industrial Engineering; Assistant General Manager of Merchandising; HR & Compliance Manager; and Factory Manager	9	Executive of Industrial Engineering, Junior Executive of Industrial Engineering, and Line Chief	3	Operators	11
S2	Executive Director, General Manager of Production, Manager of Production, Head of HR & Compliance,	7	Assistant Manager of Time and Work Study,	3	Operators, Helpers	10

	Merchandiser, General Manager of Quality Assurance, and Manager of Quality Assurance		Quality In-charge, and Line Supervisor			
S3	Executive Director; General Manager of Operation; Assistant General Manager of Merchandising & Marketing; Manager of Production; General Manager of Industrial Engineering & Planning; General Manager of Quality Assurance; General Manager of HR & Admin; Deputy Manager of Compliance; and Senior Manager of Admin, HR, & Compliance	9	Assistant Manager of Industrial Engineering & Planning, Senior Officer of Production, Management Trainee of Quality Assurance, Quality In-charge, Quality Officer, Auditor of Compliance, Assistant Officer of Maintenance, Officer of Compliance, and Line Supervisor	9	Operators	7
S4	General Manager of Operation; Manager of Admin, HR, & Compliance; Deputy Manager of Admin, HR, & Compliance; Manager of Production; and Manager of Planning; Manager of Quality	6	Officer of Administration, Executive of Production, Executive of Planning, Senior Manager of Quality, Quality In-charge, and Welfare Officer	5	Operators, Helpers	11
Buyer (DB)	Country Manager, Chief Representative, Strategic Sourcing Manager, Sustainability Manager, and Quality Assurance Manager	5	Corporate Sustainability Coordinators, Sustainability Coordinators, and Quality Assurance Coordinators	7	N/A	N/A

Table VII. Suppliers' lean knowledge, commitment and sustainability measurement criteria

Issues	Assessment Criteria		
	High	**Medium**	**Low**
Lean commitment	• Top management has knowledge about lean and is directly involved in lean projects. • Full cooperation and excellent coordination between management and employees/workers. • Employees/workers are motivated and in full support of lean intervention initiatives.	• Top management has some knowledge about lean and is indirectly involved in lean projects. • Moderate cooperation and necessary coordination between management and employees/workers. • Employees/workers are not fully motivated and are confused about the impact of lean intervention on their jobs.	• Top management has limited knowledge about lean and no involvement in the lean project. • Limited cooperation and lack of coordination between management and employees/workers. • Employees/workers are demotivated and scared of losing their jobs due to the lean intervention.
Sustainability	• The plant is expanding lean implementation to the whole plant. • Lean training is ongoing for all who are involved in lean. • Top management is following the lean implementation and monitoring key performance indicators (KPIs).	• The plant is expanding lean implementation to a few other lines on the same shop floor. • Some training is ongoing for some who are involved in lean. • Top management is not regularly following the lean implementation and is not monitoring KPIs.	• The plant stopped lean implementation after intervention completion. • All lean training stopped after the completion of the intervention project. • Top management did not do lean follow up.

Table VIII. Summary of the supplier factories' before and after productivity outcomes

Productivity Measures	Outcome	Suppliers			
		S1	S2	S3	S4
Efficiency	Before (%)	59	57	79	47
	After (%)	62	59	80	55
	Improvement (%)	5.1	3.5	1.3	17.0
VSM	Before (%)	1	3	1	2
	After (%)	2	2	2	2
	Improvement (%)	100	-33.3	100	0
5S	Before (score 0-100)	60	57	70	55
	After (score 0-100)	70	50	85	63
	Improvement (%)	16.7	-12.3	21.4	14.6
DHU	Before (%)	6	4.2	5.8	8.3
	After (%)	6	3.5	5.5	6.3
	Improvement (%)	0	-16.7	-5.2	-24.1
SMED	Before (Hours)	17.3	12.4	2.5	5.0
	After (Hours)	16.3	12.7	2.4	4.9
	Improvement (%)	-5.8	2.4	-4.0	-2.0

Table IX. Summary of the supplier factories' before and after OHS status

OHS Measures	Outcome	Suppliers			
		S1	S2	S3	S4
Machine Safety	**Needle guard**				
	Before (%)	56	82	83	56
	After (%)	88	85	88	95
	Improvement (%)	57.1	3.7	6.0	69.6
	Eye guard				
	Before (%)	70	89	87	65
	After (%)	90	92	95	97
	Improvement (%)	28.6	3.4	9.2	49.2
	Machine light				
	Before (%)	91	94	98	90
	After (%)	95	95	100	99
	Improvement (%)	4.4	1.1	2.0	10.0
Ergonomic	**Head Position**				
	Before (%)	67	75	82	72
	After (%)	89	94	83	79
	Improvement (%)	32.8	25.3	1.2	9.7
	Arm Position				
	Before (%)	83	95	80	85
	After (%)	92	97	77	87
	Improvement (%)	10.8	2.1	-3.8	2.4

	Back Position				
	Before (%)	67	90	82	72
	After (%)	79	91	83	81
	Improvement (%)	17.9	1.1	1.2	12.5
	Leg Position				
	Before (%)	50	90	68	66
	After (%)	92	94	72	77
	Improvement (%)	84.0	4.4	5.9	16.7

Table X. Assessment of suppliers' lean commitment and sustainability levels

Supplier	Lean commitment	Lean sustainability initiatives
S-1	Medium	Medium
S-2	Low	Low
S-3	Medium	High
S-4	Medium	Medium