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# Lean Production Practices in Bangladesh: An Investigation into the Extent of Practices in the Bangladeshi Garment Companies

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## ABSTRACT

*Lean Production has overcome the perception of being another management fad. An increasing number of organizations in developing countries are implementing lean production in order to generate improvements in performance and remain competitive. A sample of nine garment companies (seven companies from the Export Processing Zone (EPZ) and two companies from outside of the EPZ) of Bangladesh was chosen to conduct the study. A field survey with a semi-structured questionnaire, interviews and site visits were conducted to get necessary lean information from the respondent. These companies were selected purposively to ensure the best possible scenario of lean practices in Bangladesh.*

*The main thrust of this research is to examine the extent of lean practices in the Bangladeshi garment industry and to see the benefits derived from it. The research findings indicate that the selected companies have adopted a wide variety of lean tools and techniques and gained many improvements. Findings also identified several supporting factors as well as factors that hindered the lean implementation initiatives. It concludes with the recommendation for further work.*

**Keywords:** Lean Production, Bangladesh, Ready Made Garments, Improvement

## INTRODUCTION

Maintaining a customer focus is one of the most important elements in today's business market. Other elements such as money, resources and labor etc. are clearly important but in spite of the combination of all these factors the wheels of an organization cannot move if the customers are not satisfied. Customer requirements should get first priority. Traditionally only getting orders and shipments were major concerns for firms. It is stated by Skinner and Ivancevich (2002) that the evolution of marketing starts with only order taking and production, and ends with customer orientation. Firms are now more concerned about customer satisfaction because they have now more options than before. Customers are now demanding a wide variety of products at a lower cost but with fast delivery. They also expect more

innovative products at a competitive price (SAP AG, 2005) as customers have more opportunities to choose from a variety of options.

Organizations have realized that survival is only possible through customer satisfaction, and satisfaction will come through quality goods and services with the lowest possible price. In today's competitive and changing business world, lean production philosophy has brought changes in management practices to improve customer satisfaction as well as organizational effectiveness and efficiency.

The goal of lean is to satisfy the customer by delivering the highest quality at the lowest cost in the shortest time (Manufactured Housing Research Alliance, 2005). As stated by Bartezzaghi (1999), "Lean production is the end point of the process leading out of the Fordist-Tailorist paradigm". Lean production places emphasis on the elimination of non-value added activity as well as waste from the production process. Evidence indicates that in the industrially advanced countries, non-value added activity could comprise more than 90 percent of a company's total activity (Caulkin, 2002). Taiichi Ohno, the co-developer of the Toyota Production System suggests that the non-value added activities account for up to 95% of all costs in non-lean manufacturing environments (Kilpatrick, 2003). "Today lean may no longer be fashionable but its core principles (flow, value, pull minimizing waste etc.) have became the paradigm for many manufacturing and (service) operations" ( Lewis, 2000).

Lean production has received substantial interest internationally since the 1980s (Papadopoulou & Ozbayrak, 2005). The same study also stated that this concept spread to Japanese factories after it was first implemented in the Toyota Motor Company. Although other countries have experimented with this program, its adoption in Bangladesh was slow. Anecdotal evidence indicates that the few organizations that have adopted lean practices have experienced an overall improvement in corporate performance (Mamun & Afrin, 2001). Understandably, the firms that do not practice a lean production system have little knowledge about the experience of the lean-firms. A few inhibiting factors stand in the way of reaping the full benefits. While some work (Harun, 1990) has been done regarding the theoretical aspect of JIT; no work has so far been done in the area of lean practices in the Bangladeshi enterprises.

In Bangladesh, some companies across the garment industry sector have been practicing lean production to remain globally competitive in the face of fierce competition resulting from the rapid globalization of businesses. There is a dearth of research evidence regarding the impact of lean practices on competitive performance in Bangladeshi garment firms. Researchers are mostly silent on this

very important area of production philosophy. The entire field of lean remains unexplored in Bangladesh. This research attempts to bridge this gap. There is a general belief that since in Bangladesh political turbulence persists, economic infrastructure mostly remains undeveloped, high traffic problem, a strong supplier partnership is difficult to develop due to traditional corporate culture. Conclusive evidence regarding this requires careful and systematic investigation. The present study deals with the emerging issues and investigates the lean practices in the Bangladeshi firms and their impact on competitive performance.

## LITERATURE REVIEW

In the late 1980's the term "Lean Production" was introduced by a book titled *The Machine That Changed The World* written by Womack et al., (Piciacchia, 2003). "The idea of lean thinking comprises complex cocktail of ideas including continuous improvements, flattened organization structures, team work, elimination of waste, efficient use of resources and cooperative supply chain management" (Green, 2000). This is a Japanese concept applied in manufacturing firms. The Japanese firms (firms in other countries as well) have been using this concept to reduce the cost of any process (be it service or manufacturing) by removing waste. The basic elements of the concept include waste elimination, continuous one piece workflow (EPA, 2003).

Taichii Ohno, the vice president of manufacturing for Toyota is credited as being the father of TPS and he was the driver behind the creation of the Toyota Production System (Sohal & Eggelestone, 1994). Under this system the manufacturing processes are classified as adding value or waste. The most difficult task for a company is to define value properly. Toyota Production System has focused on this issue with very elegant solution. " The fierce competition imposed by mass production systems during and after the world war II era led the Toyota Motor Company (TMC) to a thorough study of the production system of the American automobile industry and in particular for Ford Production System-(FPS)" (Papadopoulou & Ozbayrak, 2005). The solution offered by Toyota led to a complete reconstruction of the company and they developed an alternative production system referred to as the TPS, which aimed at directly attacking any form of waste in the production process (Ohno, 1988).

According to the National Institute of Standards and Technology Manufacturing Extension Partnerships Lean Network, lean refers to systematically identifying and eliminating waste through continuous improvement using the pull

production to obtain perfection (Kilpatrick, 2003). Lean shortens the lead time between a customer order and the shipment of the products by elimination of all forms of waste in the production processes. Simply said, "lean principles and methods focus on creating a continual improvement of culture that engages employees in reducing the intensity of time, materials and capital necessary for meeting customer's need" (EPA, 2003).

The lean concept is equally applicable to any industry. It was originally developed in an automotive production environment, but the principles and techniques are transferable to any industry such as electronics, ceramic, steel, textiles as well as in service sectors. High competition, increasing operation costs, and growing operational problems led many manufacturing companies around the world to understand Japanese manufacturing practices. As stated by Kilpatrick (2003), lean makes an organization more responsive to market trends, deliver products and services faster and produces products and services less expensively than non-lean organization. As viewed by Womack and Jones (1996), firms in several industries in North America, Europe and Japan followed this path and doubled their performance through reduction of inventories, throughout times and errors.

A study on DENSO Corp. in Maryville (The newsletter, 2007), which is the world's second largest manufacturer of advanced technology, components and systems for major automakers, showed a dramatic change after the introduction of lean production system. The company adopted a wide variety of lean tools that brought several successes for the organization such as: TS 16949 and ISO 14001 certifications as well as DENSO Global Presidents Award for Keizen. The use of these lean tools and techniques reduced 95% of manufacturing waste, 32% of defects rate, 32% of warranty cost, and brought multiple quality, delivery and service awards.

Application of lean can bring 'considerable' benefits for the organization which reflects in the output and financial position of the firms. According to Alukal and Manons (2002), a planned implementation of lean production system leads to improved quality, better cash flow, increased sales, better productivity, improved morale and higher profits. They further reported that companies earned greater benefits by implementing lean techniques in the office functions in non-manufacturing organizations too, such as banks, hospitals, restaurants etc. A study on a Novartis International AG- A Switzerland based company (The e-newsletter, 2002) reviewed their production process and realized the need for some improvement. They introduced lean picking system for the movement of the goods from the warehouse to the packing lines. This redesigned material supply is

a kind of Kanban system. Through this picking system the company reduced its waste to a good extent. By using this system they were benefited in terms of waste elimination from the redesigned material supply process. The study was anticipated that this lean picking system would facilitate faster picking lines as well as would shorten the run times.

The garment industry plays a very significant role in the economy of Bangladesh. It employs a very large number of people, especially women member of the workforce. Not only in Bangladesh but also in other countries like China, Hongkong, Srilanka, India etc., the garment industry has been playing a crucial role in the economic development. Through the implementation of lean the garment sector can reduce costs, as well as increase customer responsiveness through reducing several types of waste from the production process. Customers demand quality products and on-time delivery. Lean practices can fulfill these requirements by reducing lead-time as well as manufacturing cycle time. Now, many countries have started to practice lean tools in the garment industry and observed tremendous improvement (Mazany, 1995; Bruce et. al., 2004).

## OBJECTIVES AND RESEARCH METHODS

The broad objective of the paper is to examine the extent of lean production practices in the selected Bangladeshi firms. The specific objectives include:

i. examining the adoption of lean tools and techniques in the Bangladeshi garment firms
ii. identifying the benefits experienced by the firms after lean implementation
iii. identifying the factors that affect lean implementation

This paper is primarily based on the data collected from the field survey in nine garment industries in Bangladesh, using a semi-structured questionnaire. Interviews with 'lean implementers' and plant observation was also conducted by the researcher.

## RESULT AND FINDINGS

The degree of 'leanness' of an organization can be measured by the use of various lean practices. Among a total of nine organizations, all nine claimed to have extensive lean practices in their plants. Findings indicate that the surveyed companies have different visions of lean. The companies customized the lean ideal according to their culture and resources resulting in a number of different

interpretations of lean. Perhaps for the 'ownership' of change this is essential, but the fundamental vision must not be changed and the interpretation of the philosophy must not differ from the intended meaning. In the present study in some cases the perceived results and the findings were not the same. The questionnaire was structured in such a way that unveils how good the companies are in practicing different lean tools, in addition to a number of related open questions in an attempt to identify the company's specific interpretation of lean. The first set of questions was general in nature and sought information regarding the practice of various lean tools and achievement of results as well as environmental influences. The second set of related questions was open-ended and the respondents' answers in some cases contradictory to the actual results. This indicates the level of understanding about lean philosophy. It appears that the understanding of the respondents can be construed as a barrier to lean implementation as in some cases they had misinterpreted certain aspects of the lean philosophy. The companies need to develop an action plan in order to raise awareness to achieve further improvements during lean implementation.

## EXTENT OF LEAN PRODUCTION PRACTICE

The study attempted to analyze the extent of lean production practices in the garment factories of Bangladesh. Successful lean implementation depends upon various issues. The study results revealed (Table V) that some companies initiated lean implementation from the beginning of the commencement of production in their plants, while others started lean implementation after a few years from the year of establishment. However, the findings suggest that since all companies have been successful in reducing cost and improving productivity, it is not the length of time of practices, but rather the effectiveness of implementation that determines the success of lean implementation. Table I indicates that irrespective of the legal status such as private, public or international joint venture, the companies achieved improvement in productivity and performance. So, there is no direct impact of legal status of companies on production systems or any organizational programs like lean production. While team work is one of the core concepts of lean production, Table II showed that 56% of the companies had team based structures and the remaining companies had functional structures. This is in sharp contrast with the general notion that a team structure is essential for lean implementation, or the successful implementation of any kind of change initiative. Although it is revealed in the sample that variation among the firms with different organizational structure is not an obstacle in lean implementation, at the same time it is indicated

that top management of the companies are not aware of the fact that a functional structure restricts flexibility. The surveyed companies with functional structures developed a cross-departmental coordination system (limited number of departments because of the small size of the firms) and an "oversee by the CEO' mechanism in order to reduce the inflexibility. Though they are achieving similar results to the team based companies- this prevents reconfiguring organizational structure from the functional to a team based-structure. If implemented correctly, lean provides a set of visual management techniques to easily communicate instructions, indicate inventory levels and process status and work flows.

An important indicator of lean production is a smaller supplier base (Sohal & Egglestone, 1996). In response to the question regarding "the number of suppliers of raw materials of the company"- the findings based on Table III, indicate that the majority of the companies were dependent on a large supplier base which is in contrast to the lean practice fundamentals. Although all of the companies intend to maintain long-term relationships with suppliers (Table IV), maintaining long and stable relationships with such a large supplier base is, in reality, difficult. Having a large number of suppliers and not reducing the number, even after a long period of lean implementation requires a long term strategy to reduce supplier numbers and therefore realize more benefits such as a long term relationship with suppliers through collaborative risk sharing, cost sharing and information sharing. As evident from Table IV, about half of the companies have suppliers (local) within close proximity. The respondents also indicated that they are always punctual in terms of timely delivery which indicates their general response to the question.

The findings that can be discerned from Table VI is that the sample companies had adopted a large variety of lean tools and techniques such as Kanban, JIT, 5S, Pull production, TPM, Kaizen etc. Pull production system and Just-in-Time are two very important practices of lean. The primary focus of JIT centres on a pull approach where by manufacturing activities of one level are linked and controlled by the activities of the next level (Alukal & Manos, 2006). Usually, a Kanban system directs the signal from one level to another in response to a need for product or service (Piciacchia, 2003). Finding indicates that all the companies had both a pull production and a JIT system (Table IX & Table VI) but only 66% of the companies had practiced Kanban (Table VII). From the discussion it is revealed that the companies without Kanban were using oral instructions in place of the Kanban. This oral instruction may cause noisy environment, unreliability and possible miscommunication. If these companies introduce a more structured visual tool such as a kanban system, it could make lean more successful.

JIT is a fundamental element of lean production. The findings emanated from the analysis of the responses to the questions in "whether suppliers can deliver materials to the company on a JIT basis" and "Can the companies depend on suppliers for on-time-delivery?" Findings (Table VIII) - indicate that all the companies claimed to have JIT systems, and their suppliers (local) are highly dependable in terms of frequent and timely delivery of materials. However, the import of materials cannot fall under JIT, as JIT means producing the right amount of product at the right time to the right place with a view to reduce the inventory. In the present study, Table VIII showed that the companies were found to have a JIT while getting supplies of raw materials from the local suppliers. In the case of imported materials the companies had a delivery window of two months. This allowed the companies to develop availability of products in the JIT process.

Kaizen is a basic and essential practice of lean. Findings from Table VI show that a good number of companies have been practicing continuous improvement or Kaizen (Table VI) and have built quality in the design of their products. As a part of the improvement process the companies reported about the suggestions scheme, employee involvement, reward to employees, spontaneous problem solving, management feedback to workforce in a timely fashion etc. The suggestions were highly encouraged and implemented by the companies for the purpose of continuous improvement.

As lean is a customer responsive production system, on-time delivery and adherence to a daily planned schedule are essential for the companies to be responsive. In response to the question "whether the company adheres to a daily schedule"- the findings based on Table X reveal that all the companies can meet the normal production schedule. But in the existing socio-cultural and unstable political situations in the country companies cannot meet the schedule every time. The political situation in Bangladesh is generally unstable. Clashes between different political groups are very common phenomena. Although the companies try to overcome the problems to a good extent but still the companies have some problems like power supply, transportation, and traffic congestions etc. which sometimes delay the delivery process. Under the circumstances described above, adherence to the planned schedule is difficult.

Lean production requires considerable attention to the arrangement of equipment which includes machine layout into manufacturing cells and installation of machines according to JIT production flow. Respondents were also asked regarding the physical arrangement of equipment. It is revealed from the results of Table XI that all the companies except one had a proper arrangement of layout

either in U or V shape. Efficient arrangement of equipment reduced the need for factory facilities by driving down space required for production. Observational evidence indicates that the companies have well maintained modern and high-tech machinery as well as good material handling systems.

The 5S program consists of such activities as seri (sorting out unnecessary items), seiton (arranging all necessary items in good order), seiso (cleaning workplace completely), seiketsu (maintaining a high standard of housekeeping), and shitsuki (training people to follow good housekeeping disciplines). But in the process of continuous improvement of quality, 5S is a quick and easy tool. The discussion of Table VI indicates that less than half of the companies are using 5S. When the surveyed companies are using other complex methods of lean but not 5S, it indicates the lack of a true lean environment in the companies under study. Usually if the companies have adequate knowledge and awareness regarding lean tools, they may first introduce the easy tools to observe benefits and then gradually the complex methods. Personal observation also reveals that all the companies had a clean and orderly workplace which means perhaps they are using some aspects of 5S but they did not realize it. This suggests that the companies require a thorough understanding about lean related methods to ensure success.

In response to the questions "whether the company has small lot sizes in the plant" as well as "whether the company emphasizes small lot sizes in order to increase manufacturing flexibility". It is evident from the discussion of Table XII that the use of small lot sizes was emphasized by all the nine companies. But interestingly, there is no common definition of lot size to the companies. Although in lean production small lot means single piece flow, in the present study a small lot varies from 10 to 20 pieces at a time. Even though the numbers of pieces were quite high, this realignment substantially reduced the inventory level and overproduction of the companies. Small lot size also allowed the companies to identify defective products more quickly than before.

Every lean business needs an information management system to link all the activities. The companies need to execute a pull decision. In response to the question of "Do you practice ERP, MRP or MRPII?", findings (Table XIII) indicate that none of the companies are using ERP or MRPII. Three companies are using MRP (not MRP II) while the remaining companies were using their own buyer approved customized software. Research (Piciacchia, 2003), indicates that MRP does not support lean production rather it encourages push production system. It is revealed from the discussion that the companies inherited this software before implementation of lean. As the replacement is a very costly procedure, the companies were not able to change.

Lean is a customer responsive system that highly focuses on the reduction of delivery time. From the discussion of Table XIV it is revealed that in order to deliver products on time to customers the companies reportedly used several lean tools such as JIT, Kanban, and kaizen etc. It appears from the data that by using these tools companies could significantly reduce the order-to-ship-cycle time. This means companies have more potential to gain from a fully comprehensive implementation of lean.

As evident from the discussion, to implement the above mentioned lean practices, the companies received technical assistance as well as training from their parent companies, foreign customers and from BGMEA (Bangladesh Garment Manufacturer and Exporters Association) (Table XV). The training was mainly on-the-job training so that the employees can perform a wide variety of tasks, leadership development etc. For the overall success and to experience and sustain further improvements, a fully comprehensive training program and an implementation strategy according to the individual company's requirement are needed.

## BENEFITS DERIVED FROM LEAN PRACTICE

All companies spoke about the benefits generated by the adoption of lean production in their business. It is evident from Table XVI that the following benefits, in varying extent, were identified by the respondents in the present study:

(a) increase in sales and profits;
(b) reduction in order processing errors and paper works;
(c) reduction in manufacturing cost;
(e) reduction of staff demands allowing the same number of office staff to handle large number of orders; and
(f) increase in overall revenue without increasing labor or overhead costs.

## FACTORS AFFECTING LEAN PRODUCTION

Several factors have a bearing on the implementation of a lean production system in an organization. The present study identified a number of factors that supported the lean implementation and also some factors that acted as hindrances to its implementation. However, the supporting factors varied from company to company, depending on their individual unique culture and available resources such as top management commitment, trained personnel, technical assistance etc. The study findings regarding the support-and-hindering factors are presented below:

*Supporting Factors Identified*

An attempt was made to identify the supporting and hindering factors for lean implementation. Findings showed that the surveyed companies were facilitated in lean implementation by a good number of supporting factors. The findings reveal the existence of several supporting factors as described below–

**a. Training:** The companies received training from BGMEA - the umbrella organization entrusted with the overall welfare of the garment factories in Bangladesh. Lean-related training is a bare necessity for successful implementation of any of the lean techniques. BGMEA provided training concerning mainly: on-the-job training which emphasizes theoretical training in performing other types of tasks along the production process, leadership training to accept responsibility for team leadership, and awareness development program in lean related issues.

**b. Workers' Attitude**: The positive attitude of workers played a significant role in lean implementation. Due to positive attitudes, the workers did not raise any voice against its implementation. The managers of all levels also extended their cooperation in the implementation of the lean tools. Both in the team based organizations and the hierarchical organization, communication was key to this cooperation.

**c. Management Commitment**: Another important enabling factor was the top management commitment and support in each of the companies. This commitment was spontaneous perhaps because of the fact that the top leaders could correctly appreciate the gravity of the competitive situations worldwide in the garments sector.

**d. Technical Assistance:** Technical assistance from customers or parent companies was another enabling factor that enabled the companies concerned to go with the program of lean implementation. Findings show that several companies received direct assistance from the parent companies or from their foreign buyers in terms of technical know-how and computerized database preparation. These helped in the lean implementation.

**e. Customer Suggestions:** Customer suggestions were another stimulus for some companies to implement a lean system as reported by the respondents. Big customers, especially foreign customers, insisted on a higher quality of products at a reasonably cheaper price than the most major competitors particularly of South and South East Asia including China.

**f. Level of Awareness**: A fair level of awareness among the management people in the companies about the lean system helped them proceed with the idea of lean implementation. This means training played a major role in the increase of awareness.

## HINDERING FACTORS IDENTIFIED

In general companies were experiencing hindrances to some extent in the implementation of lean. In addition to the supporting factors discussed above a number of obstacles were also experienced by the companies. These are commonly:

*Resistance from workers*

Evidence based on study results indicates that in the change program the majority of the companies face resistance from different quarters within the organization. While 22% of the companies experienced no resistance, the remaining companies faced resistance mainly by the shop floor personnel (55%), middle managers (11%) and lower level managers (11%). This resistance was due to the lack of adequate knowledge, communication as well as fear about new system.

*Migration of trained personnel*

Sometimes outside competitors hire the trained personnel from the companies by offering attractive benefits and other facilities. This migration of trained personnel is a real barrier to lean implementation as the companies are unable to maintain a 'critical mass' of trained personnel to establish and sustain new ideas, as well as train other.

*Occasional political turbulence*

In Bangladesh political unrest is a common phenomenon. Such circumstances increase the product lead time, increase the uncertainty of timely receives of raw materials as well as timely delivery of order etc. These greatly hinder the lean success.

*Port problem as well as traffic and transportation problems*

From the discussion of Table XVII it is evident that regarding transportation problems different companies provided different opinions. Due to their own transportation arrangement three companies showed no transport problems. Two companies reported that transport problems sometimes affected them, whereas four companies voiced less concerns but had some sort of port problems. Usually those who use the city route for product movement, face high traffic problem and therefore unreliable delivery times. To meet their daily schedule these companies started using alternative routes.

*Disruption in the power supply*

Although all of the companies have their own generator arrangement, the power supply problem is so frequent in Bangladesh, that still a number of companies claimed to have this problem. Slightly less than half of the companies reported about the adverse impact of power supply problems in the form of decreased productivity and increased cost (Table XVII).

*Inadequate knowledge*

Inadequate knowledge among some employees resulted in misconception and misinterpretation of the basic meaning of lean. Lack of education is the key to this problem.

Discussion reveals that the companies undertook the following measures to address the hindering factors, although the steps varied from company to company:

**a.** Introduction of incentive program for the workers to enlist their support and stop migration. Companies assured the workers that no downsizing or retrenchment would be made to drive fear out of the minds of workers. This step, along with appropriate benefit program such as home facilities, car facilities etc. worked to a great extent in stopping migration of skilled personnel. Although these benefits added additional cost but worked positively.

**b.** Rescheduling the supply /delivery of materials. The company that was facing traffic problem re-scheduled the supply plan in such a way that the inbound logistics and outbound logistics move between midnight and dawn when the roads remain free from traffic congestion. The company facing electric/power supply problem has installed gas generator in the plant. One company offered refresher training programs on lean production system to help employees gain adequate knowledge. The management of this company felt that this kind of intervention also helped partly to reduce employee resistance to lean implementation.

**c.** Creating awareness and educating workers regarding the beneficial impact of lean system and the ways lean system would enhance the effectiveness of the workers in performing their jobs.

**d.** Empowerment of employees that ensured their direct involvement in work-related decision-making in their respective work-places.

**e.** Advocacy program among the top and mid-level managers to ensure their commitment towards lean implementation.

## CONCLUSION

In a contemporary society, there is a great demand for quality products. Lean production is an established concept which reduces all forms of non-value added activities in organizations. From the analysis of the data collected, it appears that companies that adopt lean manufacturing as a working philosophy within their organizations can make significant improvement in terms of their operational performance even if it is in a modified format that best suits their particular business culture. It is obvious that there are great benefits from implementing a lean manufacturing culture, as demonstrated by the companies in this study.

In order to obtain information about the extent of lean production practices in the selected Bangladeshi garment firms, the study examined the adoption of various lean tools and the benefits derived from these lean practices. The study also identified the supporting and hindering factors in lean implementation.

## RECOMMENDATION FOR FUTURE RESEARCH

The observations based on this research indicate some recommendations for future work. Although some meaningful conclusions can be made with respect to the sample used in this study, the sample size is too small to represent a significant subset of manufacturing industry. Therefore, a more comprehensive survey is needed. This is the first pilot study in this area and therefore a follow up study is needed. It would be more illuminating to conduct a longitudinal study to understand the long-term effects and benefits of lean in the Bangladeshi garment industry. Furthermore, a study should be undertaken to understand EPZ companies' effect on the companies outside of EPZ. In addition to this, relationship with local suppliers and how to build strong and long-term relationship should be studied further.

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## APPENDIX: STATISTICAL TABLES
## (Based on the Questionnaire and Interview)

*Table I. Legal Status of Companies*

| Legal status | Percentage |
|---|---|
| a) Public Limited Company | 22 |
| b) Private Limited Company | 33 |
| c) International joint venture company | 45 |
| **Total** | **100** |

*Table II. Organization Structure of the Companies*

| Nature of structure | Percentage |
|---|---|
| a) Tall functional structure (long hierarchy) | 44 |
| b) Flat structure (team based) | 56 |
| **Total** | **100** |

*Table III. Number of Local and Foreign Suppliers of Raw Materials*

| Number of suppliers | Percentage |
|---|---|
| a) 1-10 | 33 |
| b) 11-50 | 45 |
| c) >50 | 22 |
| **Total** | **100** |

*Table IV. Supply Related Information*

| Particulars of supply | Percentage |
|---|---|
| a) Company intends to maintain long stable relationship with suppliers | 100 |
| b) The main suppliers are in close proximity | 44 |
| c) The company has reduced the number of suppliers over the last five years | 22 |
| d) Suppliers are dependable in terms of timely delivery | 100 |

*Table V. Year of Starting Lean Based on the Year of Establishment of the Companies*

| Year | No. of companies | Percentage |
|---|---|---|
| 1st Year | 3 | 55 |
| 4th Year | 1 | 11 |
| 6th Year | 1 | 11 |
| 9th Year | 1 | 11 |
| 11th Year | 1 | 11 |

*Table VI. The Different Lean Techniques the Companies Have Adopted* (Multiple Responses)

| Lean techniques | Percentage |
|---|---|
| a) Kanban | 66 |
| b) Daily schedule adherence | 100 |
| c) Small lot size | 100 |
| d) Just-in-Time | 100 |
| e) Physical arrangement of equipment | 89 |
| f) Application of preventive maintenance | 89 |
| g) Pull production systems | 100 |
| h) Continuous improvement | 78 |
| i) 5S | 44 |
| j) Other quality practices (QC) | 100 |

*Table VII. Use of Kanban System*

| Status of use | Percentage |
|---|---|
| a) System of use for movement of an item from one process in the production system to another process: | |
| Cards | -- |
| Electric media | 33 |
| Container | 33 |
| b) Use of Kanban in the production system | 66 |

*Table VIII. Just In Time Deliver by Suppliers*

| Indicators of just in time delivery | Percentage |
|---|---|
| a) Suppliers deliver materials to the company on a JIT basis | 100 |
| b) Company receive daily shipments from most/all suppliers | 56 |
| c) Companies can depend on suppliers for on-time delivery | 100 |
| d) Suppliers linked with the company by pull system | 78 |
| e) Suppliers frequently deliver materials to the company | 100 |
| f) Company have partnership oriented relations with the suppliers | 78 |

*Table IX. Pull Production System* (Multiple Responses)

| Elements | Percentage |
|---|---|
| a) Company produce products based on customer demand | 100 |
| b) The production processes have been organized in such a way that can ensure timely production based on customer demand or pull | 100 |

*Table X. Daily Schedule Adherence*

| Indicators of adherence to schedule | Percentage |
|---|---|
| a) Company can meet the normal production schedule each day | 100 |
| b) Company can complete the daily schedule as planned | 100 |
| c) Daily schedule allow time for machine breakdowns and unexpected production stoppage | 100 |
| d) The company is always behind schedule | - |

*Table XI. Physical Arrangement of Equipment* (Multiple responses)

| Activities of physical arrangement of equipment | Percentage |
|---|---|
| a) The production process and machines are in close proximity to each other | 89 |
| b) Organized plant floor into manufacturing cells | 89 |
| c) Machines are grouped according to the product family | 89 |
| d) Machines are installed in a way that can support JIT production flow | 89 |

*Table XII. Small Lot Sizes*

| Elements | Percentage |
|---|---|
| a) Small lot Sizes in the plant | 100 |
| b) Emphasizing small lot sizes, in order to increase manufacturing flexibility | 77 |

*Table XIII. Use of ERP, MRP or MRP 2*

| Nature of use | Percentage |
|---|---|
| a) Use of ERP, MRP and MRP 2 | 33 (MRP) |
| b) Use of Customized Software | 77 |
| **Total** | **100** |

*Table XIV. Short Order to Ship Cycle Time (JIT Link with Customers)*

| Indicators of short order to cycle time | Percentage |
|---|---|
| a) Companies always deliver on time to the customers. | 89 |
| b) Companies can adopt their production schedule to sudden production stoppage by your customers | 100 |
| c) Customers have a pull type link with the organization. | 100 |
| d) Order –to ship cycle time was: 120days, 35, 80, 90, 110,15, 100, 120, and 30. | Maximum was 120 days<br>Minimum was 15 days |
| e) Order to ship cycle time now: 90, 25, 70, 70, 90, 10, 80, 45, and 15. | Maximum 90 days<br>Minimum 10 days |

*Table XV. Assistance that Companies Received for Implementing Lean System* (Multiple Responses)

| Types of Assistance | Percentage |
|---|---|
| a) Help from parent company | 55 |
| b) Help from customer company | 45 |
| **Total** | **100** |

*Table XVI. Benefits Derived from the Lean Practices* (Multiple Responses)

| Elements | Percentage |
|---|---|
| a) Reduction in order processing errors | 67 |
| b) Reduction of paper work in office areas | 67 |
| c) Reduced staff demands allowing the same number of office staff to handle large number of orders | 78 |
| d) Increase in revenue with no increase in labor cost or overhead cost | 56 |
| e) Increase in Sales | 89 |
| f) Increase in profits | 89 |
| g) Reduction in manufacturing cost | 100 |
| h) Reduction in other costs | 89 |
| i) Reduction in the number of workers | 45 |

*Table XVII. Factors Affecting the Success and Failure of Lean Management Strategies in the Companies*

| Factors | Percentage |
|---|---|
| **Political turbulence** | |
| 1. Yes | 89 |
| 2. No | - |
| 3. Less | 11 |
| **Trade union** | |
| (a) Yes | |
| (b) No | 100 |
| (c) Less | |
| **Power supply** | |
| (a) Yes | 44 |
| (b) No | 22 |
| (c) Less | 33 |
| **Infrastructure problem** | |
| (a) Yes | 22 |
| (b) No | 33 |
| (c) Less | 44 |
| **Traffic problem** | |
| (a) Yes | 33 |
| (b) No | 22 |
| (c) Less | 44 |