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Analyses of the Practice of Lean Business System in Textile Design and Production of Smocks in Northern Ghana for Sustainable Development

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Abstract: Lean Production has defeated the judgment of it being another management fad. 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. To continue to be competitive, several textile producers have attempted to advance their manufacturing methods so that they can more easily compete with other international producers. A growing number of industries in emerging countries are executing lean production to generate performance advancements and remain competitive. The current study's central thrust is to analyse the textile design and production effectiveness with the lean business system as a final model of smock production in Northern Ghana. The study employed essential concepts from the theory of constraints and contingency theory organisation design to explain the textile design and production effectiveness with the lean business system of smock production in northern Ghana. An 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 is 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: Analyses, Textile Design Production, Lean System, Sustainable Development

1. Introduction

The textile industry is a dominant source of export and foreign exchange in several developing countries such as Ghana. Textile exports in Ghana in 1992 generated $27.2 million and then increased to 179.7 million in 1994 however, revenue from exports declined consistently [1].

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. In the late 1970s, Ghana was keen on improving its textile industry which contributed significantly to developing the livelihood of Ghanaians. The textile industry employed about 25000 workforces and contributed to 27% of total manufacturing employment in 1997 [2]. However, in recent times the industry is grasping with 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 examples are the Ghana Textile Print (GTP) which had an exceptional manufacturing volume of 30.7 million yards. The weaving and spinning departments of this industry were also shut down laying off most of its workforce.

Also, Ghana Textile Manufacturing Company Limited (GTMC) shut down its production line in December 2005. 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 lean business systems in the Ghanaian textile industry will not only improve customer satisfaction but will also enhance overall organizational efficiency and effectiveness [3].

There is an uncertain financial landscape, and 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 [4]. The innovative structure suggests that organizations have to address performance in domains like maintenance processes and advancement. To address this, many manufacturing sectors, have explored and introduced lean business systems. Research confirms that organizations can increase performance by introducing lean [5]. 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 the primary purpose of the current 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. The owners and other shareholders, 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 [6]. 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 and financial terrain.

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 industrial sectors, it has experienced several crises. Increased competition in the market resulted in the outsourcing of manufacturing to low-wage countries, and in some cases, venerable businesses went bankrupt as a result of changing market demands. The textile industry globally has lost one-third of manufactured volume and jobs during a ten-year period starting from 1996 [7].

However, the textile industry is still among the most significant branches in the EU, representing 6% of the employment in manufacturing and 4.2% of merchandise exports, establishing it as an essential part of the European economy. The challenges and changes 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 [8]. Most organizations attempt to develop their business, by 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. 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. Lean as a concept is, however, more than a cost-cutting strategy and contains both organizational learning and improvement programmes and structures. The lean business system can also support quality improvements and quality structures [9].

The lean manufacturing concept has increasingly attracted attention due to the benefits and business improvements researchers as well practitioners attach to the lean business system [10], the fundamental differences that made Japanese automakers more competitive than their European and American counterparts [11]. This fact caught the attention of senior management since the performance gap was a business risk. A business pursuing a lean strategy will tend to achieve improvements on business performance parameters, such as delivery speed and reliability, quality and cost resulting in a possible competitive advantage [12].

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 the lean business system only as a cost-cutting programme [13]. Short-term financial goals established and endorsed by shareholders to cut costs are one of the causes of this problem. A lean business system needs to be adopted as a long-term strategy, changing among others the culture in the organization [14]. The involvement of senior management and the way they support the organization are also important factors in the effectiveness of lean business systems can be another source of failure [15].

A fundamental understanding is that there is no standard formula for implementing the lean business system in an organization, and one possible reason is the need for adaptation. Historically, lack of adaptation has been a source of failure in implementing quality management concepts, such as total quality management [16]. The interest in lean businesystemstem 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, construction and public sectors among others [17].

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, there is a lack of research exploring lean business systems in the textile design and production context [18]. Claim that lean business system is not widespread in the textile sector nevertheless applicable in a textile set. With the textile sector's focus on finding ways to improve productivity and efficiency, unexplored possibilities with lean business systems pose an exciting research gap.

The textile sector, in Sweden for instance, has been a subject of outsourcing and off-shoring for several decades. Outsourcing and off-shoring activities change the landscape of 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 need 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 [19]. The application of lean business systems 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. Elements of lean, such as Total Productive Maintenance and Just-in-Time, have in a manufacturing context been researched, but their application still possesses 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 [20]. Lean production aims at maximising customer value while minimising waste, 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, it is also based on two fundamental concepts: just-in-time (JIT) and autonomation [21]. JIT's 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 [22]. This 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 the reoccurrence of problems [23]. 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 were propounded by [24]. The ultimate goal of Lean Thinking is to maximise customer value while minimising waste. 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 include;

1) Identify customer value.
2) Identify the value stream.
3) Implement flow.
4) Implement pull.
5) 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 an 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 in 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 [25].

Seven (7) types of waste can be found in a production process namely:

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

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 conceal difficulties due to fabrication [26]. 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 during the process [27]. 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 [28]. The VSM analysis allows for 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 can be eliminated because they are not needed to deliver the product [29].

Mapping the entire value stream allows one to shift the focus from improving the performance of isolated activities or processes to enhancing the whole value stream [30]. The third Lean Thinking principle is to implement flow, which requires focusing on the product instead of the organisation; 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 [31], producing and moving one item at a time 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 it can, as fast as it can, and pushes its 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 [32]. 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. Seeking perfection in Lean systems requires transparency, a characteristic of Lean systems, where everyone can see everything and systems are able to communicate with people, e.g., the use of indicators and standards that allow immediate recognition of deviations [33].

1.1. 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 list is mostly based on the work developed by the Lean Enterprise Institute (LEI) and presented in the Lean Lexicon [34].

1) *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).
2) *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.
3) *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.
4) *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).
5) *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.
6) *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 is 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.

1.2. 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 industries. Manufacturing, especially in the automotive sector, presents a substantial bulk of research, while the textile design context is insufficient [35]. Three relevant publications in the textile area, suggest 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. Lean is not widespread among 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 [36]. 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 from a business perspective. In terms of lean application and usage in the textile sector, the main discussion exists at the supply chain level [37]. Lean is adequate for some supply chains in a textile context, these findings are however partly contradicted by [38], who claim that lean is not a perfect approach for a textile value chain, and [39], contends that the agile concept is suitable in supply chains, fitting the volatile demand patterns in the textile fashion market.

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 [40]. Using the viewpoint of [41] 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 the textile design and production dimension is missing in the discussion. The study by [42] 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 [43]. 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 [44], is not present. This fact in relation to reports that suggest that for textile companies, especially SMEs, human capital is a crucial asset, adding to the research findings 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 [45].

1.3. 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 impact the performance of the organisation. Some of the benefits include the ensuing: [46].

1) *Reduced cost*: By implementing 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 increase output with reduced cost from their existing facilities.
2) *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.
3) *Waste reduction*: Waste identification and mitigation are one of the primary functions of the Lean Manufacturing implementation plan. All the forms of waste, i.e. overproduction, defect, transportation, or work–in–progress entry, processing waiting motion are reduced with Lean manufacturing implementation.
4) *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).
5) *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.
6) *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.
7) *Improved Flexibility*: Have the ability to produce a more flexible range of products with minimum changeover costs and change over time.
8) *Multi-skill worker:* Involvement of workers 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 and material flow among the team and improves core competencies of the worker.
9) *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.
10) *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.

1.4. 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 the 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: [47].

1) *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 the lean implementation process.
2) *Initiate with smaller projects* - the Initial project 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.
3) *Start with limited execution* – Lean implementation should be within a 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 to other areas.
4) *Employ a professional* –Services of a professional mentor should be taken at least at the start. During the conversion of a traditional organisation to a lean organisation, lots of issues will arise and should be handled professionally they can be taken care of with the use of an expert.

1.5. Obstacles in Lean Manufacturing Implementation

The following may be some obstacles to Lean manufacturing implementation: [48].

1) *Lack of management support*: the reason can be pressure from the 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.
2) *Lack of training:* An added aim is a lack of clear understanding about lean throughout the organisation. The organisation where knowledge of lean lacks it cannot be implemented.

3) *Communication:* Inadequate communication is one of the prime obstacles to lean manufacturing implementation.
4) *Resistance to Change*: Resistance to change is ubiquitous phenomenon as it increases fear of failure, and initial cost, so and many of routine liking people do not want to change, and hence it stops the progress of lean implementation.
5) *No direct financial advantage*: Lean does not produce any immediate economic benefits, but it helps in the identification and elimination of waste hence reduction of costs. Lean does not have any financial measure in terms of input and output, so sometimes lean idea is superseded by other organisational priorities.
6) *Past failures*: In case of poor launching of Lean is itself a significant obstacle. A Lack of implementation strategy may lead to a lack of faith in the whole philosophy.

The traditional value of smock is central to the people of Northern Ghana especially the Kusasi, Mamprusi, Gonja and Dagomba who are also identified by their type of textiles art which is usually used for smock locally referred to as 'fugu.' The Smock is one of the cherished traditional apparel of the people of the north and therefore any effort to reactivate indigenous smock weaving centres 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 wear of people in northern Ghana but has now gotten attention in the entire country and the globe. Smocks traditionally wear were worn by Chiefs and kingmakers of Northern Ghana. They were also worn during special occasions like festivals and casually in few areas [49]. 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 smock is produced in many towns in the 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 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 [50]. 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 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" [51] found in Southern Ghana. Colours generally seen in the "fugu" fabric is formed by the warping design of the cloth with white being predominant. This is 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. The specified 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 preferences of users [52]. 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", "abin makorla", "obarko", "minister", "Angelina" and many more. There are many other designs and patterns that this study cannot exhaust. These names are mostly based on the colour combinations, events for production, objects, names of persons and nature of usage. Individual weavers also assign names of their choices to designed patterns based on their own discretion [53]. 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, a smock goes with some corresponding trousers referred to as "kpakoto" [54].

Key actors involved in the supply of smock products are discussed. A discussion on its supply/value chain is therefore presented along with actors at each stage. 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. This is 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" [55]. 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 using handlooms. 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. This confirms the male dominance of African textile industries. This is however different from what exists in the traditional weaving industry in Yoruba land where both men and women participate in the cloth weaving process [56]. 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 the garment section of the industry. Smock textile, in the form of cloth or materials, is transformed into a 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 an individual’s specialities and experience. Smock-making is mostly carried out at homes or markets or roadside stalls by children or male adults in the form of contracts 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 handmade smocks more than machine-made. This is because the techniques and styles used by hand sewing are unique which the machines are not able to perform. This is also because hand sewing enables smock makers to stitch materials which are thick 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 smocks based on individual consumer demands is also one of the most prevalent ways of smock trade. Recent trends have shown that smocks are sold at 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. Smock trading in the Tamale Metropolis, therefore, includes women who sell smocks like any other commodity in the open market [57].

Sustainability is a necessity and a primary issue of the twenty-first century and is often paired with Corporate Social Responsibility (CSR), an emerging green orientation at some companies and informed purchasing decisions. There are many definitions of sustainability. The three commonly used are 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. Sustainability is much more than our relationship with the environment; it’s about our relationship with us, 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 the community, which raises profound issues [58].

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 [59]. 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 have been explored in Jared Diamond's book Collapse: How Complex Societies Choose to Fail or Survive. Sustainability takes into account how humans live in harmony with the natural world, protecting it from damage and destruction. 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, heating and other public and household power requirements. This does not mean sustainable living only focuses on people who live in urban centres. It is estimated that people use about 40% more resources every year than they can put back [60]. 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. 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 a Lean Business System for Smock Production in Northern Ghana for Sustainable Development and also to contribute to existing knowledge, regarding the subject area.

2. Methods

2.1. 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. For this reason, the 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 on the opinions, attitudes and behaviours of the weavers and sewers of smock.

2.2. Population/Sample Technique

The accessible population for the study comprises independent weavers and sewers of smock in the three designated study centres: Tamale, Daboya, and Bolgatanga. These were chosen as fair representations of the population for the study in the Northern region. The 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 selection of respondents which provided relevant and important information for discussion. The respondents selected were mainly weavers and sewers of smock and aged between 30-60 years mainly Men.

2.3. Instruments for Data Collection

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

1) To reconnoitre how lean business system, principles, and methods, from a textile production perspective, can benefit textile design and production of smock in northern Ghana for sustainable development.
2) To propose appropriate techniques for enhancing the effectiveness of the design and production of the smock with the lean business system as a final model of production in northern Ghana questionnaire administration, respondents were assured of anonymity and confidentiality, making them respond confidentiality which made them responded positively.

3. Result and Discussion

A good number of research papers have been written on smocks and their mode of production in Ghana, typical amongst them are those written by Dzramedo et al. and Abdul-Rahim et al. on topics such as; Challenges and sustainability of smock weaving within the West Gonja District of the Northern Region and The Smock: Exploring an indigenous industry in Tamale Metropolis of Northern Ghana respectively. Although, these authors ascertain smock weaving in Northern Ghana as a potential economic activity, they have not linked them to the best business practices in the design and production processes to ensure sustainability. It was observed that, producers of smocks in Northern Ghana have no idea of the lean business approach as the best practice which aims at increasing performance in the design and production of smocks by ensuring effectiveness in business with reduction of waste and maximizing profit, which the study is targeted at.

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; 30 respondents (33.71%) 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.

4. Mathematical Related Analysis

Table 2. *Run Kendal's coefficient on the lean business production strategy.*

Variables	Mean Rank
Reduce stock	10.18
Increase capital investment productivity	7.55
Increase on-time delivery rate	7.43
Reduce waste rates	7.05
Increase flexibility of machines and labour	6.71
Increase assets utilization (e.g. machines)	6.26
Reduce cycle time	6.22
Reduce lead time (lead time: time from raw material to finish goods include all kinds of process steps)	6.21
Reduce set-up time	5.94
Increase employee productivity	5.09
Accelerate new product introductions	4.93
Increase supplier quality	4.43

Kendall's W^a=.210, χ^2=170.567, df=11, Sig = .001
Source: Fieldwork 2020.

In Table 2, Kendall's coefficient of concordance for ranks (W^a) which estimates agreements between 3 or more respondents as they rank some subjects according to a set of characteristics was used to rank the lean business production strategies. From the table it could be observed reducing stock obtained the highest mean rank (Km=10.18) and hence ranked first with Increase capital investment productivity being ranked the second highest (Km=7.55). However, increasing supplier quality obtained the lowest mean rank (Km=4.43).

Respondents $\chi^2(11, N=74) = .210$, $p = .001$ did not differ much in their responses to the effectiveness of vehicle management and a Kendal coefficient value (W^a=170.567) indicates less unanimity among the various respondents in their responses to the lean business production strategies.

Table 3. *Kendall's coefficient on the extent the textile industry applies lean business system to improve manufacturing performance.*

Variables	Mean Rank
Our machines are mainly maintained internally; we try to avoid external maintenance service as for as possible.	6.32
Maintenance plans and checklists are posted closely to our machines and maintenance jobs are documented	5.27
We emphasize proper maintenance as a strategy for increasing quality and planning for compliance	5.16
Our maintenance operators are actively involved in the decision-making process when we decide to buy new machines.	4.78
Our maintenance department focuses on assisting machine operators to perform their own preventive maintenance.	4.54
We have a formal program for keeping our machines and equipment	4.18
All potential bottleneck machines are identified and supplied with additional spares parts	3.12
We continuously optimize our program based on dedicated failure analysis.	2.62

Kendall's W^a=.278, χ^2=142.131, df=7, Sig = .001
Source: Fieldwork 2020.

In Table 3 Kendall's coefficient of concordance test was run to assess the extent the textile industry applies lean business systems to improve manufacturing performance. From the table, it could be observed that the assertion that their machines are mainly maintained internally; as they try to avoid external maintenance service as far as possible obtained the highest ranking (m=6.32) indicating a high level of agreement among the respondents on the item. However, the initiative to optimize their program based on dedicated failure analysis, on the other hand, had the least ranking (m=2.62) which showed that there was rather a low level of unanimity in relation to the question.

Reference to Kendall's coefficient (W^a) $\chi^2(11, N=74) = .278$, $p = .001$ gives an indication of a weak level of unanimity among the respondents in relation to the constructs measures the extent of application of the lean business system in the textile industry in Ghana. It can thus be concluded that there is a low level of application of the lean business concept in the Ghanaian textile industry.

Table 4. *Kendall's coefficient on customer involvement.*

	Mean Rank
On time delivery is our philosophy	5.00
We regularly conduct customer satisfaction surveys.	4.54
We regularly survey our customer's requirement	3.72
We are regularly in close contact with our customers.	2.94
We jointly have improvement programs with our customers to increase our performance.	2.89
Our customers frequently give us feedback on quality and delivery performance.	1.91

Kendall's W^a = .436, χ^2=152.521, df=5, Sig = .001
Source: Fieldwork 2020.

Table 4 presents Kendall's coefficient on customer involvement in the smock production processes. From the responses, it could be observed that the variable on-time delivery is our philosophy attained the highest Kendall's mean score of (m=5.00) hence ranked first. This was followed by the item 'we regularly conduct customer satisfaction surveys also obtaining (m=4.54) which was then ranked second. It is worth noting that customer's frequently giving them feedback on quality and delivery performances obtained the least mean ranking (m=1.9). Again, a reference to Kendall's coefficient of concordance on the variables showed that there was a close to moderate level of agreement among the respondents on the involvement of customers in the smock production processes.

Kendall's coefficient of concordance was run on how the lean business system influences textile design as well as the production of smocks. The outcome shows that seeking optimized set-up and cleaning procedures are documented as best practice process and rolled-out throughout the whole production system obtained the highest mean score (m=4.66) whereas the question on the absence of significant differences between the design and production of the smock with lean business system and those without lean business systems obtained the least mean score of (m=2.33).

Kendall's coefficient of $\chi^2(5, N=74) = 77.062$, p = .001 did not differ much in their responses to the benefits of the lean business system and its impact on textile design, particularly in the production of smock. However, the Kendal coefficient value (W = .208) indicates a less level of agreement among the various respondents in their responses to the benefits of the lean business system to textile design and the production of smocks.

Table 5. *Kendall's coefficient on how lean business system benefits industry.*

Variables	Mean Rank
Optimized set-up and cleaning procedures are documented as a best-practice process and rolled-out throughout the whole production	4.66
We are endlessly working to lower set-up and cleaning times in our equipment	3.94
We have low set-up times for equipment.	3.67
The textile design and production with lean business system of smock production can lead to sustainable development	3.27
We have managed to schedule a significant portion of our set-ups so that the regular uptime of our machines is usually not affected.	3.14
There is no significant difference between the design and production of smock with lean business system and those without lean business system	2.33

Kendall's W^a = .208, χ^2=77.062, df=5, Sig = .001
Source: Fieldwork 2020.

Table 6. *ANOVA on Lean Business Systems and its application.*

		Sum of Squares	df	Mean Square	F	Sig.
Reduce cycle time	Between Groups	.122	1	.122	.232	.020
	Within Groups	37.838	72	.526		
	Total	37.959	73			
Reduce set-up time	Between Groups	.277	1	.277	.248	.620
	Within Groups	80.588	72	1.119		
	Total	80.865	73			
Increase flexibility of machines and labour	Between Groups	1.004	1	1.004	2.917	.092
	Within Groups	24.780	72	.344		
	Total	25.784	73			
Accelerate new product introductions	Between Groups	.021	1	.021	.020	.001
	Within Groups	78.195	72	1.086		
	Total	78.216	73			

Source: Fieldwork 2020.

The one-way analysis of variance (ANOVA) was employed to determine whether there are any statistically significant differences between the means of two or more independent groups. Table 6 presents the ANOVA statistics on lean business systems and its application in the smock production business. The analysis was conducted based on the locations from which the data were collected. The results show that statistics on lean business reducing cycle time acceleration of new product introductions showed statistically significant ($p < .05$) differences in mean values between the three different groups surveyed based on their respective locations. Furthermore, it could observe that on all four variables sum of squares within groups posted more significant mean scores than the mean scores between groups.

Table 7. *Multiple Comparisons: Tukey HSD on Lean Business Systems and its application.*

Dependent Variable	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Reduce cycle time	Tamale	Bolgatanga	-.185	.195	.612	-.65	.28
		Daboya	-.133	.217	.812	-.65	.39
Reduce set-up time	Tamale	Bolgatanga	.300	.284	.543	-.38	.98
		Daboya	.189	.316	.821	-.57	.94
Increase supplier quality	Tamale	Bolgatanga	-.228	.244	.619	-.81	.36
		Daboya	.178	.271	.790	-.47	.83
Reduce waste rates	Tamale	Bolgatanga	.308	.234	.391	-.25	.87
		Daboya	-.444	.260	.209	-1.07	.18
Increase on-time delivery rate	Tamale	Bolgatanga	.041	.157	.963	-.34	.42
		Daboya	.456*	.175	.030	.04	.87

*. The mean difference is significant at the 0.05 level.
Source: Fieldwork 2020.

From the results in Table 7, it could be observed that there are statistically significant differences between the groups as a whole. The Multiple Comparisons Table shows which groups differed from each other. The results showed increase on-time delivery rate showed significant values among the rest of the variables. The Tukey post hoc test is generally the preferred test for conducting post hoc tests on a one-way ANOVA. A Tukey post hoc test revealed that the mean scores between Tamale smock producers and those of Daboya were statistically significantly higher (.456*, p = .030). There was no statistically significant difference between the Tamale and Bolgatanga and advanced groups (.041, p = .963).

Table 8. *ANOVA on Lean Business Systems and its application on increasing quality.*

		Sum of Squares	df	Mean Square	F	Sig.
Increase supplier quality	Between Groups	.304	1	.304	.364	.548
	Within Groups	60.290	72	.837		
	Total	60.595	73			
Reduce waste rates	Between Groups	2.474	1	2.474	2.948	.030
	Within Groups	60.405	72	.839		
	Total	62.878	73			

Source: Fieldwork 2020.

Results in Table 8, shows the outcome of the analysis of variance on lean business systems and their application on increasing quality. From the output of the ANOVA analysis and whether there is a statistically significant difference between the group (location of the data collection) means. It could be seen that the significance value is (p=.030), which is below 0.05. and, consequently, there is a statistically significant difference in the mean scores between the three groups surveyed particularly when it comes to the application of lean business processes. However, it is worth noting this outcome fails to show which group differed among the three locations surveyed. The Multiple Comparisons table which contains the results of the Tukey post hoc test is used to show the individual group means to indicate which group differed from the other.

Table 9. *Multiple Comparisons: Tukey HSD analysis on Lean Business Systems and its application on increasing quality.*

Dependent Variable	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Increase supplier quality	Tamale	Bolgatanga	-.228	.244	.619	-.81	.36
		Daboya	.178	.271	.790	-.47	.83
Reduce waste rates	Tamale	Bolgatanga	.308	.234	.391	-.25	.87
		Daboya	-.444	.260	.209	-1.07	.18

*. The mean difference is significant at the 0.05 level.
Source: Fieldwork 2020.

Presented in Table 9, concerns the multiple comparisons table on the Tukey HSD analysis on the lean business systems and its application on increasing quality. From the results, it could be observed that on increasing supplier quality Tamale smock producers had low mean recordings than those in Bolgatanga (-.228, ± .244) but larger mean score than the producers in Daboya (.178, ± .271). However, it is further observed that on the note of reduction in waste rates Tamale smock producers had high mean scores than Bolgatanga producers, but lower mean scores compared to the Daboya smock producers (.444, ± .260). It is worth noting that none of the mean differences showed was significant; suggesting that the differences between the responses given by the producers in these three centres did not differ significantly.

In Table 10, the analysis of variance on lean business systems and its application on increasing quality of smock production. From the table, it can be seen that none of the differences observed between and within the groups posted any statistically significant F statistic. The results for the option to reduce the lead time (F(1.310, p = .256) compared to the mean differences between and within groups on the increase in-time delivery rates which was also not significant (F(.043, p = .837). It is worth noting that this fails to recount the direction of the differences between and within the groups.

Presented in Table 11 concerns the multiple comparisons table on the Tukey HSD analysis on the lean business systems and its application on increasing service level as a result of lean business practices. From the results, it could be seen that on increasing service level Tamale smock producers obtained low ratings compared to producers in both Bolgatanga and Daboya (-.041) and (-.011) respectively. However, producers in Tamale had higher mean scores than those in the remaining two other places (.41) and (.456) respectively; suggesting Tamale had improved service levels than those in the other places.

Table 10. *ANOVA on Lean Business Systems and its application on increasing quality.*

		Sum of Squares	df	Mean Square	F	Sig.
Reduce lead time (lead time: time from raw material to finish goods include all kinds of process steps)	Between Groups	1.190	1	1.190	1.310	.256
	Within Groups	65.405	72	.908		
	Total	66.595	73			
Increase on-time delivery rate	Between Groups	.016	1	.016	.043	.837
	Within Groups	27.119	72	.377		
	Total	27.135	73			

Source: Fieldwork 2020.

Table 11. *Multiple Comparisons: Tukey HSD analysis on Lean Business Systems and its application on increasing service level.*

Dependent Variable	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Reduce lead time (lead time: time from raw material to finish goods include all kinds of process steps)	Tamale	Bolgatanga	-.041	.209	.979	-.54	.46
		Daboya	-.011	.232	.999	-.57	.54
Increase on-time delivery rate	Tamale	Bolgatanga	.041	.157	.963	-.34	.42
		Daboya	.456*	.175	.030	.04	.87

*. The mean difference is significant at the 0.05 level.
Source: Fieldwork 2020.

Table 12. *ANOVA on Lean Business Systems and its application on reducing costs.*

		Sum of Squares	df	Mean Square	F	Sig.
Reduce stock	Between Groups	.034	1	.034	.077	.782
	Within Groups	31.588	72	.439		
	Total	31.622	73			
Increase assets utilization (e.g. machines)	Between Groups	.979	1	.979	1.278	.262
	Within Groups	55.143	72	.766		
	Total	56.122	73			
Increase employee productivity	Between Groups	.117	1	.117	.106	.745
	Within Groups	79.518	72	1.104		
	Total	79.635	73			
Increase capital investment productivity	Between Groups	2.698	1	2.698	2.225	.140
	Within Groups	87.302	72	1.213		
	Total	90.000	73			

Source: Fieldwork 2020.

In Table 12 ANOVA tests have been conducted on lean business systems and its application in reducing costs. From the results, differences were observed between and within the groups used for the tests. However, there were no statistically significant F-statistics for any of the items measured. The table does not show the extent of differences observed between the means. This is presented in the table below.

Table 13. *Multiple Comparisons: Tukey HSD analysis on Lean Business Systems and its application on reducing cost.*

Dependent Variable	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Reduce stock	Tamale	Bolgatanga	.069	.179	.921	-.36	.50
		Daboya	.078	.199	.919	-.40	.55
Increase assets utilization (e.g. machines)	Tamale	Bolgatanga	.113	.237	.883	-.46	.68
		Daboya	-.067	.264	.966	-.70	.57
Increase weaver/sewer productivity	Tamale	Bolgatanga	-.508	.268	.149	-1.15	.14
		Daboya	.356	.299	.463	-.36	1.07
Increase capital investment productivity	Tamale	Bolgatanga	-.010	.300	.999	-.73	.71
		Daboya	.289	.333	.663	-.51	1.09

*. The mean difference is significant at the 0.05 level.
Source: Fieldwork 2020.

Presented in Table 13 concerns the multiple comparisons table on the Tukey HSD analysis on the lean business systems and its application on reducing costs as a result of the lean business practices. The results evidence that in reference to reducing stock Tamale producers obtained a higher mean statistic than those in Bolgatanga and Daboya (m=.069) and (.078) respectively. Meanwhile, the result further showed that with regards to increasing assets utilization again, Tamale smock producers had better utilization of assets than Bolgatanga (.113) smock producers, but Daboya producers were better (-.067) whereas regarding increasing employee productivity Tamale smock producers were better than those of Daboya, but Bolgatanga smock producers posted a better statistic of increasing weaver/sewer productivity. It could be further noted that regarding increased capital investment productivity Tamale smock producers had a better score than the Daboya producers, but Bolgatanga had better investment capital than the other two. From the results, it can be concluded that Tamale smock producers performed better than Bolgatanga and Daboya smock producers in terms of reducing costs.

Table 14. *Multiple Comparisons: Tukey HSD analysis on Lean Business Systems and its application on improving smock production performance.*

Dependent Variable	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
We have a formal program for keeping our machines and equipment	Tamale	Bolgatanga	.182	.251	.750	-.42	.78
		Daboya	.400	.280	.331	-.27	1.07
Maintenance plans and checklists are posted closely to our machines and maintenance jobs are documented	Tamale	Bolgatanga	.408	.266	.281	-.23	1.04
		Daboya	.433	.295	.313	-.27	1.14
We emphasize good maintenance as a strategy for increasing quality and planning for compliance	Tamale	Bolgatanga	.541	.277	.131	-.12	1.20
		Daboya	.622	.308	.114	-.11	1.36
All potential bottle neck machines are identified and supplied with additional spares parts	Tamale	Bolgatanga	-.144	.130	.517	-.46	.17
		Daboya	.211	.145	.319	-.14	.56
We continuously optimize our program based on dedicated failure analysis.	Tamale	Bolgatanga	.079	.115	.769	-.20	.35
		Daboya	-.156	.128	.447	-.46	.15
Our maintenance department focuses on assisting machine operators to perform their own preventive maintenance.	Tamale	Bolgatanga	.133	.278	.881	-.53	.80
		Daboya	.078	.309	.966	-.66	.82
Our maintenance operators are actively involved in the decision-making process when we decide to buy new machines.	Tamale	Bolgatanga	-.622*	.222	.018	-1.15	-.09
		Daboya	-.554	.247	.071	-1.14	.04
Our machines are mainly maintained internally; we try to avoid external maintenance service as for as possible.	Tamale	Bolgatanga	-.395	.206	.142	-.89	.10
		Daboya	-.322	.230	.345	-.87	.23
Our workers strive to keep our machine and environment neat and clean.	Tamale	Bolgatanga	-.479*	.166	.014	-.88	-.08
		Daboya	-.467*	.185	.037	-.91	-.02
Our machine and environment procedures emphasize putting all tools and fixtures in their place.	Tamale	Bolgatanga	-.526	.280	.152	-1.19	.14
		Daboya	-.111	.311	.932	-.86	.63
We have a housekeeping checklist to continuously monitor the condition and cleanness of our machines and equipment.	Tamale	Bolgatanga	-.154	.254	.818	-.76	.45
		Daboya	.500	.283	.188	-.18	1.18

*. The mean difference is significant at the 0.05 level.

Table 14 presents the multiple comparison results of Tukey HSD analysis on variables that sought to measure the strategies the smock producers adopt to improve production. Reference to the utilization of formal programs for maintaining their machines and equipment showed that Tamale had a high mean score than what was recorded at Bolgatanga and Daboya.

Furthermore, it could be observed that on the maintenance plans and checklists posted closely to their machines and maintenance jobs being documented again, Tamale had high ratings than it did in the two other locations. That notwithstanding, emphasising good maintenance as a strategy for increasing quality and planning for compliance; the smock producers in Tamale had better strategies for dealing with the increasing demands for quality and planning for compliance than it is being practised in Bolgatanga and Daboya.

Additionally, the assertion that all potential bottleneck machines and implements are identified and supplied with additional spare parts showed that Bolgatanga had higher mean scores than their counterparts in Tamale and Daboya. This then suggests that when it comes to identifying bottlenecks and dealing with them, Bolgatanga smock producers are quicker to act than the producers in Tamale and Daboya.

In relation to the application of tools of the trade, it could be observed that Bolgatanga recorded higher mean scores than those at Tamale and Daboya. This, suggests that Tamale smock centre performs poorly in relation to their tools operators being actively involved in the decision-making processes when they decide to acquire new sets.

On the machines and tools for production being maintained internally, the results show that Tamale again performed poorly on the measuring scale as it obtained relatively lower mean scores compared to those recorded for Bolgatanga and Daboya smock producers. That notwithstanding it can be concluded that Bolgatanga and Daboya smock producers have a better strategy for dealing with maintenance tools operators by keeping them actively involved in the decision-making process when they decide to buy new tools and equipment.

More so, when the respondents were asked to rate on how they handle maintenance; the results showed the difference in mean scores between the three locations surveyed. The results indicated that Tamale smock producers had less mean scores compared to the ratings in Bolgatanga and Daboya. This shows that Bolgatanga and Daboya smock producers have better strategies to maintain their tools of trade.

Furthermore, when the respondents were asked about having a housekeeping checklist to continuously monitor the condition and cleanliness of their tools and equipment the ratings showed that Tamale smock producers had higher mean scores than the producers in Daboya but less than those at Bolgatanga. From the results, it could be determined that the management of maintenance of tools of the trade by the smock producers in the three designated study areas indicated that they all have varied ways of handling their maintenance of trade particularly with varying strengths in comparison.

Table 15. *Multiple Comparisons: Tukey HSD analysis on how lean business system is effectively applied in terms of textile design and production of smock production for sustainable development.*

Dependent Variable	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
We are frequently in close contact with our clients.	Tamale	Bolgatanga	-.410	.401	.565	-1.37	.55
		Daboya	.218	.445	.876	-.85	1.28
Our customers frequently give us feedback on quality and delivery performance.	Tamale	Bolgatanga	.128	.182	.762	-.31	.56
		Daboya	-.056	.202	.959	-.54	.43
We regularly survey our customer's requirement	Tamale	Bolgatanga	-.503	.325	.276	-1.28	.28
		Daboya	-.148	.360	.911	-1.01	.72
We regularly conduct customer satisfaction surveys.	Tamale	Bolgatanga	.164	.306	.854	-.57	.90
		Daboya	-.067	.340	.979	-.88	.75
On time delivery is our philosophy	Tamale	Bolgatanga	-.028	.232	.992	-.58	.53
		Daboya	.156	.259	.820	-.46	.77
We jointly have improvement programs with our customers to increase our performance.	Tamale	Bolgatanga	-.147	.327	.895	-.93	.64
		Daboya	-.557	.363	.281	-1.43	.31

Table 15 presents multiple comparisons in relation to the application of lean business systems as an approach to improve smock production for sustainable development. In reference to the involvement of customers in the process the table shows that Tamale smock producers obtained lower mean scores than recorded in the two other locations. Suggesting that Bolgatanga smock producers are in more close contact with their customers than the smock producers at Tamale and Daboya.

In addition, the ratings of the respondents on the frequency of their customers give them feedback on the quality and delivery performance. The trend of the outcome shows that Daboya smock producers had better mean statistics than Bolgatanga and Tamale producers. This also gives the indication that Daboya smock producers frequently receive feedback from their customers better than experienced by the Tamale and Bolgatanga smock producers.

Also, about maintaining an on-time delivery philosophy, the responses show that Bolgatanga (-.028) on the other hand obtained a higher mean statistic than Tamale and Daboya (.156) This further implies that among the three locations Bolgatanga boasts the highest in terms of timely delivery of orders than the other two locations surveyed. It is worth noting that none of the variables had a significant mean variance between the smock productions in the surveyed areas.

In summary, it could be observed that the smock producers in the three locations have their unique trend of strengths when it comes adopting strategies to improve smock production for sustainable development.

Table 16. *Multiple Comparisons: Tukey HSD analysis on lean business system, principles, and methods, from a textile production perspective benefit textile design and production of smock.*

Dependent Variable	(I) Location	(J) Location	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
We are continuously working to lower set-up and cleaning times in our apparatus	Tamale	Bolgatanga	-.103	.372	.959	-.99	.79
		Daboya	-.556	.414	.377	-1.55	.44
We have low set-up times for equipment.	Tamale	Bolgatanga	-.423	.306	.356	-1.16	.31
		Daboya	.444	.341	.398	-.37	1.26
We have managed to schedule a significant portion of our set-ups so that the regular uptime of our machines is usually not affected.	Tamale	Bolgatanga	-.615	.288	.089	-1.30	.07
		Daboya	.389	.320	.449	-.38	1.16
Optimized set-up and cleaning procedures are documented as a best-practice process and rolled-out throughout the whole production	Tamale	Bolgatanga	-.041	.304	.990	-.77	.69
		Daboya	-.233	.338	.770	-1.04	.58

*. The mean difference is significant at the 0.05 level.

Table 16 presents the multiple comparison results in relation to the benefits of the lean business system to the textile design and the production of the smock. In relation to the attempt to lower set up and cleaning times, the results in the Table shows that means statistics recorded by smock producers in Tamale were lower than those recorded in Bolgatanga and Daboya. This gives the indication that Bolgatanga and Daboya producers have a better working atmosphere to lower their set up and cleaning times better than their counterparts in Tamale.

Again, a reference to the results on how they manage to schedule a significant portion of their setups to than the regular set up times of the production equipment. The results show that Tamale recorded lower mean scores than those recorded at Bolgatanga but higher than the mean statistics recorded at Daboya. From the results, it can be concluded that Bolgatanga smock producers have a better strategy in scheduling significant portions of their set-ups so that the regular set-up time of their machines is usually not affected.

From the general outlook of the results, it can be concluded that the three locations surveyed have equal opportunities for benefit from lean business practices which can thus improve smock production.

Table 17. *Hypothesis Results.*

SN	Hypothesis	Tests	Sig.	Chi-square/Mann-Whitney U and P-Values	Outcome
1.	There is no significant difference between the design and production of smock with lean business system and those without lean business system	Chi-square Tests of Goodness Fit	4 (5%)	18.601[a] (.001)	Reject
2.	The textile design and production with lean business system of smock production can lead to sustainable development	Mann-Whitney U Test	(5%)	3245 (.730)	Accept

Source: Fieldwork (2020).

Hypothesis 1: There is no significant difference between the design and production of a smock with a lean business system and businesses without a lean business system.

Since the data were normally distributed, the Chi-square Tests of Goodness Fit Test was employed to test this hypothesis. The hypothesis theorised that there is no significant difference between the design and production of the smock with a lean business system and those without a lean business system. Chi-square Goodness of Fit Test (χ^2=18.601[a], $p<.05$), suggests that the hypothesis can be rejected as there is rather a statistically significant difference between the design and production of the smock with lean business system and those without lean business system.

Hypothesis 2: The textile design and production with a lean business system of smock production can lead to sustainable development.

Since the data were not normally distributed, a Mann-Whitney U Test was employed to test this hypothesis. Textile design and production with a lean business system of smock production can lead to sustainable development. Mann-Whitney U test value of ($U=3245$, $p=.730$), hints that the hypothesis is accepted invariably inferring that textile design and production with a lean business system of smock production can lead to sustainable development.

5. Conclusions

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 experience when it comes to the smock production industry. More so it can be concluded 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 lean business practices. From the results, it can be concluded 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 a low level of application of the lean business concept in the Ghanaian 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 the adoption of strategies to improve smock production for sustainable development and the three locations surveyed have equal opportunities to benefit from lean business practices which can thus improve smock production.

Textiles and apparel production is characterized by volatile markets, short product lifecycles, and high product variety. The sector has narrow profit margins producing and even holding small quantities of stock is not a viable option. Therefore businesses in the sector have to produce products rapidly to fulfil orders. The findings of the study show that lean manufacturing is not efficiently implemented in the textile sector in Ghana. This sector lacks an understanding of lean manufacturing concepts and therefore has not reaped the full benefits of lean implementation. Most businesses only focus on a few tools and techniques neglecting others. The textile establishments in Ghana need focused training on lean manufacturing to enable its better understanding. They need to implement lean practices in all areas of production. Another critical element for successful lean implementation is the proprietors' commitment to transformation. They need to invest in the training of workers and make sure they are involved in the whole process. Most workers show resistance to change hence attention must be given to changing their mindset. Incentives must also be given to changing workers for their support. The benefits of lean must be shared among all stakeholders. Also, textile firms must be encouraged to benchmark their system with world-class firms. This can help bring rapid improvements in their performance.

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