International Journal of Science Academic Research
Vol. 03, Issue 08, pp.4266-4277, August, 2022
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

Research Article

ANALYZING THE EFFECTIVENESS OF SMOCK PRODUCTION USING LEAN SYSTEM AS A MODEL IN NORTHERN GHANA FOR SUSTAINABLE DEVELOPMENT

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Received 07th June 2022; **Accepted** 13th July 2022; **Published online** 30th August 2022

Abstract

Lean manufacturing comprises a mixture of systems and procedures, all of which have a similar ultimate purpose; to reduce waste and non-value-added activities at each production or service process to provide the most fulfilment to the consumer. A growing number of industries in emerging countries are executing lean production to generate performance advancements and remain competitive. The central thrust of the current study is to analyze the effectiveness of the textile design and production of Smock using the lean businesss system as a modelin Northern Ghana forsustainability. The study employed essential concepts from the theory of constraints and contingency theory organisation design to explain the effectiveness of the textile design and production with a lean business system of smock production in northern Ghana. The exploratory and descriptive research design was chosen due to the nature of the study. A mixed method strategy was employed to reach conclusions that are accurate, reliable and reproducible. The population of the study was made up of 89 participants, focused on weavers and sewers working in smock production in Northern Ghana. Interviews, as well as questionnaires, were employed to collect the required data for the study. SPSS was employed to analyze the quantitative data. The major empirical findings of the study demonstrate that respondents have no idea about lean business practices. Thus, smock producers demonstrated their lack of understanding when it comes to the concept of lean business practices, and as a result, there is a low level of application of the lean business concept in the Ghanaian textile industry.

Keywords: Analysis, Smock Production, Lean system, Sustainable Development.

INTRODUCTION

The textile industry is a dominant source of export and foreign exchange in several developing countries such as Ghana. Ghana fulfilled the requirements for the Athe African and Growth and Opportunity Act (AGOA) in the year 2000 and the exportation of Ghanaian textiles and clothes to the United States market amounted to over $550,000, $4. 5 million and $7. 4 million in 2002, 2003 and 2004 respectively. Notwithstanding, imports of US textiles and apparel were $8. 87million, $12. 73million and 11. 48million respectively (Quartey 2006). Industrial growth is considered to be one of the principal constituents that has led to sustainable growth; hence, most African countries are concentrating on the advancement of the industrial sector including the textiles sector (Quartey, 2006). In the late 1970s, Ghana was keen on improving on its textile industry which contributed significantly to developing the livelihood of Ghanaians. The textile industry employed about 25000 workforce and contributed to 27% of total manufacturing employment in 1997 (Quartey, 2006). However, in recent times the industry is facing severe difficulties which have led to the closure of many of these facilities, leading to the widespread unemployment of the workforce employed in that sector. Other facilities that are in business have also closed down most of their lines. A few instances are the Ghana Textile Print (GTP) which had an exceptional manufacturing volume of 30. 7 million yards. Their weaving and spinning departments were also shut down laying off most of its workforce. Again, Ghana Textile Manufacturing Company Limited (GTMC) shut down its production line in December 2005.

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The implementation of lean business production principles can aid this sector to emerge from this constant competition and recapture its enviable status in the international market. Implementing leanbusiness systems in the Ghanaian textiles industry will not only improve customer satisfaction but will also enhance the overall organizational efficiency and effectiveness (Ferdousi and Ahmed, 2009). According to the European Commission (2014), there is an uncertain financial landscape and a competitive market for textile industries and increased competition from low-wage countries is one cause. This has forced changes to most company structures and supply chains such as off-shoring and outsourcing of production projects. The innovative structure suggests that organizations have to address performance in domains like maintenance processes and advancement (Womack& Jones2010). To address this, manymanufacturing sectors, have explored and introduced lean business systems. Research confirms that organizations can increase performance by introducing lean (Upadhye *et al.,* 2010). However, in the textile manufacturing sector, several researchers have identified research gaps, both in terms of administrative applications and how employees are affected. These gaps are explored in the different research questions supporting this study. The market can be a challenging landscape to handle for any company, and the ability to adapt to new events and trends is essential to be successful, stay competitive and increase the margins. The need for flexibility to handle the changing business environment is therefore high. Owners and other shareholders of Companies, are in many cases demanding constant profit from investments, sometimes focusing on long-term and occasionally short-term. Hence, either company prevail and handle the challenges, or they perish and go bankrupt or operates an ever-declining business. As pointed out by Bahmu and Sangwan, (2014), most manufacturing

industries in emerging economies are struggling, facing challenges from customer-driven and global competitive markets. Reports from the European Commission, such as the annual report on European small and medium enterprises, stress issues of demanding marketplace financial terrain (European Commission, 2014). Most of the industry sectors have experienced crises which have had impacts and driven the need for change. The textile sector is not different, and as one of the oldest industry actors, it has experienced several crises (European Commission, 2009). Increased competition in the market resulted in the outsourcing of manufacturing to low-wage countries (European Commission, 2009), and in some cases,venerable businesses went bankrupt as a result of changing market demands (Pal, 2013). The textile industry globally has lost one-third of manufactured volume and jobs during a ten-year period starting from 1996 (European Commission, 2009).

However, the textile industry is still among the most significant branches in EU,the representing 6% of the employment in manufacturing and 4. 2% of merchandise exports (Euratex, 2015), establishing it as an essential part of the European economy. The challenges and changes according to Adinolfi& Andersen, (2011) have resulted in structural reforms, focusing among other things on productivity improvements and the introduction of new strategies for the European textile sector. Businesses have pursued cost reduction-oriented strategies; however, this has not been sufficient to halt the declining trend of the textile industry globally. The future challenges with respect to the needed internal changes in most textile sectors are still primarily concerning enhanced productivity as well as human capital (Adinolfi and Andersen, 2011). Most organizations attempt to develop their business, using different methods, tools, and strategies to handle challenges like those presented above. Contemporary research discusses several different concepts to maintain and improve business efficiency. Among these is the lean business system which is one of the most prominent concepts as a way to pursue effectiveness in business processes (see Emiliani*et al. ,* 2003; Nicoletti, 2013). The aim of lean is to be responsive to customer demands by reducing waste in the organization, at the same time pursuing a low cost (Bahmu and Sangwan, 2014). Lean as a concept is, however, more than a cost-cutting strategy and contains both organizational learning and improvement programmes and structures. As pointed out by Petersen, (2009), the lean business system can also support quality improvements and quality structures.

Since its popularization by Womack *et al.* (1990) the lean manufacturing concept has increasingly attracted attention due to the benefits and business improvements researchers, as well as practitioners, teach to the lean business system. Womack *et al.,* (1990) points point undamental differences that made Japanese automakers more competitive than their European and American counterparts. This fact caught the attention of senior management since the performance gap was a business risk. A business pursuing a lean strategy according to Hallgren and Olhager (2009) and Narasimhan *et al.* (2006), will tend to achieve improvements inbusiness performance parameters, such as delivery speed and reliability, and quality and cost resulting in a possible competitive advantage. Shah & Ward, (2003) also suggest that at the global level lean is an advantage. To pursue the lean business system and create a successful lean initiative is however not a simple task. Many corporations fail during the journey since they view a lean business system only as a cost-cutting programme (Mann, 2009). Short-term financial goals established and endorsed by shareholders to cut cost arcostse of the causes of this problem (Emiliani, 2006). Lean business system needs to be adopted as a long-term strategy, changing among others the culture in the organization (Bashin and Burcher, 2006). The involvement of senior management and the way they support the organization are also important factors in the effectiveness of lean business system and can be another source of failure (Halling 2013; Renström, 2014). A fundamental understanding is that there is no standard formula for implementing the lean business system in an organization (Bashin, 2012), and one possible reason is the need for adaptation. Historically, lack of adaptation has been a source of failure according to Dahlgaard and Dahlgaard-Park, (2006) in implementing quality management concepts, such as total quality management. The interest of lean business system is not only connected to automotive and manufacturing, where it has its origin. Other industry sectors have during the previous years started to pursue lean initiatives, e.g., healthcare (Souza, 2009), construction (Jörgensen and Emmitt, 2008) and public sectors among others (Radnor & Walley, 2008). Despite the fact that the textile sector is one of the oldest industries and as mentioned an indispensable component of the European Union's economy (Eurotex, 2015), there is a lack of research exploring lean business system in textile design and production context. Hodges *et al.* (2011) claim that lean business system is not widespread in the textile sector nevertheless applicable in a textile setting. With the textile sector's focus on finding ways to improve productivity and efficiency, unexplored possibilities with lean business system pose an exciting research gap.

The textile sector, in Sweden for instance, has been a subject for outsourcing and off-shoring for several decades. Outsourcing and off-shoring activities change the landscape of the companies. Design, support, and other logistics operations remain, while production is moved. Formerly internal operations are today carried out by other companies and/or in other parts of the world. These issues infer that to work with cost reduction and improvements, other processes than manufacturing needs to be in focus even more. In general, the administrative process or service process of companies often represents a context with immense possibilities for improvements. The application of lean business system beyond a manufacturing context is possible, suggesting possibilities of a transition. The textile sector's need for productivity improvements and a structure to maintain other activities than manufacturing supports the argument that this transition is essential also for the textile industry (Hyer and Wemmerlov, 2002; Tiplady 2010). Elements of lean, such as Total Productive Maintenance (Petersen, 2009) and Just-in-Time (Petersen 2009), have in a manufacturing context been researched, but in their application still pose research gaps. Even if it is clear that a lean initiative needs to cover the whole organization, it is essential to understand how lean elements can be adopted and applied in production contexts to support the transition from a manufacturing context and hence support the implementation of lean in the whole organization. There are still domains within the lean business system that need further investigation, as specified by Marodin and Saurin (2013). Leanproduction aims at maximising customer value while minimising waste (Ohno, 1998). Lean production is lean because it requires less of everything when compared with mass production while allowing the production of a wide

variety of quality products at lower costs (Womack *et al.,* (1991). Leanis based on two fundamental concepts: just-in-time (JIT) and autonomation. JITs basic idea requires that in a production system each production process should only receive the items needed, when needed, in the amount required. Autonomation, or automation with a human touch, refers to giving intelligence to machines and equipment or autonomy to workers to stop production when a problem occurs. Thisaccording to Ohno, (1998) requires that machines and workers should be able to quickly identify abnormal situations, based on standard conditions set for the system, stop production and call for help to prevent reoccurrence of problems. Womack and Jones (1996) presented a set of five (5) principles that combined actions involving different concepts - value, value stream, flow, pull, perfection- present in a Lean system and suggested order for their implementation. Womack and Jones designated this set of principles as Lean Thinking (Womack *et al.,* 1991). According to these authors, the ultimate goal of Lean Thinking is to maximise customer value while minimisingwaste. To accomplish this, a business must look at the activities that create value and at the same time eliminate all other activities. The five Lean Thinking principles that a company needs to implement includes;

- Identify customer value
- Identify the value stream
- Implement flow
- Implement pull
- Seek perfection

These five (5) principles are applied in a sequential order starting with the definition of the customer values. The first principle of Lean Thinking requires the explanation of customer value. This implies identifying the client and understanding what the client is expecting from the product or service and what s/he is willing to pay for. Only then one is able to provide the right product with the right way while reducing or eliminating the waste from the processes. As defined by lean thinkers, waste is anything that consumes resources but does not add value to the product or service from the client's point of view (Liker 2003).

Ohno (1998) identifies seven (7) types of waste that can be found in a production process namely:

- Overproduction or the production of items not required and which accumulate as inventory.
- Time on hand or waiting for inputs from other activities.
- Transportation of parts, materials or equipment.
- Over-processing.
- Stock on hands or inventory.
- Unnecessary movement of workers.
- Producing defective products.

According to Ohno, overproduction should be avoided because it generates inventory, which hides problems in the production system and creates products that are not required by the client. Excessive inventory may concealdifficulties due to fabrication. The second Lean Thinking principle is to identify the value stream. The value stream is all the specified actions that are required to bring a specific product from the conceptual stage until it is delivered to the final customer. The identification of the value stream requires looking at the process to deliver a product or service as a whole, including the work performed by all intervening companies and all handoffs exchanged the process. It is worth noting that the value stream comprises all activities, i.e., value-adding and non-value adding, necessary to deliver a product or service. Once the value stream is identified it can be mapped into a value stream map (VSM). The VSM is a management tool that graphically represents the value stream, with all of its participants for a defined scope of work and allows the visualisation of the flow of materials and information exchanged (Rother, and Shook, 2003). The VSM analysis allows identifying the activities that add value to the process (value-added activities). The events that do not augment any value but are necessary under the current way the product is processed, and activities that do not add any value and can be eliminated because they are not needed to deliver the product (Womack and Jones, 1996). Mapping the entire value stream allows one to shift the focus from improving the performance of isolated activities or processes to enhancingthe whole value stream (Liker 2003). The third Lean Thinking principle is to implement flow, which requires focusing on the product instead of the organisation. Womack and Jones (1996) suggest that companies should focus on the processes necessary to continually deliver the product from start to finish. Thus, making it flow continuously, or as defined by the Lean Lexicon (2008) producing and moving one item at the through a series of processing steps making just what is requested by the next level.

The fourth Lean Thinking principle is to implement pull, i.e. trigger production based on actual demand and conditions. Traditionally, each department or company optimise their own processes or services to produce as much as they can, as fast as they can, and pushes their products or services downstream without considering what the customer really wants at the time of production or what the actual demand is. Implementing pull means that upstream processes only design and produce exactly what customers downstream need when needed, drastically reducing lead times and inventories, and all the waste that overproduction represents. For instance, an excess of inventory, transportation, motion, rework, work-in-process, or late detection of entire batches with defects, to name a few. Implementing pull results from the fundamental concept of JIT, which states that production should be triggered based on actual demand from customers (Ohno 1988). The last principle used to implement Lean Thinking is to seek perfection, or kaizen, the Japanese term for continuous improvement, through a Plan-Do-Check-Act (PDCA) cycle (Liker 2003) Seeking perfection in Lean systems requires transparency, a characteristic of the Lean systems, where everyone can see everything (Womack and Jones 1996) and systems are able to communicate with people, e.g., use of indicators and standards that allow immediate recognition of deviations.

Important lean concepts and terms

This segment presents a list of definitions of lean concepts and terms, commonly used by lean thinkers, which have their roots in the Industrial Engineering field and Quality movement. The listis mostly based on the work developed by the Lean Enterprise Institute (LEI) and presented in the Lean Lexicon (2008).

- ***Batch-and-Queue*** - a mass production approach to operations in which large lots (batches) of items are processed and moved to the next step - regardless of whether they wait in a line (a queue)

- ***Cycle Time*** - how often a part or a product actually is completed by a process, as timed by observation. Similarly, the time it takes an operative to go through all work elements before repeating it.
- ***Five Whys*** - consists of asking why five times every time a problem happens so that the root cause of the problem can be adequately identified and its recurrence can be prevented.
- ***Inventories*** - materials (and information) present along a value stream between processing steps. Inventories can be broadly categorised as raw material (material not yet used during the fabrication process), work in process (work started but not finished)and finished products (products that have all processing steps completed and are ready to be made available to the client).
- ***Plan, Do, Check, Act (PDCA***) - an improvement cycle based on the scientific method of proposing a change in a process, implementing the change, measuring the results, and taking appropriate action.
- ***Production Lead Time (LT***) - the time it takes one piece to move all the way through a process or value stream, from start to finish. Envision timing a marked part as it moves from beginning to end.

Value - the inherent worth of a product as judged by the customer and reflected in its selling price and market demand.

Lean business systems in the textile design context

Narrowing down the scope to a textile context with a focus on textile design there are both similarities and differences with other industry. Manufacturing, especially in the automotive sector, presents a substantial bulk of research, while the textile design context is insufficient (Bhamuand Sangwan, 2014). Bhamuand Sangwan (2014) identify only three relevant publications in the textile area, which suggests that this area is relatively unexplored. The unclear definition of lean may influence this perception, since research categorised as lean, according to some, might not be so by others. Also, Hogde *et al.* (2011) specify that lean is not widespread through textile companies; however, it concludes that lean should be suitable for textile companies and that lean fits both small and large organisations. Since the textile sector in Europe mainly consists of SMEs, adaption to smaller companies is essential. The suggestion that lean fits a textile context is supported by Comm and Mathaisel (2005). They conducted an exploratory survey at a Chinese textile manufacturer with the conclusion that a lean approach is both applicable and likely to improve business performance at the supply chain level. The results from this study fit the general perception of effects associated with lean practices in a business perspective. In terms oflean application and usage in the textile sector, the main discussion exists at supply chain level. Hilletofth and Hilmola (2008) note that lean is adequate for some supply chains in a textile context. These findings are however partly contradicted by Bruce *et al.* (2004), who claim that lean is not a perfect approach for a textile value chain, and Christopher (2000), who contends that the agile concept is suitable in supply chains, fitting the volatile demand patterns in the textile fashion market. Yet Bruce et al. (2004) continue to elaborate that a mix of lean and agile in a mixed supply chain setup would work. A possible interpretation is that lean, although merged with other concepts could also work in a textile context, partly agreeing with Hodges *et al.* (2011). Using the viewpoint of Mason-Jones *et al.* (2000) claiming that lean could be a starting point for agility, the different conclusions could match. With supply chain and business development also, agility will be enabled. However, like in other areas, the effectiveness of textile design and production dimension is missing in the discussion. The study by Hodge *et al.* (2011) discusses parts of the employee perspective as implementation barriers and cultural changes. The model suggests, however, a focus on customer satisfaction and tools similar to those of Stentoft Arlbjørn *et al.* (2011). In this sense, even if there is a suggestion of a fit of a lean framework in textile companies as well as in a supply chain dimension, a gap remains. The human perspective, as discussed among others by Halling and Renstrom (2014), is not present. This fact in relation to reports that suggest that for textile companies, especially SMEs, the human capital is a crucialasset (Adinolfi and Andersen, 2011). Adding the research findings by Edman (2009), that companies with higher employee satisfaction produce better shareholder returns than those with low employee satisfaction, suggests and strengthens the view that both an employee and a business perspective need to be examined to understand the possibilities of lean in a textile context.

Benefits of lean business system implementation

Lean manufacturing focuses on waste reduction, lowering cycle time, reducing defects and reduction of response time and work in progress inventory. All these positively impacts the performance of the organisation. Some of the benefits include the ensuing: (Ahuja and Khamba2008).

- *Reduced cost*: By implementation of Lean Manufacturing organisations can achieve reduced cycle times, increased labour productivity and elimination of bottlenecks and reduced machine downtime can be achieved, and companies can generally significantly increased output with reduced cost from their existing facilities.
- *Reduced lead time*: With the effect of reduced cycle time and work in progress inventory lead time to manufacture and deliver the product is drastically reduced.
- *Waste reduction*: Waste identification and mitigationare one of the primary functions of Lean Manufacturing implementation plan. All the form of waste, i.e. overproduction, defect, transportation, work in progress inventory, over processing, waiting and motion are reduced with Lean manufacturing implementation.
- *Improved productivity* - Improve labour productivity, both by reducing the idle time of workers and ensuring that when workers are working, they are using their effort as productively as possible (including not doing unnecessary tasks or unnecessary motions).
- *Reduced work in progress (WIP) Inventory*: Minimize inventory levels at all stages of production, particularly works-in-progress between production stages. Lower inventories also mean lower working capital requirements.
- *Lower Cycle Times*: Reduce manufacturing lead times and production cycle times by reducing waiting times between processing stages, as well as process preparation times and product/model conversion times.
- *Improved Flexibility*: Have the ability to produce a more flexible range of products with minimum changeover costs and changeover time.
- *Multi-skill worker:* Involvement of worker in various Lean tools, i.e. quality circles, kaizen circle, layout improvement; value stream mapping, set up time reduction

etc. creates a better understanding of processes, machines, material flow among the team and improves core competencies of the worker.

- *Better Utilization of equipment and space*: Use equipment and manufacturing space more efficiently by eliminating bottlenecks and maximising the rate of production through existing equipment, while minimising machine downtime
- *Reduced Defects:* Reduce defects and unnecessary physical wastage, including the excess use of raw material inputs, preventable defects, costs associated with reprocessing defective items, and extraneous product characteristics which are not required by customers.

Lean manufacturing implementation strategies

Lean manufacturing is a philosophy which cannot be implemented instantly, so it requires tolerantly developing understanding within the organisation about lean, starting with smaller projects of lean at tool level, taking guidelines of an expert, making and following the strategy with due course correction in strategy while implementing lean throughout the organisation. Some of the steps are as follows: (Shams et al. 2010).

- *Senior Management Involvement*-For any significant change, support and commitment from top management are vital. It is very much possible that problems will arise when lean implementation progresses, and these issues must be understood and solved by senior management without affecting lean implementation process.
- *Initiate with smaller projects* - the Initialproject must be small so that more resources are utilised, and more chances are for better results with lesser risk moreover people working on a project and around will learn while doing the project. The results will motivate others to follow the same and people will start having faith in lean techniques. So the recommendation is to start with the smaller project at the tool level.
- *Start with limited execution* – Lean implementation should be within limited area during the start so that it can be monitored, corrected and directed for further implementation starting lean all-around the organisation will reduce control and mentoring of people involved in lean implementation. Once movement is gained, it should be spread in other areas.
- *Employ a professional* –Services of a professional mentor should be taken at least at the start. During conversion of a traditionalorganisation to a lean organisation lots of issue will arise and should be handled professionally they can be taken care with the use of an expert.

Obstacles in lean manufacturing implementation

The following may be some obstacles to Lean manufacturing implementation: (Anand and Kodali2009).

- *Lack of management support*: the reason can be pressure from customer side; a competitor is following lean practices or others. In this case, management just starts and does not propel further these results only superficial lean, and neither lean is implemented nor does it get the benefit.
- *Lack of training:*An added aim is lack of clear understanding about lean throughout the organisation. The organisation where knowledge of lean lacks it cannot be implemented.
- *Communication:* Inadequate communication is one of the prime obstacles to lean manufacturing implementation.
- *Resistance to Change*: Resistance to change is ubiquitous phenomena as it increases fear of failure, initial cost, so many of routine liking people donot want to change, and hence it stops the progress of lean implementation.
- *No direct financial advantage*: Lean does not produce any immediateeconomic benefits, but it helps in identification and elimination of waste hence reduction of cost. Lean does not have any financial measure in terms of input and output, sosometimes lean idea is superseded by other organisational priorities.
- *Past failures*: In case of poor launching of Lean is itself significant obstacle. Lack of implementation strategy may lead to lack of faith in whole philosophy.

According to Amateye (2009), the traditional value of smock is central to the people of Northern Ghana especially the Kusasi, Mamprusi, Gonja and the Dagomba who are also identified by their type of textiles art which is usually used for smock locally referred to as 'fugu. 'Smock is one of the cherished traditional apparels of the people of the north and therefore any effort to reactivate indigenous smock weaving centers in West Gonja District is a recipe for sustainable rural development. The smock or Fugu is a product that is exclusive to Ghana, being fully hand woven and as mentioned above, has its origins in the Northern regions. The smock historically served as the traditional wears of people in northern Ghana but has now gotten attention in the entire country and the globe. Smocks traditionally were worn by Chiefs and kingmakers of Northern Ghana. They were also worn during special occasions like festivals and casually in few areas. In these modern times, smock has become designer clothes worn by ordinary Ghanaians hence the need for a lean business system in its design and production. The smockis produced in many towns in Northern part of Ghana, but most of its trading activities are concentrated in Tamale, Bolgatanga and Wa; the regional capitals of Northern, Upper East and Upper West Regions respectively. There are also established smock activities in smaller towns like Yendi, Daboya and many others spread across the three Northern regions. The smock industry according to Tettehfio (2009) has a historical origin and provides the traditional clothing of the people of the North. The smock historically served as the traditional wears of people in northern Ghana but has now gotten attention in the entire country and the globe. Smocks traditionally were worn by Chiefs and kingmakers of Northern Ghana. They were also worn during special occasions like festivals and casually in few areas. In these modern times, smock has become designer clothes worn by Ordinary men, women and children in Ghana and beyond (Adincraft 2015). Fugu or smock is a variety of loose garments sewn from strips of cloth woven on traditional looms in Northern Ghana. The Smocks of Northern Ghana are made of fabrics of pure cotton. Textiles of every country and tradition on earth have its own decorative Textiles (Bhangtana 2009) which make it unique. The smock mostly has white background having captivating colour stripes of different kinds and is not as complicated as the "Kente" (Tettehfio 2009) found in Southern Ghana. Colours generally seen in the "fugu" fabric is formed by the warping design of the cloth with white being predominant. Thisis attributed to indigenous knowledge of the relevance of colours as white colour reflects the sun rays so as to limit the heat generated. The use of white was, therefore, a measure to give comfort to users in the warm savannah climate in Ghana. Tettehfio (2009) specified that

colours mostly used or mixed with white include blue, black and white with an occasional choice of green, red, violet, yellow and brown. Modern-day demands are however expanding the colour choices of smocks to include almost all possible preference of users. Similar to what prevails in many other traditional textiles, smocks also have names that differentiate one weave from another. The names are assigned to different colour combinations. The most popular design is the guinea fowl pattern which is made of a pattern of white and light black or ash mixup. Tettehfio asserts that, apart from the guinea fowl pattern popularly known as "kpankobri", other patterns include: "tupalzie", "kutorfa", "bon-zie", "VIP", "bonsabinli", "cedi", "tupal-sabinli", "sanda". The commonly known ones also include "alkila", "abinmakorla", "obarko", "minister", "Angelina" and many more. There are many other designs and patterns which this study cannot exhaust. These names are mostly based on the colour combinations, event for production, objects, and names of persons and nature of usage. Individual weavers also assign names of their choices to designed patterns based on their own discretion (Chivivi et al. 2014). Smock garments are also made in different styles and lengths with each having its distinct name. Some of the distinct types include; "banaga" (short smock with sleeves), "dansiki" (short smock without sleeves) and "kutunbi" (long outer smock with long sleeves). Combinations of these fugu types with a similar hat are also made and generally referred to as "kutunbi suit" (long outer smock (kutunbi) with long sleeves, short sleeveless inner smock (dansiki), trousers and hat. In some instances, smock goes with some corresponding trousers referred to as "kpakoto" (Chivivi *et al.,* 2014).

The smock industry supply/value chain starts with the cultivation of cotton, mostly grown in rural areas of Northern Ghana. Cotton serves as the primary input transformed to smock textiles. Harvested cotton is turned into strings at homes. Thisis termed as spinning. Aged women mostly do this act. At this stage of smock input supply, women's role in the art of producing smock starts with the planting of the cotton seed and ends with the spinning of harvested cotton into thread. In spinning, great deftness and skill are displayed by old women in the process. The spinning of raw cotton is done on a spindle called "jeni" (Tettehfio, 2009). Value is therefore added to raw cotton at this stage. Modernization is beginning to catch up with this stage of the supply chain. It is virtually extinct in present days as imported synthetic strings are instead preferred to naturally spun ones despite the superior quality of the later. This is due to the inability of the traditional style of string making to supply adequate inputs for the growing industry. More to this, additional value is added to strings by weavers turning strings into smock textiles generally usinghandlooms. This involved the use of techniques of interlacing longer threads known as the warp threads, with a set of crossing threads known as the weft threads. Weavers play essential roles in the smock industry. In general, all weavers in the smock industry are males. Thisaccording to Adu-Agyemand Ross (2008) confirm the male dominance of African textile industries. This is however different from what exists in the traditional weaving industry in Yorubal and where both men and women participate in the cloth weaving process (Ajayi, 2009). The smock weaving sector gives a sense of design to the final product. It is at this stage that the design of the textile is determined. It is mostly based on the discretion of the weaver and to some extent, recommendations and demands by users. This is the final stage which provides the actual smock textile which serves as the inputs to garment section of the industry. Smock textile, in the form of cloth or materials,is transformed into garment customarily called smock or fugu. There are two (2) core actors involved in this stage (smock making) and together referred to as "smock makers/merchants".

The making of the smock garment is done by individuals with the specialities and experience(Esseland Amissah2015). Smock making is mostly carried out at homes or markets or roadside stalls by children or male adults in the form of contract with merchants who themselves are makers. It is done using hand stitching to put together materials to form the garments. Recent trends in the industry are however moving towards the use of sewing machines to perform this task. This is because; the increase in demand patterns of smocks has compelled merchants to use improved technology to support handmade to improve productivity. Actors of the industry, however, believe in the quality of handmadesmocks than machine made. This is because of the techniques and styles used by hand sewing are unique for which the machines are not able to perform. This is also because hand sewing enables smock makers to stitch materials which are thick for which the machines are unable to do. The finished smock products are displayed for sale in several forms in the market. Merchandise of smock products is either by freelance sales or display in market stalls. Supply of smock based on individual consumer demands is also one of the most prevalent ways of smock trade. Recent trends have shown that smocksare sold in conferences and special gatherings in all parts of the country. The current situation, however, reflects that of the kente industry where modernisation and changing social structures have opened up an originally sacred prohibited area to all sexes (Adu-Agyemand Ross2008). Smock trading in the Tamale Metropolis, therefore, includes women who sell smock like any other commodity in the open market.

Sustainability is a necessity and a primary issue of the twenty-first century and is often paired with Corporate Social Responsibility (CSR) (Aguilera et al. 2007), and an emerging green orientation at some companies and informed purchasing decisions (Bansal and Roth 2000). There are many definitions of sustainability. The three commonly used is based on an activity that can be continued indefinitely as well as doing unto others as one expects others to do unto them. And meeting a current generation's needs without jeopardizing the future of unborn generations (Fletcher 2008; Partridge 2011; Report of the World Commission on Environment and Development 1987). According to Seidman (2007) 'sustainability is much more than our relationship with the environment; it's about our relationship with ourselves, our institutions' and society as a whole. Sustainability involves complex and changing environmental dynamics that affect human livelihoods and well-being, with intersecting ecological, economic, and socio-political dimensions, both globally and locally. Organisations are embedded in society and reflect the value they offer community, which raises profound issues. As Beard (2008) notes, 'the difficulty associated with the fashion industry is to recognise how all the component suppliers can be secured ethically and accounted for, together with the labour used to manufacture the garment. Its transport from factory to retail outlet, and ultimately the garment's aftercare and disposal'. Sustainability is defined as the study of how natural systems function, remain diverse and produce everything it needs for the ecology to continue in its scheduled balance. It also acknowledges that human civilisation takes resources to

sustain man's modern way of life (Epa 2016). There are many examples across the history of humanity where civilisation has damaged its own environment and severely affected the very survival of its own (some of which has been explored in Jared Diamond's book Collapse: How Complex Societies Choose to Fail or Survive (Diamond 2005). Sustainability takes into account how humans live in harmony with the natural world, protecting it from damage and destruction. According to academia (2015), humans now live in a modern, consumerist and mostly urban existence and consume a lot of natural resources each day. In urban centres, people consume more power than those who live in rural settings and urban centres use more energy than average, keeping the streets, and civic buildings lit, power appliances, and heating and other public and household power requirements. This does not mean sustainable living only focus on people who live in urban centres. It is estimated that people use about 40% more resources every year than they can put back (Lorek, 2005). Sustainability and sustainable development focus on balancing that fine line between competing needs, i. e. the need to move forward economically and technologically, and the need to protect the environments in which humans live. As Epa (2015) points out, sustainability is not just about the environment; it is also about our health as a community in ensuring that no one suffers because of environmental legislation. The primary purpose of the present study is to analyse the effectiveness of Textile Design and production with Lean Business System for Smock Production in Northern Ghana for Sustainable Development and also to contribute to existing knowledge, regarding the subject area.

METHODOLOGY

Empirical evidence shows that the validity and reliability of information for a study depends to a great extent on the strategies designed and used for the collection of data (Cooper, 1985). For this reason, qualitative research method which allowed close interaction with the respondents and their settings was employed for the study. The strategy included both interview guides and questionnaires. This assisted the researchers to obtain first-hand information of the opinions, attitudes and behaviours of the weavers and sewers of smock.

Population/Sample Technique

The accessible population for the study comprises independent weavers and sewers of smock in the three designated study centres: Tamale, Daboya, andBolgatanga. These were chosen as fair representation of the population for the study in the Northen region. Purposive sample technique was employed to sample out eighty-nine (89) respondents,that is thirty (30) from Tamale,thirty-one (31)from Bolgatanga and twenty-eight (28) from Daboya that provided relevant data for the conduct of the study. The use of purposive sampling technique aided in the selection of respondents who provided relevant and important information for discussion (Leedy and Ormrod, 2005). The respondents selected were mainly weavers and sewers of smock and aged between 30-60 years mainly Men.

Instruments for data collection

The instruments used for data collection were formal interview and questionnaire. The interview guide and questionnaire were developed based upon the following objectives:

1. To explore lean business system and its application in the Ghanaian textiles industry
2. To determine the extent to which textiles industries in Ghana apply lean business system practices for improving manufacturing performance.
3. To examine how the application of lean business system in the textile design and production of smock bring about sustainable development in Northern Ghana.

During the administration of the questionnaire, respondents were assured of anonymity and confidentiality which made them responded positively.

RESULTS AND DISCUSSION

The results of the study have been tabulated and discussed descriptively.

Table 1. Location of data collection

Location	Frequency(n)	Percent (%)
Tamale	30	33. 71
Bolgatanga	31	34. 83
Daboya	28	31. 46
Total	89	100. 00

Source: Fieldwork 2020

The various designations from which the data was collected have been presented in Table 1; from the table 30 (33. 71%) respondents were drawn from the Tamale metropolis whereas 31 representing 34. 83% were also sampled from the Bolgatanga vicinity. The remaining was also taken from the Daboya community making up a total of 89 respondents.

Demography

Table 2. Age distribution of respondents

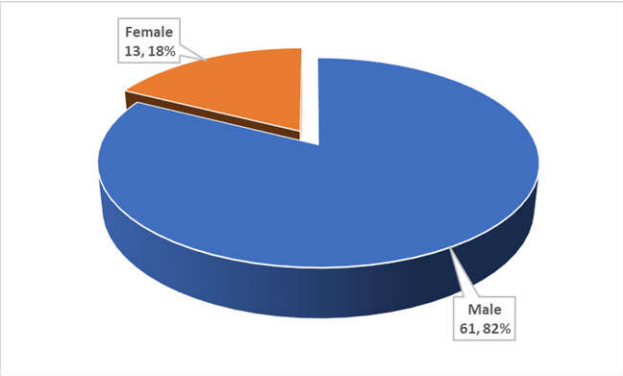
Age	Frequency(*n*)	Percent (%)
< 30 yrs.	11	14. 9
31 - 40 yrs.	27	36. 5
41 - 50 yrs.	26	35. 1
51 - 60 yrs.	10	13. 5
Total	74	100. 0

Source: Fieldwork (2020)

Table: 2 presents the age distribution of the respondents which shows that the majority (n=27, 36. 5%) of the respondents indicated they were between the ages of 31 – 40 years at the time of the study. Additionally, the results show that 26 representing 35. 1% of the respondents pointed out they were aged between 41 – 50 years. It is worth observing that less than 10 per cent of the respondent indicated they were less than 30 years. From the responses, it can be concluded that the smock production industry is dominated by the youth rather than the old aged contrary to previous assertions.

Gender distribution of respondents

Figure 1, displays the gender distribution of the respondents used for the study. The output gives the indication that an overwhelming majority (n=61, 82%) of the respondents were males compared to 13 representing 18% of the respondents who were females. It is evident from the result that the smock production unlike other areas of the fashion industry is rathermale-dominated as more males are involved in the production of smock than females.



Source: Fieldwork (2020)

Figure 1. Distribution of respondents' gender

Table 3. Position

Position	Frequency (*n*)	Percent (%)
Sewer	42	56. 8
Weaver	32	43. 2
Total	74	100. 0

Source: Fieldwork (2020)

Table 3 presents the position or role of the respondents in the smock production industry. The results show that more than half (n=42, 56. 8%) of the respondents were Sewers whereas the 32 representing 43. 2% of the respondents were found to be smock weavers in the metropolis surveyed. This gives the impression that there are fewer weavers than sewers in the areas surveyed and thus can be concluded that the sewing activity represents the primary activity related to smock production carried out in the areas surveyed.

Table 4. Years of experience

Years of experience	Frequency(*n*)	Percent (%)
< 5 yrs.	8	10.8
6 - 10 yrs.	19	25.7
11 - 15 yrs.	28	37.8
16 - 20 yrs.	17	23.0
> 20 yrs.	2	2.7
Total	74	100.0

Source: Fieldwork (2020)

In Table 4 respondents were asked about the years of experience they have acquired working in the smock production industry. From the results, it can be seen that the majority (n=28, 37. 8%) of the respondents indicated they had had 11 – 15 years of working in the smock production business. More so, 19 representing 25. 7% of the respondents also have been working for 6 – 10 years whereas 17 (23%) of the respondents surveyed pointed out they have been in the business for 16 – 20 years. However, it is worth noting that 8 (10. 8%) of the respondents have been working in the industry for not more than 5 years. The trend of the responses gives cause to conclude that most of the respondents have had enough experiences when it comes to the smock production industry hence, appropriate for their inclusion in the study.

Production strategy

Table: 5 presents the descriptive statistics regarding the increasing flexibility when it comes to the production of smock. From the responses, it could be observed that their ability to increase the flexibility of machines and labour used in the production of smock obtained the highest mean score of 2. 95 (±SD=. 594). On the contrary, their ability to accelerate new product introductions had the lowest mean statistics (m=2. 32, ±SD=1. 035) among the variables of the construct. From the overall score for the variable of (m=2. 68, ±SD=0. 85) which suggests that the smock producers in the areas surveyed consider the application of lean practices essential and relevant to their efforts to increase their flexibility in the production of smock.

Table 5. Descriptive statistics on increasing flexibility

Variables	N	Min	Max	Mean	±SD
Reduce cycle time	74	1	4	2.80	.721
Reduce set-up time	74	1	4	2.65	1.052
Increase flexibility of machines and labour	74	1	4	2.95	.594
Accelerate new product introductions	74	1	4	2.32	1.035
Valid N (listwise)	74			2.68	0.85

Strongly Disagree=5, Disagree=4, Don't know=3, Agree=2, Strongly Agree=1
Source: Fieldwork (2020)

Table 6. Increase supplier qualities

Location	Increase supplier quality				Total
	Disagree	Don't Know	Agree	Strongly Agree	
Tamale	7	10	12	1	30
	41.2%	38.5%	48.0%	16.7%	40.5%
Bolgatanga	3	11	9	3	26
	17.6%	42.3%	36.0%	50.0%	35.1%
Daboya	7	5	4	2	18
	41.2%	19.2%	16.0%	33.3%	24.3%
Total	17	26	25	6	74
	23.0%	35.1%	33.8%	8.1%	100.0%

Source: Fieldwork 2020

In Table 6, respondents were asked to indicate whether the application of lean practices and how it can be applied in relation to the textiles industry how it applies to increase supplier quality. The results show that the majority (n=26, 35. 1%) of the respondents stated they didn't have any idea concerning the assertion that the practice of lean business will help them increase their supplier quality. However, 25 representing 33. 8% of the respondents agreed that they the practices could be used to increase their supplier quality. That notwithstanding, the results have been presented in relation to the various locations the data were collected. From the trend of the responses, it can be concluded that most of the respondents did not know that lean business practices will increase their supplier quality.

In Table 7 respondents were asked about how important it is for lean business practices could be adapted to the rates of waste in the production of smocks. From the responses, it could be observed that about half (n=38, 51. 4%) of the respondents pointed out they haveno idea regarding the practice of lean business and its application when it comes to reducing the rate of wastes in the production of smocks in the areas of the study. However, 16 representing 21. 6% of the respondents, on the other hand, agreed to the effects that lean business practices when introduced can reduce the rate of waste in the production of smocks. From the responses, it is obvious that respondents had no idea about the lean business practices.

Presented Table 8 concerns the knowledge of respondents regarding lean business practices and how it can be used to reduce lead time. The trend of the responses gives the indication that close to two-thirds (n=52, 70. 3%) of the respondents stated they don't know how the practice of lean business can reduce lead time.

Table 7. Reduce waste rates

Location	Reduce waste rates					Total
	Strongly Disagree	Disagree	Don't Know	Agree	Strongly Agree	
Tamale	2	4	17	6	1	30
	40.0%	33.3%	44.7%	37.5%	33.3%	40.5%
Bolgatanga	3	7	11	5	0	26
	60.0%	58.3%	28.9%	31.2%	.0%	35.1%
Daboya	0	1	10	5	2	18
	.0%	8.3%	26.3%	31.2%	66.7%	24.3%
Total	5	12	38	16	3	74
	6.8%	16.2%	51.4%	21.6%	4.1%	100.0%

Source: Fieldwork 2020

Table 8. Reduce lead time (lead time: time from raw material to finish goods include all kinds of process steps)

Location	Response scale				Total
	Disagree	Don't Know	Agree	Strongly Agree	
Tamale	2	22	2	4	30
	40.0%	42.3%	25.0%	44.4%	40.5%
Bolgatanga	2	18	2	4	26
	40.0%	34.6%	25.0%	44.4%	35.1%
Daboya	1	12	4	1	18
	20.0%	23.1%	50.0%	11.1%	24.3%
Total	5	52	8	9	74
	6.8%	70.3%	10.8%	12.2%	100.0%

Source: Fieldwork 2018

Table 9. Increase on-time delivery rate

Location	Increase on-time delivery rate				Total
	Disagree	Don't Know	Agree	Strongly Agree	
Tamale	0	15	12	3	30
	.0%	31.9%	57.1%	60.0%	40.5%
Bolgatanga	0	19	6	1	26
	.0%	40.4%	28.6%	20.0%	35.1%
Daboya	1	13	3	1	18
	100.0%	27.7%	14.3%	20.0%	24.3%
Total	1	47	21	5	74
	1.4%	63.5%	28.4%	6.8%	100.0%

Source: Fieldwork 2020

Table 10. Descriptive statistics on Lean Practices reducing costs

Variables	N	Min	Max	Mean	±SD
Reduce stock	74	1	4	3.76	.658
Increase assets utilization (e.g. machines)	74	1	4	2.74	.877
Increase employee productivity	74	1	4	2.39	1.044
Increase capital investment productivity	74	1	4	3.00	1.110
Valid N (listwise)	74			2.97	0.92

Strongly Disagree=1, Disagree=2, Don't know=3, Agree=4, Strongly Agree=5
Source: Fieldwork 2020

However, a total of 17 respondents representing an accumulated percentage of 23% were on the agreement end of the scale. It is worth noting that the responses have been presented in relation to the localities from which the data were collected. More so, the responses have been presented in relation to the location of the respondents. From the outcomes, it can be determined that the respondents have the least knowledge about the rudiments of lean business practices and how they could be applied to reduce lead time in the production of smocks. In Table 9, respondents were asked whether the lean business practices can help them increase on-time delivery rates. The results show that the majority (n=47, 63. 5%) of the respondents stated they have no idea in relation to the lean business practices and how it can be used to increase on-time delivery rates. On the contrary, 21 representing 28. 4% of the respondents agreed that lean business practices could be used to increase the on-time delivery rates. From the responses, it can be concluded that the respondents mostly do not have enough knowledge of the concept of lean business practices.

Table 10 descriptive statistics on how lean practices reduces the costs of production. From the table, it can be seen that reducing stock obtained the least mean score of (m=3. 76, ±SD=. 658) whereas increasing employee productivity obtained the lowest mean score (m=2. 39, ±SD=1. 044). Suggesting that the respondents rated the assertion of lean production practices low on increasing employee productivity. From the overall mean score of the construct of (m=2. 97, ±SD=0. 92) which is approximately 3. 0 in the region of uncertain giving the impression that respondents do not have adequate knowledge and understanding of the concept of lean business practices.

Table 11 presents the descriptive statistics on how the smock producing businesses in the surveyed areas can apply the concept of lean business practices. Analysis of the responses shows that none of the variables obtained mean scores more than the 3. 0 threshold suggesting that most of the responses or ratings were on the disagreement end of the rating scale.

Table 11. Descriptive statistics on how respondents apply the lean business concept in their production processes

Variables	N	Min	Max	Mean	±SD
We have a formal program for keeping our machines and equipment	74	1	4	1.91	.939
Maintenance plans and checklists are posted closely to our machines and maintenance jobs are documented	74	1	4	2.35	.999
We stress good maintenance as a strategy for increasing quality and planning for compliance	74	1	4	2.39	1.057
All potential bottleneck machines are identified and supplied with additional spares parts	74	1	2	1.43	.499
We continuously optimize our program based on dedicated failure analysis.	74	1	2	1.24	.432
Our maintenance department focuses on assisting machine operators to perform their own preventive maintenance.	74	1	4	2.07	1.025
Our maintenance operators are actively involved in the decision-making process when we decide to buy new machines.	73	1	3	2.08	.862
Our machines are mainly maintained internally; we try to avoid external maintenance service as for as possible.	74	1	4	2.78	.781
Our workers strive to keep our machine and environment neat and clean.	74	1	4	2.15	.655
Our machine and environment procedures emphasize putting all tools and fixtures in their place.	74	1	4	2.38	1.056
We have a housekeeping checklist to continuously monitor the condition and cleanness of our machines and equipment.	74	1	4	1.93	.970
Valid N (listwise)	74			2.06	0.84

4=completely, 3=partially, 2=don't know, 1=not at all
Source: Fieldwork 2020

Table 12. Descriptive statistics on the extent of lean business practices

Variables	N	Min	Max	Mean	±SD
We are regularly in close contact with our customers.	74	1	5	2.64	1.485
Our customers frequently give us feedback on quality and delivery performance.	74	1	4	1.64	.674
We regularly survey our customer's requirement	71	1	5	3.30	1.188
We regularly conduct customer satisfaction surveys.	74	2	5	3.89	1.130
On time delivery is our philosophy	74	1	5	4.41	.859
We jointly have improvement programs with our customers to increase our performance.	74	1	5	2.47	1.214
Valid N (listwise)	74			3.06	1.09

Completely=4, Partially=3, Don't know=2, Not at all=1
Source: Fieldwork 2020

TablE 13. Descriptive statistics on the application of lean business practices in reducing set up times

Variables	N	Min	Max	Mean	±SD
We are endlessly working to lower set-up and cleaning times in our equipment	74	1	5	3.34	1.388
We have low set-up times for equipment.	74	1	5	3.04	1.176
We have managed to schedule a great portion of our set-ups so that the regularuptime of our machines is usually not affected.	74	1	5	2.62	1.131
Optimized set-up and cleaning procedures are documented as a best-practice process and rolled-out throughout the whole production	74	1	5	3.84	1.123
There is no significant difference between the design and production of smock with lean business system and those without lean business system	74	1	5	1.96	1.026
The textile design and production with lean business system of smock production can lead to sustainable development	74	1	5	2.77	1.380
Valid N (listwise)	74			2.93	1.20

Strongly Disagree=1, Disagree=2, Don't know=3, Agree=4, Strongly Agree=5
Source: Fieldwork 2020

Reference to the overall mean score obtained by the construct (m=2. 06, ±SD=. 84) also confirming that respondents are not yet exposed to the contemporary concept of lean business practices. In Table 12 the respondents were asked to give their ratings on the extent to which lean business practices are effectively applied in getting customers involved in the textile designs and production of smocks. From the results, it could be seen that only three variables obtained mean scores higher than the 3. 0 threshold. On time delivery is being their philosophy obtained the highest mean score of (m=4. 41, ±SD=. 859) followed by their ability to conduct customer satisfaction surveys regularly. It is worth noting that their customers are frequently giving them feedback on quality and delivery performances obtained the lowest mean score (m=1. 64, ±SD=. 674). However, a reference to the overall mean score of (m=3. 06, ±SD=1. 09) gives the impression that responses for most of the variables centred around the midpoints of the rating scale giving the course to conclude that smock producers lack understanding about lean business practices. It is a well-established notion that the integration of lean business practices into the business activities has the advantage of reducing set up times. Against this background, respondents were asked to rate variables that relate to the benefits in lieu of the application of lean business practices to reduce production set up times. In Table 4. 13 the rating shows that most of the variables obtained mean scores a little above the 3. 0 midpoint. Responses to the assertion that there are no significant differences between the design and production of smock with lean business systems and those without lean business systems obtained the lowest mean score of m=1. 96 (±SD=1. 03) whereas responses to the respondents optimized set-up and cleaning procedures are documented as best-practice process and rolled-out throughout the whole production had the highest mean statistic of (m=3. 84, ±SD=1. 12). From the overall mean statistics (m=2. 93, ±SD=1. 20) it can thus be confirmed the trend of analysis that the smock producers are not privy to the concept of lean business practices.

Conclusion

From the responses, it can be concluded that the smock production industry is dominated by the youth rather than the old aged contrary to previous assertions. Also, smock production in the Northern part of Ghana is a male-dominated industry. Most of the producers have had enough experiences when it comes to the smock production industry. More so it can be that most of the respondents did not know that lean business practices will increase their quality supplies. From the responses, it is obvious that respondents had no idea about the lean business practices. It can be concluded from the result that the respondents have the least knowledge about the rudiments of lean business practices and how they could be applied to reduce lead time in the production of smocks. Smock producers demonstrated their lack of understanding when it comes to the concept of lean business practices, and as a result, there is low level of application of the lean business concept in

the Ghanaian smock textile industry. Tamale smock producers have improved service levels than those in the other surveyed places. Also, Tamale smock producers performed better than Bolgatanga and Daboya smock producers in terms of reducing costs related to the production of smock. The smock producers in the three locations have their unique trend of strengths when it comes to adoption of strategies to improve smock production for sustainable development and that the three locations surveyed have equal opportunities tobenefit from lean business practices which can thus improve smock production. The findings of the study show that the lean manufacturing is not efficiently implemented in t Ghanaian smock texties. This sector lacks understanding of lean manufacturing concepts and therefore have not reahasthe full benefits of lean implementation. Most businesses only focus on a few tools and techniques neglecting others. The textile establishments in Ghana need focuseneedining on lean manufacturing to enable its better understanding. They need to implement lean practices in all areas of production. Another critical element for the successful lean implementation is proprietors'proprietors fortransportation. They need to invest in training the workers and make sure they are involved in the whole process. Most workers show resistance to change hence attention must be given to their change theirchanginget. Incentives must also be given to the workers for their support. The benefits of lean must be shared among all stakeholders. Also, textile firms must be encouraged to benchmark their systemswith world confirmsnfirms. This can help bring rapid improvements in their performance.

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