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SUSTAINABILITY OF WASTEWATER MANAGEMENT IN TEXTILE SECTORS: A CONCEPTUAL FRAMEWORK

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Abstract

The main focus of the current research work is an identification of sustainability of textile wastewater management (STWM) practices and subsequently to suggest a conceptual framework that influences the STWM practices on performance improvement. By exhaustive literature review, STWM practices are examined and designated highly significant STWM practices for further analysis. The proposed design shows a clear interpretation of sustainable textile wastewater management that depends on economic performance, environmental impact, and operational performance. This framework mainly provides information to society, textile sectors, labors, manufactures as well as users to reduce the wastes by implementing suitable waste management strategies. It is also observed that this study can provide new direction to the textile manufacturing sectors for determining other related practices as well as performances for future study. Hence, sustainable waste management innovative technique needs to be applied initially in developing countries to implement new technology, new vision, labor awareness program, and policymakers' initiation.

Key words: framework, sustainability, textile waste management, technology

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1. Introduction

Industrial waste is one of the prime factors in the present world generated from different manufacturing industries and creates a huge problem for the environment as well as produces more quantity of toxic gases. These wastes are either drained to river water or most of the time by different heating techniques transferred to the environment. Hence, most of the countries are more serious about the reduction of wastes and the use of new technology to control the waste generated from industries.

The textile industry is one of the largest sectors in the world due to an increase in customer requirement leading to the drastic increase in textile production in the last three decades. This sector not only improves the economic condition of the country but also one of the major job creators in the world. However, on the other side, this sector also generates larger quantities of wastes that naturally create problem to society in terms of health and pollution. In general, the garments rejected by consumers are donated to different charitable organization, sold in the market at lower price, retails collectors etc. (Palm, 2011), but in Europe the rejected clothes are mixed with municipality wastes and filled inside the land or sent back to industry for recycling or reuse based on the company demand (David et al., 2014; Monteiro et al., 2018).

Most of the developing countries nowadays are trying to implement new ways of manufacturing products to make the society sustainable and achieve the solution by considering keeping three major significant factors such as economic, environmental and social issues (Chavan, 2014; Guedes et al., 2017). However, few of the developed countries use the textile sludges for low-grade construction applications by replacement of cement, paver blocks and locking

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tiles. It was reported that by replacing the aggregates as well as cement for preparation of construction materials, the textile mill sludge mixed product show better compressive strength than the conventional concrete structure (Kulkarni et al., 2012).

Evangelinos et al. (2013) discussed environmental management practices as well as various cleaner production methods to improve the industrial sectors and also impact environmental issues. They also discussed other issues such as environmental management practices, different techniques, and methods that benefit the manufacturing sectors by following the raised points. Similarly, Chapman et al. (2009) described the conceptual selenium management model for the coal mining sectors in Western Canada and reported that the conceptual model provided a better approach for managing ecological as well as associated risk. It is also useful for better management interventions for conceptual selenium and risk reduction respectively. In our previous work (Pattnaik et al., 2018), we have discussed the following textile sectors issues that mainly covers different purification techniques used till date in textile industries along with utilization of low-cost absorbent for treatment. After that after treatment lot of waste sludges were also generated and these textile sludges were also used for preparation of concrete structures by the replacement of cement. However, most of the small scale industries they reuse the textile wastewater without any further treatment can be used again for the cleaning of textile clothes etc.

The purpose of this study is to develop a conceptual framework for the sustainable development of textile wastewater management by analyzing various factors related to labor input, wastewater, disposal of wastewater, consumption of energy, emission of CO_2, policy, sustainability performance etc. Finally, this study also proposes a valuable direction for implementing the desired input factors to obtain the target performance output for the sustainability of textile wastewater management.

2. Literature review

The literature review on sustainable textile wastewater management (STWM) mainly focused on policy implication, environment effect, social impact, waste utilization, the productivity of textile industries, sustainability-related problems as well as operational performance, etc. This main study focus is to identify the research gaps from the published literature and the implementation of a conceptual framework to obtain better performance output. To achieve a better sustainable textile sector industry, management needs to focus on the following significant factors (Ghinea et al., 2017; Pattnaik et al., 2018), i.e., labor input in the textile industry, dyes and additives, policy implications, energy consumption and carbon dioxide emissions, wastewater treatment and disposal, improvement of sustainability-related performance, textile industry productivity, textile reuse, and recycling, environmental impact, economic performance, and operational performance respectively. Sustainability in textile wastewater management mainly links to the following main dimensions such as economic performance, environmental impact, and operational performance, respectively as per present desirable.

2.1. Research gap

In the early nineties, Njikam (2016) discussed labor market liberalization in manufacturing sectors that includes both skilled and unskilled employment. Finally, the author concluded that firms reforms successfully increased the demand for unskilled jobs and therewere no effects on skilled labor demand. Almeida and Poole (2017) discussed both labor market regulations law and trade market effects on the labor market in developing country like Brazil's. They also reported that this labor regulation purely relies on Brazil's currency crisis based on administrative data available with them.

It was also reported that for the development of economic and social performance, a sound political framework was needed (Belkhir et al., 2017). Again, the management person from the country like Sri Lanka discussed on conventional accounting failure strategy effects on workers in textile mills but suggested that the modern industrial culture changes the conventional accounting to modern accounting. The failure in rural culture purely based on kingship obligation, and therefore, Government interference changed the commercial budgeting practices (Wickramasinghe and Hopper, 2005). Nunes et al. (2015) discussed the development of new policy for improvement of energy efficiency in the textile sector with the advancement of competitiveness of the enterprises.

In the last two decades, the use of eco-efficiency principle was successfully implemented in various textile sectors (Fortuna et al., 2012). Eco-efficiency not only helps to develop appropriate alternative but is also considered to be a best and promising results in textile sectors of Biella, Italy. Two innovative technologies such as resource efficiency and reducing emissions of water were finally implemented out of six different innovative technologies (Dimakis et al., 2016). Again Gebrati et al. (2018) discussed the rejection of toxic substance in the environment that was generated as effluent from textile industries. It was also pointed out that by use of gamma radiation, few elements grows faster (such as nitrogen content) that specifically act as bio-fertilizer helpful for the better growth of plants as it acts as additional nutrients.

Similarly, Bilinska et al. (2016) discussed the limitation of one of the treatment technique for textile wastewater. This technique reduced the colors, biological-oxygen-demand (BOD) and chemical-oxygen-demand (COD) etc. from textile wastewater by ozone-based advanced oxidation processes.Martínez (2010) discussed the development of energy efficiency in German and Colombian textile industries by using three different alternatives as a case study between the year 1998 to 2005. The energy consumption of different textile industries concerning the production level was also studied and further a relationship was developed between output and energy use. Again, they reported in the second stage of study that in case of German textile sector both capital and energy cost enhanced the gross production energy ratio, but in Colombian textile sector, the importance on the labor, material, and plant capacity utilization improved the gross production energy ratio.The productivity can be improved in any textile sectors by protecting the environment into greener production with the help of stakeholder action.

United State, in the period from 1980 to 1995, the textile sectors improved at a faster rate that ultimately produces huge quantities of textile wastewater that automatically discharges to an environment like river water. Hence, different types of toxicity assessment tool were developed that was beneficial to industries for reduction of wastewater generation (Moore and Ausley, 2004). Al-Salman (2008)discussed the manufacturing sector in the Kuwaiti by changing the mechanism of both the input-output frameworks along with productivity analysis. However, Zhu et al. (2018) discussed greenhouse gas management system in the textile enterprises in China due to increase in global warming phenomena specifically due to textile sectors. Hence, an effective greenhouse gas management system was required to identify the weakness and report the sustainable development criteria to improve their management level. Lenzo et al. (2018) explained three different sustainability performance tools to improve environmental impact, performance to achieve a green economy. Considering the detailed literature review, the considerable STWM practices (Variables, sub-variables, performance output and source of items from literature) were reported in Table 1.

Mwangi and Thuo (2014) discussed on only municipal solid waste management techniques and developed a conceptualframework for analyzing various problems associated with solid waste management practices as well as factors. They finally design suitable municipal solid waste management practices for sustainability by adopting a conceptual framework. Similarly, Bernal (2018) proposed a conceptual model for wastewater management concept in urban areas by considering the improvement of technology, social and environment impact, economic dimensions respectively. They observed that while implementing the conceptual model, the benefits associated with the decentralization should not be overlooked. Samuel (2018) proposed a conceptual model for teaching management accounting to improve the organizational, economic condition through identification of three aspects that theoretically characterize market transactions. This framework helps them not only improved management accounting subject but also given an adequate idea in diverse topics to work logically articulated manner.

- After the identification of the researchgap, the STWM literature draws attentionto finalizing a comprehensive methodology by correspondingly using main variables and sub-variables. The research gap mainly focused on the following main variables such as policy implication, environment effect, social impact, waste utilization, the productivity of textile industries, sustainability-related problems as well as operational performance.
- It was also observed that limited research on the sustainability of textile wastewater management as far as the Indian textile sector is concerned, and no specific framework is also developed for the improvement of the textile manufacturing sector.

Hence, it is expected that by adopting a perfect conceptual framework to reduce the textile wastes as well as to improve the economic condition of the textile manufacturing sector can be fruitful at the end for sustainable textile wastewater management.

2.2. Research methodology

The research methodology is based on the survey of Indian textile manufacturing sectors to assess the adoption of STWM practices and their impact of sustainable manufacturing performance regarding adopting the conceptual framework as well as proposes of the hypothesis. A schematic diagram of research methodology steps for sustainable development of textile wastewater management is adopted as shown in Fig. 1. In this study, the data is collected through various literature reviews from the period 1991 to till 2018 due to most of the development in technology mainly focused after in the year 1991.

The selection of research articles are mainly collected from the reputed publishers like Wiley online library, Science direct, Taylor and Francis, Emerald online as well as few available onlinethesis from different sources (Fig. 1). The articles are collected based on the following key points such as textile wastes, technology, sustainable textile sectors, reuse of textile wastewater, operational parameters, environmental effect, and sustainable management respectively. After that summarized the relevant articles as per the STWM practices and unnecessary articles are removed from the downloaded lists.

The major part of this research methodology section is the truncation process that identified more than three industry experts, academicians working in the area of textile waste management, downloaded research articles for the truncation process. During the truncation process, the research articles related to sustainable textile wastewater management are separated.

Table 1. Categorization of sustainability of textile wastewater management system

Variables	*Sub-variables*	*Source of items*
Labor input in the textile industry	Increase in employee wages	Almeida and Poole (2017), Aly and Shield (1999), Diodato et al. (2018), Fedderke and Hill(2011)
	Difficulty in recruiting general staff	Ahmed and Peerlings(2009), Edilberto and Roberta(2018),Jahanshahloo and Khodabakhshi (2004)
	The low rate of work retention	Duranton and Puga (2004), Fujita and Thisse (2013) Krugman(1991), Mengdi et al. (2017), Wadho and Chaudhry (2018)
	Difficulty in recruiting engineer staff	Almeida and Poole(2017) Mair et al.(2016), Njikam (2016)
Policy implications	The unstable political & social condition	Belkhir et al. (2017), Chen et al. (2018), Lin et al. (2015), Conway(2009)
	Underdeveloped infrastructure	Hong et al. (2010) Naud and Rossouw (2008), Nunes et al. (2015), Long et al. (2018), Wickramasinghe and Hopper(2005)
	Unclear policy management by the local Govt	Shui et al. (1993), Wang et al. (2016a), Zheng and Shi (2018)
	Complicated tax procedures	Lin et al. (2018), Martínez (2010), Paul et al. (2012)
Dyes and additives	Basic dyes, moderate dyes & acid dyes	Gebrati et al. (2018), Rossi et al. (2017)
	Direct dyes &disperse dyes	Dimakis et al. (2016), Paz et al. (2017)
	Vat dyes &sulfur dyes	Abidi et al. (2015), Babu and Murthy(2017), Lu et al. (2010), Nadeem et al. (2017)
	Azotic dyes & Reactive Dyes	Li et al. (2018)
Wastewater treatment and disposal	Landfill	Saraya and Aboul-Fetouh (2012)
	Agricultural use	Bilinska et al. (2016), Dey and Islam(2015)
	Recovery	Bhuiyan et al. (2016), Lu et al. (2010)
	Building and construction materials	Chuah et al. (2005), Kumar and Porkodi (2009), Lakshmi and Sasidharan (2015), Malik (2003), Mostafa et al. (2005), Shaid et al. (2013), Wong et al. (2003)
Energy consumption and carbon dioxide emissions	Implementation of a certified energy management system	Hasanbeigi and Price (2012), Lin and Zhao (2016)
	Energy footprint of a production order	Costantini et al. (2018), Wang (2018a), Lin and Moubarak (2013), Wang et al. (2016b)
	Post calculation	Lin et al. (2018), Lin and Moubarak (2014), Martínez (2010)
	Establishing services to support carbon emissions trading	Cui et al. (2018), Huang et al. (2017), Wang and Ma (2018b), Zabaniotou and Andreou (2010)
Textile industry productivity	Regulation influenced technology transfer and R&D activity	Hasanbeigi and Price (2015), Lin et al. (2011)
	Has the follow rate productivity changes	Lin and Zhao (2016), Moore and Ausley (2004), Wadho and Chaudhry (2018)
	Adopt to improve productivity	Al-Salman (2008), Martínez (2010), Meksi and Moussa (2017)
	plan to increase the degree of automation of production	Dimakis et al. (2016), Küsters et al. (2017), Nadiria et al. (2018)
Textile reuse and recycling	Reuse(run your own store)	Sandin and Peters(2018)
	reuse (sell to non-profits or other businesses)	Dahlbo et al. (2017), Güyer et al. (2016)
	Reuse(sell to a broker)	Silva et al. (2018)
	Recycling	Silva et al. (2018)
Improvement of sustainability-related performance	sludge disposal efficiency	Choudhury (2017), Gardas et al. (2018), Nimkar(2017)
	The efficiency of sludge treatment	Baskaran et al. (2012), Zhu et al. (2018)
	weighted average reagent consumption	Acar et al. (2015), Lenzo et al. (2018)
	Sustainable performance measurement for TWTP	Sawaf and Karaca (2018)
Economic performance	Reduction in cost through improved efficiency	Fischer and Pascucci(2017), Sawaf and Karaca (2018)
	Expand the range of low price product	Brasil et al. (2016), Luthra and Mangla (2018)
	No measures have been taken	Yin et al. (2016), Zhou et al. (2017)
	Increased efficiency through management integration	Butnariu and Avasilcai (2014), Martínez (2010)
Environmental impact	Stricter environmental regulation	Butnariu and Avasilcai (2014), Fan et al. (2016), Koligkioni et al. (2018)
	has air pollution ever affected your health	Jiang et al. (2016), Resta et al. (2016)
	any other effects of air pollution	Lo et al. (2012), Shiwanthi et al. (2018)
	Today job is important as compare to Env.	Hossain et al. (2018), Miller et al. (2018), Muthukumarana et al. (2018)
Operational performance	Brand identity	Kenyon et al. (2016), Lucato et al. (2017), Seyoum (2007)
	Goodwill	Fan and Zhou(2018), Sahinkaya et al. (2017)
	Old customer relationship	Aziz et al. (2018), Ozturk and Cinperi (2018)
	Quality of the fabric	Cámara et al. (2016), Kovach et al. (2015), Prajogo et al. (2018)

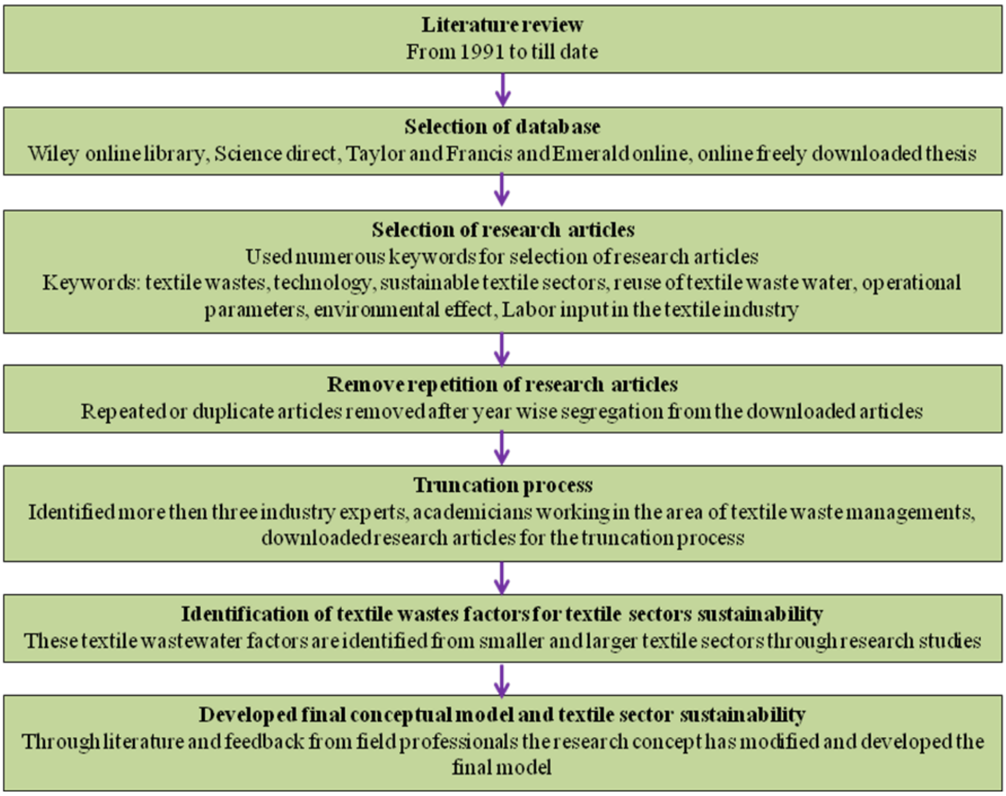

Fig. 1. Schematic diagram for research methodology steps for sustainable development of textile wastewater management

After that the articles are grouped as per STWM practices, i.e., labor input in the textile industry, dyes and additives, policy implications, energy consumption and carbon dioxide emissions, wastewater treatment and disposal, improvement of sustainability-related performance, textile industry productivity, textile reuse, and recycling, environmental impact, economic performance, and operational performance respectively. In the end, developed a final conceptual framework for textile sector sustainability by keeping in view the collected literature and feedback received from field professionals and these conversations are also documented in the conceptual research framework. After, development of the conceptual framework, few senior industry managers are also requested for improvement of the proposed conceptual framework. Hence, based upon the opinion of individual experts the formal research framework is confirmed for further analysis.

3. Conceptual framework and hypotheses

To get these questions to answer, the authors initially proposed a hypothetical model between the variables and performance measures for better sustainable textile wastewater management (Fig. 2). Mair et al. (2016), defined Western Europe textile and clothing rising demand due to globalized production structure and developed a framework for sustainability between 1995 and 2009. The analysis was based on the effect of the environmental and socio-economic impact on low-labor-cost in a few developing countries with the rise in clothing consumption rate. Finally, it was concluded that by analyzing the implications on results there might be a more sustainable future for Western European textiles consumption. It was also discussed that the development of technology could significantly improve the economic scale in the country (Martínez, 2010).

Hasanbeigi and Price (2012) reviewed energy efficiency and energy use efficiency of various textile industries all over the world and also studied few case studies on different textile industries energy saving and other cost information adopted till date. It was reported that all the textile industries need to analyze individually further various economic measures and their applicability regarding the implementation feasibility. The proposed conceptual framework of sustainability of textile wastewater management is to achieve sustainability in textile sectors as shown in Fig. 2. In the subsequent stages hypothesis are developed that shows a better relationship among STWM practices and output performances.

3.1. Labor input in the textile industry

Diodato et al. (2018) discussed three types of externalities such as labor, knowledge, and sharing of inputs and observed that agglomeration partnership concept all most all the industries might not get the equal benefit. Therefore, the authors focused on industry-specific coagglomeration a pattern which helps to improve labor and input-output linkages between location and industry for employment growth. Similarly, Almeida and Rocha (2017) discussed labor pooling as one of the major agglomeration factors observed from the research data in the period 2004 to 2014 (Edilberto and Roberta, 2018). They also studied different theoretical models and reported that the productivity growth with agglomeration factor (Duranton and Puga, 2004; Fujita and Thisse, 2013; Krugman, 1991). Again, in a developing country like China, the focus was on the mainly discussed on textile industries pollution which directly impacts the environment problem as well as labor working in the industries. As environmental regulation nowadays is a major concern for employment in any Industries and hence, policymakers defined the impact of job and country economic growth main issues. As the practice were most of the textile industries discharge huge quantities of wastewater in rivers as well as dump it in nearby dumping yards (Mengdi et al., 2017).

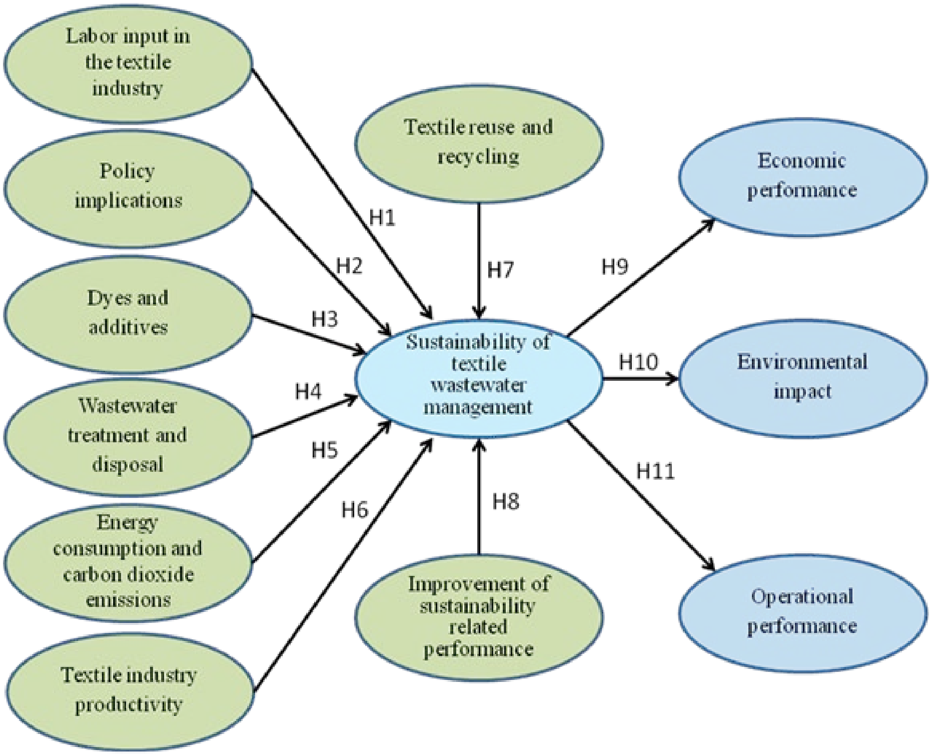

Fig. 2. Proposed conceptual framework of the relationship between sustainability of textile wastewater management and performance measures

Similarly, Wadho and Chaudhry (2018), discussed the implementation of firm innovation which increased both product innovation and firm performance that ultimately increased labor productivity. They reported that with the increase in 10% innovative sales/ worker directly increases 10% labor productivity as well as labor productivity growth. Again, another group of researchers discussed on Egyptian textile sectors about privatization and surplus labor was one of the indications that increased unemployment. Therefore, Egyptian textile sectors adopted Ray Homothetic production function principle which ultimately uses more capital as well as labor (Aly and Shield, 1999).

A similar situation also happened in other countries like China as well as developing countries where any change in inputs combination directly affects the labor inputs due to changes in economic policy. Hence, Jahanshahloo and Khodabakhshi (2004), reported about labor crises in textile industries of China as every year nearly 14 to 16 millions of labors are under the unemployment category, but those labors must be employed. This happened only by changing the input policy that hampered the economic condition of the country.

Henceforth, the country like Brazil adopted de jure labor regulation which dynamically improved plant productivity and also created new job opportunity with the association of the global market. In South Africa, the manufacturing sector specially discussed on increased labor flexibility especially rigidity in labor pricing in the period 1970s and at the beginning of 1980s (Fedderke and Hill, 2011). Again, in the 1990s an improved form of African labor flexibility was implemented by changing the core policy for reduction of unemployment (Fedderke and Hill, 2011). Based on the content of the review literature, the following hypothesis is offered (Fig. 2).

Hypothesis **H1:** Labor input in the textile industry is positively related to firm performance

3.2. Policy implications

The US textile firms tried to enter the global market due to plant closure rapidly, market price down and layoffs. Hence, the major importance was to import the products due to the closed firms which typically affects the worker's unemployment. Conway (2009), reported that US textile firms adopted a new policy to improve technology progress, trade liberalization, and wage growth. However, Lin et al. (2015) discussed how China firms started a political network to build corporate social responsibility by ignoring empirical difficulty. Hence, the government subsidies the various factors and gave an opportunity to foreign investors to improve corporate social responsibility. Again, in China, nearly 176 manufacturing firms integrated their supply chain partners to get excellent performance as compared with the superior firms tie up with the top managers to improve supply chain integration. This concept improved the economic condition, technology changes as well as manufacturing firms performance by the tie-up with top management in China and other countries also (Chen et al., 2018). However, the policymakers in the Middle East and North Africa region (MENA) region implemented an important policy to improve the business environment. Shui et al. (1993) discussed textile trade liberalization by implementing multi-market displacement model and observed that by implementing the above model no dought there was marginal changes in total demand for U.S cotton but affect cotton growers more on the world market.

The investigation was conducted in all four sectors: social, technology advancement, economic and political factors to reduce greenhouse emission. Hong et al. (2010), reported the implementation of Taiwan energy policy to save energy because of energy crises specifically in firms like Textile industries. Hence, because of that reason, Taiwan developed self-produced energy which increasedefficiency as well as energy saving capacity. Finally, it was concluded that nearly 94,614 MWh of electricity, 23,686 kl of fuel oil and 4887 ton of fuel coal was saved. Again, Naud and Rossouw (2008) discussed the implementation of new policy for export of textile cloths and products related to textile from China to South African quotas for two years. This was due to the increase inunemployment by nearly 62% from 1995 to 2005.

However,subsequently, it was observed that South African trade policy mostly damaged the domestic market and government was regrettable about policy mistake. Long et al. (2018) identified the sectoral economic interaction in Japan because in traditional approaches the industrial emissions wereseriously criticized by-product based perspectives. Their main goal was in direct emission high quantity of emission rate in manufacturing sectors. Specifically, agriculture sectors, as well as textile sectors due to these sectors, exceed in indirect emission intensities. Hence, a better emission process was proposed for environmental sustainability along with other factors like chemical pollutions as well as reduction of natural resources. However, Wang et al. (2016a) discussed climate policy implementation in developing countries called carbon tariffs policy where they produced their textile products and transferred to the other developing countries. This ultimately resulted in better performance in the international market and subsequently examined the policy from time to time. Consequently, each manufacturing company produced the same type of textile products and established a competitive market model for standardization of the price.

Whereas, Zheng and Shi (2018) reported on three different issues such as land policy, firm location and firm heterogeneity in Chinese manufacturing firms and observed that the expansion of land supply and land distribution policy show positive impact towards the firm location. Therefore, the local government successfully implemented allocation policy instead of developing more massive construction. The number of textile industries in China was more significant as compared with other developing countries and was also a large exporter. Therefore, energy saving was also one of the major issues in China and to save energy Chinese textile manufacturing industries implemented advanced technology for improvement of energy saving potential along with the reduction of CO_2 emission. They not only modify the manufacturing technology but also simultaneously changed labor productivity, enterprise scale, foreign trade and electricity prices (Lin et al., 2018). Similarly, German and Colombian textile industries also discussed energy efficiency development which benefits the improvement of production level, output performance, labor productivity, textile products as well as proper energy uses in industries. Based on the content of the review literature, the following hypothesis is proposed (Fig.2).

Hypothesis **H2:** Policy implications in the textile industry is positively related to firm performance

3.3. Dyes and additives

Nowadays huge quantities of synthetic dyes are used as per market demand, and these synthetic dyes are also producing more amount of chemical which is dangerous to human health as well as environment. However, natural dyes are better than synthetic dyes, but the cost is a major factor which automatically increases the price of the cloth. It also affects the market values because the synthetic dyes are naturally toxic, carcinogenic and have toxicological properties. Rossi et al. (2017) discussed the use of natural dyes extracted from production waste product through innovative approach for minimization of waste resources and also exhibiting less toxicity. They used colored liquid wastes collected from the steam treatment of eucalyptus wood and used it to dye cotton, nylon, and other woolen products without any use of mordant. Similarly, Paz et al. (2017) reported on the performance of species *Bacillus Aryabhattai* that degrade commercially available dye and after that also proposed three more dyes studied in different operating conditions. They optimized the process by using central composite rotational design and finally validated with indigo carmine and Coomassie Brilliantblue G-250 (CBB). It was also suggested that the species *Bacillus aryabhattai* was considered as a novel strain that was an eco-friendly and cheaper procedure as well.

It was suggested that after activated sludge treatment from textile effluent nearly 50% bacterial activity was decreased and found that bacterial activity mainly depends on contact time as well as the volume of effluent. Belpaire et al. (2015) studied different types of dyes used in different sector starting from leather industries to textile industries and their toxic nature for our environment. They collected information from the period 2000 to 2009 in different locations that include river, canals, and lakes by using liquid chromatography-tandem mass spectrometry to measure the ultra performance.

Babu and Murthy (2017) discussed on the new type of treatment techniques for wastewater collected from textile industries, which can further reduce the toxic effect as well as the permit the use of treated wastewater in auxiliary applications. The study was mainly focused on nanofiltration membranes technique and show better performance than conventional techniques on the removal of dyes from wastewater effluent. However, Abidi et al. (2015) discussed on use of natural clay for treatment of dye-effluent because natural clay was able to remove the color from wastewater effluents that usually contains various types of dyes as well as additives. It was found that during the preparation of dyes, a lot of chemicals and salts were used and natural clay can easily absorb the dye containing effluents.Therefore, natural clay was one of the significant alternative treatment techniques for the removal of colors from textile wastewater effluent. Biological treatment was also one of the newest techniques commonly used by textile industries for the treatment of textile wastewater effluents. This was due to the enormous waste generated by textile industries that contain toxic, colors and organic compounds, depending on the production rate of industries, types of fibers used, technology, raw materials, and management system, etc. Hence, biological treatment could able to reduce waste effluents for achieving sustainability (Nadeem et al., 2017).

Li et al. (2018) reported on the use of direct contact membrane distillation technique for treatment of dyeing wastewater and removal of related pollutants. It was finally concluded that this method removes a maximum quantity of suspended solids, color and dispersed dyes with limited energy consumption and show better performance. Wet processing sectors like textile and leather were also facing a lot of environment problem due to the generation of both salts and reactive dyes in huge quantity as compared to conventional processes because of the low resemblance of the dye to substrates with the help of hydrolyzed collagen (Paul et al., 2012). Similarly, Lu et al. (2010) discussed both biological treatment and membrane technology for recovery of wastewater effluent of textile industries in China. It was observed that nearly 93% removal efficiency of COD, 94.55 color and 92.9% turbidity were achieved through this technology. Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H3:** Dyes and additives in the textile industry are positively related to technology performance

3.4. Wastewater treatment and disposal

Normal water is one most essential part of every living being for a matter of survival; water is also beneficial for the development of industries extending agriculture sector to the manufacturing sector. However, nowadays the level of water on the surface is slowly reducing due to improper utilization of wastewater generated from different industries. Moreover, the municipality, as well as chemical and textile sectors, are the source of major wastages. Therefore, reuse of wastewater is a major concern for every country. The wastewater not only harms the environment but also reduce the country growth in all most all the sectors, this may be because of the deteriorating quality of the water used nowadays. Hence, every government is implementing new regulation to improve the technology for reuse the wastewater generated from the textile industries. Wastewater is generated mainly from municipal sewage, food processing, leather industries, textile industries, automobile industries, paper, and pulp industries, canning industries, etc. There is huge number of sectors where generated wastewater get mixed with either river water or dumped in different dumping yards. This ultimately creates a number of the health-related problem to human life and creates similar problems to another living being on the earth.

The present work mainly focused on textile sectors waste utilization and its reuse in the textile sectors. The textile industry is one of the major sources of income for most of the developing countries, and most of the unskilled and skilled labors are depending on the textile sectors either directly or indirectly in their life for survival. There are few countries in which the main source of income is through the textile sectors only, and there is no alternative sector for their dependence. Lu et al. (2010) discussed on effective utilization textile wastewater in China and reported that reuse of textile wastewater was one of the best alternatives instead of using fresh water as far as cost is concerned. It was observed that through biological treatment and membrane technology the wastewater recovery was successful due to which nearly 0.25US$/ m^3 can be saved at the time of initial manufacturing. As it will also save the environment, the technique is claimed to be one of the best promising methods to reuse the wastewater for textile treatment plants. Bhuiyan et al. (2016) discussed another method for reuse of wastewater in either textile sector or some other sectors. It was reported that by the use of gamma irradiation technique, the dye molecules and organic pollutants available in wastewater could be degraded and then the treated wastewater can be used for dyeing purposes as well as irrigation purposes.

Similarly, Dey and Islam (2015) discussed Bangladesh textile wastewater treatment techniques, which reduces huge quantity of waste generated from textile sectors and creates problem to the environment as well as agriculture, workers health, and also damaged the society financial growth. Therefore, the use of one of the basic treatment technique, i.e., physicochemical techniques was emphasized. Bangladesh government made a specific rule for all the textile sectors to use this technique as a prerequisite for the establishment of a textile industry in this country. Saraya and Aboul-Fetouh (2012), reported on the use of alternative treatment technique by using cement kiln dust for removal of acid dye from aqueous solution. The cement kiln dust is also similar solid waste obtained from cement manufacturing plants. In Egypt, most of the textile industries produce huge quantities of textile waste or waste effluents during cleaning and coloring of textile fibers. These wastes were ultimately transferred to the river which causes a major concern to the environment. Most of the textile industries use different techniques to remove acid dyes, and these procedures were not cost effective. The use of cement kiln dust residue to remove the color dyes from the wastewater effluent is one of the effective techniques. Similarly, Mostafa et al. (2005) used an optimal quantity of cement by-pass dust or cement kiln dust for removal of colors as well as reduce other elements like COD, TSS, and some heavy metals. Itwas reported that the percentage dose of cement by-pass dust should be in the range of 0.5 to 3.5 mg/L for better performance as compared with other types of solid wastes.

However, Kumar and Porkodi (2009) discussed the use of rubberwood sawdust for the removal of color from dye bearing effluents because such wastewater was very difficult to treat by conventional methods. Rubberwood sawdust was used as an adsorbent for extraction of brown Bismarck from aqueous solution, which is carcinogenic to humans as far as health was concerned. In the line of this study, Malik (2003) used both sawdust and rice husk as low-cost adsorption for removal of acid yellow 36 this was because of from the low cost adsorbent activated carbon was prepared. It was also concluded that the carbon percentage was maximum in saw dust as compared with rice husk. Similarly, Chuah et al. (2005) reported on only sawdust used as low cost sorbent materials for removal of heavy metals and could also remove dye, because in the present methodology removal of heavy materials such as Al, Au, Cr, Cu, Pb, Fe, Mn, Zn and Cd from solution was very expensive procedure. However, Wong et al. (2003) discussed on tartaric acid modified rice husk as better sorbent materials due to the highest binding capacities for removal of Cu and Pb. Finally, it was concluded that the pseudo-second-order model shows better sorption capacity than the pseudo-first-order model.

Shaid et al. (2013), concentrated more on the effective utilization of the textile wastewater without any further treatment mostly defined as direct use of textile wastewater for the scouring bleaching of knitted cotton goods or fabrics. Itwas observed that by comparing both freshwater and textile wastewater, the weight loss was marginal and the reflectance of whiteness was also in a similar result. Lekshmi and Sasidharan (2015) reported that nearly 70 to 80 million tons of textile waste are generated every year in Thiruour, India, and the disposal of wastewater is one of the major problems in every part of the country. Hence, now a day these textile wastes were used for construction applications for replacement of cement. The optimal cement and textile sludge ratio were determined as 10:0.4 respectively for better compressive strength, which satisfies the paver blocks standard. Based on the content of the review literature, the following hypothesis is proposed (Fig.2).

Hypothesis **H4:** Wastewater treatment and disposal in the textile industry is positively related to technology performance

3.5. Energy consumption and carbon dioxide emissions

The development of a country economy depends upon the growth of industrialization and urbanization that in turn depends on energy. This implies that the energy shortage typically affects the international market and energy security. China government recently promoted energy conservation with emission reduction in textile industries. Therefore, in order to reduce the generation of heat, energy conservation technology has been implemented to improve energy efficiency, product quality and ultimately to curb pollution (Lin and Zhao, 2016).

Similarly, another group of researchers reported on the improvement of energy productivity in any manufacturing sectors need to be changed the technology as well as efficiency factors in a country like China. This may be due to the nominal price of energy as well as low energy taxes in China as compared with other countries. Hence, technological reformation is highly needed to make strong market competition (Wang, 2018a). Costantini et al. (2018) explained on EU employment dynamics to improve energy efficiency both in private as well as public sectors and observed that any sectoral output improvement, investment, activities, and energy efficiency gain shown an adverse effect on employment growth. However, Lin et al. (2018) discussed the improvement of energy efficiency in China textile sectors by the development of technology using macroeconomic concept. A model was proposed for the future improvement of energy saving by developing technology, labor productivity, foreign trading, electricity prices with energy intensity. Analysis of the above relationship, they also discussed on energy saving concept and reduction of

CO_2 emission in China textile industries by implementing scenario analysis.

Similarly, Zabaniotou and Andreou (2010) discussed the use of cotton gaining wastes as a green fuel for improvement of environmental sustainability and the development of alternative energy in textile sectors with the reduction of emissions. Through this technique one part the waste cotton was effectively utilized for energy production and in second section reduction of use of heavy fuel oil with nearly 52% of the production of bioenergy for thermal requirements. As in China the CO_2 emission was nearly half of the total power industry and was also the largest CO_2 emitter in the world. Hence, China's power sector played a significant role in the reduction of the carbon economy by implementing micro and macro policy in power sectors. Ultimately, both the government and power enterprise should take a major role to reduce emission in power sectors (Cui et al., 2018). Lin and Moubarak (2013) discussed Chinese textile industries potential changes in energy-related CO_2 emission from the period 1986 to 2010 and observed that industrial activities and energy intensity were the main producers of CO_2 emissions. They reported that the increased in CO_2 emission was mainly increased textile sectors nearly 5% annually from the period 1986 to 2010 along with 4% increased in energy consumption.

Again, the same group forecasting the CO_2 emission in different scenarios for the reduction of CO_2 emission in the Chinese textile industry by implementing the Johansen co-integration technique. They also clearly concluded that the energy cost, energy substitution, labor productivity as well as technology play a major impact on the carbon intensity (Lin and Moubarak, 2014). Huang et al. (2017) explained that the reduction in greenhouse gas emissions was a significant challenge in textile industry sectors because China was the sixth largest energy consuming industry sector. This was due to an increase in industry sectors in China that ultimately increased greenhouse gas emissions. Wang and Ma (2018b) reported on Jiangsu province, carbon dioxide emission strategy from the period 2000 to 2014 and analyzed the CO_2 emission using Tobit model by taking into account four variables, i.e. foreign trade, R & D expenditure, industrialization level, and energy consumption structure. They also explained the development of new technology during the said period at a growth rate of 1.5% per year. However, technical and scale efficiency were shown declined in order.

Whereas, Wang et al. (2016b) discussed both energy consumption and carbon dioxide emission of industries from the period of 2003 to 2012 of Tianjin province and observed that 9.11% annual growth was noticed along with 53.17% decrease in emission rate. However, to improve the energy efficiency and reduction in carbon dioxide emission of Tianjin's energy consumption during the period 2008 to 2012, it was suggested that development of green and low carbon industries could reduce emission rate and improve energy conservation drastically. Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H5:** Energy consumption and carbon dioxide emissions in the textile industry is positively related to economic performance

3.6. Textile industry productivity

Textile industries mainly depend on large volume of water for printing and cleaning, electricity as well as fuel and then discharging textile wastewater effluent, greenhouse gas, etc. With the increased consumption rate of textile products, the textile production rate also increased symmetrically along with an increase in energy use. Hence, keeping in view the above limitations, automatically textile manufacturing sectors introduced emerging technologies for the workers, reduction of pollution improvement of energy and recycling of wastewater for further utilization in textile industries (Hasanbeigi and Price, 2015). Similarly, Lin et al. (2011) also reported that China hadgiven more significance to manufacturing activities which increases the textile firm productivity. The calculated the Ellison–Glaeser (EG) index was around 0.00019 from the available data collected in the period 2000 to 2005 and it was concluded that industrial agglomeration enhanced the productivity. Lin and Zhao (2016) discussed energy efficiency with the change in technology and energy rebound effect in Chin's textile industries by implementing new policies. Therefore, by implementing these new policies, energy consumption and effective prices can be reduced with the increase in energy services. The improvement of energy was verified through the rebound effect in the textile sectors (20.991%) that ultimately improve the productivity of the sectors.

The main outcome of the proposed methodology was to create a relationship between the sectors and the development of new technology in manufacturing industries. It was also demonstrated that with the change in technology, the initial investment was increased, but import capacity was successfully enhanced. Dimakis et al. (2016) provided a greener and sustainable development concept to measure the eco-efficiency that suitably measured the product or services lifecycle. Hence, eco-efficiency guides are used for the improvement of perfect metrics for evaluation of perfect alternative solutions. The development of technology not only improved industry productivity but also controls the production of wastes in the industries. Nowadays environmental sustainability is one of the majorfactors for almost all the manufacturing industries specifically textile industries. This is due to the generation of huge quantities of waste starting from solid waste to water waste. Hence, research on textile engineering is highly innovative as far as an industrial process is concerned because the wet textile process was highly expensive in terms of energy, water, textile materials degradation and wastewater treatment respectively (Meksi and Moussa, 2017).

Kusters et al. (2017) discussed the implementation of digital operations technologies and Industry 4.0 solutions in Textile industry in Germany. It was concluded that by implementing a value chain structure starting from order to deliver, the manufacturing sector becomes smarter and also enhancement in product development within the factory based on the customer requirement. This study was entirely different from other studies in the US industries for improvement of productivity growth, demand and production structure. In US industries they mainly focused on the importance of modern infrastructure such as latest broadband technology network that easily transfers the information related to the changing in technology, production function in other sectors as well as other parts of the country (Nadiria et al., 2018). Similarly, Wadho and Chaudhry (2018) reported product innovation and its impact on a firm's performance. Information was collected through survey homogeneous data collection technique in Pakistan by obeying multi-stage structural modeling. It was observed that by implementing the above model, the innovation sale was increased by 10% per worker simultaneously increased in labor productivity and growth by 10%. This helps in the improvement of knowledge flows from foreign customers to firm decision to innovation. Finally, itwas concluded that larger firms invested more in innovation that increased organizational sales and automatically improves productivity.

Martínez (2010) discussed three different alternative indicators for measurement of performance regarding energy efficiency in German and Colombian textile sectors in the period 1998 to 2005. The results show that by changing in energy efficiency between these two countries, the German textile sector, capital, and energy variables improve the gross production and energy ratio whereas, in Colombian textile sector improve the gross production and energy ratio by putting in different variables such as labor, material, and plant capacity utilization respectively. Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H6:** Textile industry productivity is positively related to firm performance

3.7. Textile reuse and recycling

The textile product gradually increased with the increased demand in the world due continuously growth in population and the development of economic conditions. Therefore, on one side the demand rate is unanimous increased, and on another side, the pollution rate is also increased. Most of the wastes are generated during the cleaning of fibers and treatment time which is ultimately discharged into river water and or kept in artificial dump peat that subsequently spread into the environment. Therefore, textile sectors took several measures to improve the treatment process, improve the technology and reduce the waste effluent for development of effective manufacturing process that gives rise to more substantialenvironmental impact to the society as well as improve the textile sectors economic growth. Therefore, based on the above analysis Gustav and Peters (Sandin and Peters, 2018) discussed on the recycle and reuse of textile wastewater for further development of the textile sectors by using advanced technology to recycle the wastewater so that the same water could be reused for treatment of textile fibers as well as some other applications. The major benefit behind the above discussion was the reduction of wastes from water to textile products. In Finland, the textile wastes increased to a large extent with the increase in textile products and the limited study was only performed to reuse/recycle the wastes in any country.

Therefore, much research was going on effective utilization of textile fiber wastes and or other solid wastes for further use in the same textile industry application or some other applications like agriculture or construction applications. It was also pointed out that the reuse of textile wastes could also hamper the production of raw textile materials and hence automatically reduction in the production of wastes. However, certain policies were implemented to reuse discarded textiles i.e. around 20% and generated energy from there (Dahlbo et al., 2017). Butstill, researchers are working on the effective utilization of wastes all over the world. Güyeret al. (2016) discussed the waste management technique, reuse and recycle of textile wastes were one of the major factor as well as a challenging job in all most all the developing countries. It was observed that during cleaning and bleaching, the generated reactive dyes after treatment through advanced oxidation processes was investigated. The study concluded that during pad washing nearly 100% water was recycled so that the fresh water consumption rate was reduced which ultimately save fresh water purchase cost along with energy saving. Similarly, Silva et al. (2018) pointed out that during different chemical and electrochemical advanced oxidation processes, much wastewater was generated that transferred into the environment. The same wastewater was reused again in textile industries after going through minor processing and then used for bleaching, scouring and dye processing. Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H7:** Textile reuse and recycling in the textile industry is positively related to environment performance

3.8. Improvement of sustainability-related performance

Textile sectors are one of the major industries Worldwide for the production of textile products. The textile sectors also improve country economic condition as well as create a relationship between countries. However, during the manufacturing of textile products, large huge quantities of textile solid wastes are generated which creates pollution in the localized area as well as being harmful to the human environment. Hence, an application of green chemistry and clean technology leads to the development of environmentally friendly manufacturing system (Choudhury, 2017). Gardas et al. (2018) discussed three-dimensional sustainability such as economic, environment and social that eliminated the barriers in the textile and apparel. Then it was identified that there exist nearly 14 challenges for sustainable development of textile and apparel sector by using decision making trial and proposed that poor infrastructure facility and lack of government policies were the most significant barriers.

Indian textile and clothing industry nowadays follows sustainability criteria through a supply chain that is mainly a combination of customer, manufacturers, and suppliers. The sustainability criteria were categorized into six numbers, and a sample size of 63 suppliers was considered, where the suppliers were of three group's namely good, moderate and poor performance. Finally, the grey approach was applied to analyze all the potential criteria's and reported the important criteria such as pollution, unfair competition and employing child labors (Baskaran et al., 2012). Nimkar (2017) reported that the innovation in chemistry was highly required to achieve zero waste discharge by 2020 because with the increase in global population the chemical production in all over the world also increases rapidly. They identified more than 8000 chemicals nominated under the supply chain group and these chemicals created huge chemical wastes, and hence sustainability chemistry was the major solution for innovation in the present day industry success.

Nowadays huge number of approaches and methods are used such as life cycle assessment, life cycle costing as well as social life cycle assessment to obtain better products. Textile sectors by seeing the environment condition and harmful effect on human health used a different methodology for sustainability performance. The main focus of the textile industries was to reduce the waste products and improve in three different dimensions such as economic, social and environment respectively by adopting multi-criteria decision making optimization technique (TOPSIS technique) (ACAR et al., 2015). Sawaf and Karaca (2018) discussed the sustainability of wastewater treatment technology from textile industries in Turkey to obtain better performance in terms of economic technology, social and environment. To optimize the system parameters they used analytical hierarchy process (multi-attribute decision-making method) by incorporating sustainability criteria as well as their relevant indicators and observed that chemical treatment technology show lowest sustainable alternative for textile sectors. Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H8:** Improvement of sustainability-related performance in the textile industry is positively related to technology performance

3.9. Economic performance

Dutch textile industry discussed on the circular economy as well as institutional analysis for the arrangement of the organization in two different ways by developing a perfect conceptual framework. This may be because of adopting the circular economy creates new organization forms and inter-firm collaboration that is enhancing the sustainability of new institutions. However, later on, this circular economy concept after going through clear formulation as well as existing theories this principle was lacking to establish a standard textile industry. Hence, after that introduced Status Quo arrangements and Product as Service arrangements to provide modified optimized technology, better infrastructure, circular relations and providing products subjected to the implementation of new approaches to the ownership of materials (Sawaf and Karaca, 2018). Fischer and Pascucci (2017) discussed on low tech industries not only support the growth of economics and GDP in the countries but also simultaneously create the strong ground for improvement of technology as well as progress for innovation in subsequent development in the same research area. Hence, various laws and regulations were implemented by the Lithuanian industry in the state levels and observed that these industries loss their stability later on due to their rivals competitiveness. Brasil et al. (2016) proposed a resource-based theory that mainly depends on three different sectors such as process, product and organizational and observed that after going through different textile industries performance data the business performance affected the product and organizational eco-innovations. This process automatically improves the technology of the textile sectors and simultaneously improved the performance of the textile industries.

Yin et al. (2016) discussed two different major factors such as the economy and environment as the most significant desirable parameters to improve the quality of any manufacturing industries. Pollution transfer and diffusion of wastes integrate for up gradation of economic development and then identify the series of wastes generated from industries by putting the pollution intensity index in manufacturing sectors. China implemented such index from 1997 to 2007 and proposed nearly eight sectors were under polluting industries out of which seventh industries were mining, food, textile, tobacco processing, and garments, etc. This study mainly focused on the identification of various gaps between two countries such as China and the US textile industry. The major key identification was an improvement of energy efficiency of chemical fiber industry and identified a few more factors that influence the energy efficiency in China and compared with national-level results. Therefore, the key influencing factors that are required for improving the energy efficiency were technology, energy, and economic structure and industrial scale.

Martínez (2010) focused on energy efficiency and energy use for the development of German and

Colombian textile sectors to achieve sustainable development. In textile manufacturing industry the implementation of energy consumption that directly improves the production level has a direct relationship between the output and energy use. This indicates that the development of technology, energy efficiency related policies and mainly the implementation of management strategies improve the energy efficiency in the textile manufacturing industry. Whereas, Luthra and Mangla (2018) discussed the implementation of Industry 4.0 such as product design, produced, delivery and discarded to improve the business system. This study mainly focused on Indian manufacturing industries keeping in view for controlling the pollution, protecting the environment and process safety for supply chain sustainability. However, adoption of Industry 4.0 was a challenging task for implementation because this concept is passing through a lot of critical procedures. This technique not only improves the technological aspects but also improve other factors such as social and legal issues, strategic challenges and ethical issues also.

Zhou et al. (2017) discussed the reduction of freshwater use in textile dyeing industries by implementing the Genetic algorithm optimization technique. After going through various case studies, it was concluded that nearly 21% of fresh water consumption was reduced as compared with conventional processing techniques. Nowadays ecological footprint analysis was one of the crucial demands for societal benefit and able to demonstrate new potential applications on the biosphere. The main insight behind the present approach is the development of new tools which are useful to calculate the environmental impact as well as the environmental performance of various types of manufacturing processes (Butnariu and Avasilcai, 2014). Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H9:** Economic performance in the textile industry is positively related to firm performance

3.10. Environmental impact

Sustainable environmental impact on the textile sector is one of the significant concerns nowadays for sustainable production improvement. Hence, sustainable production is required to improve consumption efficiency and simultaneously consumption pattern. The reduction in resource consumption need is required for improvement in technology as well as eco-efficiency support system because today most of the textile manufacturing industries are facing problems on climate change related problem, pollution increase in the environment, degradation of eco-system and raw materials exhaustion. Busi et al. (2016) discussed the implementation of nanotechnology for textile industries to improve the technological potential and observed that this new concept develop technology in textile sectors. This improves the process performance in terms of energy and consumption of resources so-called self-cleaning textiles. Nanocrystalline TiO_2 photocatalytic layer was deposited on the surface of the new textile, which could easily destroy organic materials in the presence of solar irradiation. Therefore, automatically the maintenance cost of the textile products, use of the chemical is reduced and also a reduction in the uses of water for cleaning of textile products. Fan et al. (2016) reported about China's national economy improvement by implementing green economy, which develops the economy in global scale because environmental protection industries in recent days are considered to be an emerging industry for the present economic condition as well as for future enhancement of economic strategy. This strategy subsequently provides a valuable model to the government agencies to implement a sound policy for improvement of environmental impact and economic condition.

Similarly, in Italy also introduced sustainability strategies successfully in textile sectors due to the increase in the number of textile industries. They also introduced a new decision-making process for monitoring management and environment system through which they could quickly identify the activity and improvement of mechanical performance. They finally controlled environmental pollution, cost saving and also explore the sustainable business strategy (Resta et al., 2016). In the same line, Jiang et al. (2016) discussed the improvement of environmental efficiency in China's Jiangsu province and collected nearly 137 textile firms data. The data mostly covers the following major factors such as energy efficiency, output efficiency, wastewater and gas, labor, energy input, wastewater discharge and emission of undesirable output. Finally, itwas concluded that environment efficiency showsmajor impact on output efficiency, but the reverse had no impact.

Similarly, Shiwanthi et al. (2018) reported the role of textile industry for improvement of economic condition in Sri Lankan, as Sri Lankan was the fifth largest contributor to CO_2 emission and major energy consumer in the world. With the increase in popularity of the production process of textile products in Sri Lanka, they adopted environmental production processes and followed sustainability as a tool for marketing. It was concluded that each company subsequently implemented the sustainability policy in their industries and obtained an eco-friendly environment that improved the revenue and eco-efficiency also.

However, Lo et al. (2012) discussed the environmental management systems for the growth of financial performance in both fashion and textile sectors. Therefore, by the adoption of the environmental management system, the firm operational performance and profitability significantly improved, because profitability improvement was directly linked with cost efficiency and return on sale as per ISO 14000 certification standard. In Bangladesh textile sector controls entire country economic condition due to a large number of textile industries.

This sector exports nearly 28 billion USD per annum which nearly covers the country's 82% export earnings. In Bangladesh, the common export materials were ready-made garments that generally produces large quantities of wastewater, create environmental pollution and discharging a largenumber of waste gases as well. That creates a lot of health issues due to these waste effluents subsequently discharged into river water. Hence, the lack of technology affects the environment to a large extent and other related issues (Hossain et al., 2018). Miller et al. (2018) discussed the construction materials growing with the increasing demand impacting the environment with their production. The primary material was bio-based composites having a longer life, better mechanical properties, and creep deformation and one of the best alternatives than conventional materials. Textile reinforced bio-based composites were better environmental friendly and better life as far as a construction material was concerned. Again, the European Union main focus was waste prevention, eco-design, reuse and recycling of materials that depend on the circular economy. They estimated that nearly 17% textile product gains second life and reuse of textile products also show higher benefits (Koligkioni et al., 2018). Muthukumarana et al. (2018) discussed the environmental impacts in Sri Lanka for creating a sustainable industry that could provide a competitive and strategic advantage in the global market. However, it was observed that due to the lack of limited data available and no specific analysis was done about textile industries environmental concern. Therefore, life cycle analysis was made to quantify the amount of energy used, energy sources, transportation and production rate, etc. for garments products. Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H10:** Environmental impact is positively related to firm performance

3.11. Operational performance

Textile industries in the US after the 1990s showed dramatic changes in the manufacturing of textile products in the global market because trade liberalization and clothing industries were opened in the US textiles market. It was observed that no doubt textile tread was increased, but the domestic manufacturing output in the US steadily decreased. Hence, most of the clothing industries slowly moved to other low salary countries. After the North American Free Trade Agreement, most of the textile industries were able to produce products in partnership with other countries. Due to which, the US textile sector developed had faster growth in collaboration with other developing countries (Seyoum, 2007). Brazil textile sectors were more concern about environmental safety and simultaneously improve competitiveness in the international market. They always used a well-defined structured procedure to reduce their other costs and expenses.

Lucato et al. (2017) investigated through the survey the environmental performance correlated with eco-efficiency level along with the financial performance of textile manufacturing industries by considering both small scale and medium scale industries. They also suggested that due to a limitation in surveying these two parameters, i.e. both environment and financial performance correlation the achievement of financial performance was difficult to achieve. There is a number ofliterature available on the correlation between a firm's inventory and financial performance, but limited research was conducted on operational management and operations managers. This study was focused on the supply-demand mismatch in the firm's safety performance textile and fashion manufacturing sectors. Hence, by adopting this concept the complex operating performance and environment become safe along with significant improvement shown in health, safety management and operational management (Fan and Zhou, 2018).

Aziz et al. (2018) reported that wastewater treatment was one of the tedious challenging tasks in the textile industry and the methods adopted till date were not capable of doing successful treatment. This study explained two inorganic coagulants such as $TiCl_4$ and $ZrCl_4$ having high cationic charges used for the treatment of textile wastewater to remove ammonia, suspended solids, and chemical oxygen demand. Textile industries mainly used a high quantity of fresh water and produced huge quantity of wastewater that is finally transferred to river water, and in few cases, the wastewater was evaporated to the environment generally in textile finishing industries. However, a limited analysis was done to date on woolen textile production with the reduction of water consumption, pollutant load, and wastewater generation by using appropriate technology. There were nearly 82 techniques performed and out of which nine techniques were used for woolen textile production successfully. Finally, they reported that nearly 69% water consumption, wastewater amount nearly 75% and wastewater chemical load by 63% were reduced by minimization technique (Ozturk and Cinperi, 2018).

Information management was also a highly important technique to achieve better process management in the present competitive market and also probably impact on the operational performance. It was also observed that after studying more than 200 manufacturing firms in Australia, the interrelationship between internal and external management information correlated with the internal and external process management successfully (Prajogo et al., 2018). Kovach et al. (2015) observed mainly two factors to improve firm performance in order to achieve the firm's dynamic environment. They also collected nearly 3857 publicly traded firms' data about these factors such as operational scope and operational slack that improved unpredictable environment performance as well as unpredictable environment respectively that ultimately improved firm performance. Kenyon et al. (2016) explained that initiations of supply chain technique improved the performance of manufacturing firms and observed that most of the practitioners as well as academics combined shown best practice. They also reported that supply chain and quality management could help better operational performance when outsourcing production that ultimately improved the new technology and on-time delivery.

However, Sahinkaya et al. (2017) discussed process performance by using dynamic membrane bioreactor for the treatment of wastewater in textile industries. The use of dynamic membrane bioreactor in the dynamic layer could easily detect the soluble organics together with the identification of proteins and polysaccharides respectively through FTIR analysis. As per literature, it was observed that supply chain integration mainly biased to obtain a positive impact on operational performance. The purpose of this discussion was to create a relationship between customer integration as well as operational performance that allows both buyers and suppliers to develop common forecasting. Similarly, Cámara et al. (2016) discussed specific types of supply chain integration and cloud technology as well as a physical flow that improve operational performance. Based on the content of the review literature, the following hypothesis is proposed (Fig. 2).

Hypothesis **H11:** Operational performance in the textile industry is positively related to firm performance

4. Conclusions

The conceptual framework produces a sustainable benchmark to the society; the manufacturing industry as well as policymakers specifically textile industries along with other allied organizations. The following essential points were evolved for developing a clean environment as

- The present textile water-waste management system suffers huge loss in terms of health hazards, product, technology, operational performance, and economic conditions respectively. These waste can be reduced by developing advanced technology, create better labor policy, reuse of textile wastes or effluents for construction as well as agriculture applications.
- Exhaustive literature has been collected to identify the research gap in textile manufacturing sectors and then identify the key sustainable wastewater management practices to improve the performance of sustainable output performance.
- Conceptual framework has been proposed based on the available literature as well as through experts opinion, and the key aspects to be considered in this study is on Labor input in the textile industry, Policy implications, Energy consumption and carbon dioxide emissions, Dyes and additives, Wastewater treatment and disposal, Textile industry productivity, Textile reuse, Improvement of sustainability-related performance, and recycling, Economic performance, Environmental impact, and Operational performance respectively.
- Finally, we acknowledge that this framework needs further analysis for checking the reliability and validity of the conceptual framework by applying empirical framework based on the survey questionnaire data. We believe that this study definitely provides sufficient information to the manufacturing sectors irrespective of the type of sector because by implementing the empirical analysis will provide a better correlation between the STWM practices and sustainable output performance.

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References

Abidi N., Errais E., Duplay J., Berez A., Jrad A., Scheafer G., Ghazi M., Semhi K., Trabelsi-Ayadi M., (2015), Treatment of dye-containing effluent by natural clay, *Journal of Cleaner Production*, **86**, 432-440.

Acar E., Kiliç M., Mücella G., (2015), Measurement of sustainability performance in textile industry by using a multi-criteria decision making method, *Tekstil ve konfeksiyon*, **25**, 3-9.

Ahmed N., Peerlings J.H.M., (2009), Addressing workers' rights in the textile and apparel industries: consequences for the Bangladesh economy, *World Development*, **37**, 661-675.

Almeida R.K., Poole J.P., (2017), Trade and labor reallocation with heterogeneous enforcement of labor regulations, *Journal of Development Economics*, **126**, 154-166.

Al-Salman M.H.A., (2008), Measuring the technological change and productivity in food, textile and chemical industries in Kuwait (1992-2002), *Telematic and Informatics*, **25**, 237-245.

Aly H.Y., Shield M.P., (1999), Privatization and surplus labor in the Egyptian textile industry, *Economics Letters*, **63**, 187-191.

Aziz H.A., Razak M.H.A., Rahim M.Z.A., Kamar W.I.S.W., AbuAmr S.S., Hussain S., Leeuwen J.V., (2018), Evaluation and comparison the performance of titanium and zirconium (IV) tetrachloride in textile wastewater treatment, *Data in Brief*, **18**, 920-927.

Babu J., Murthy Z.V.P., (2017), Treatment of textile dyes containing wastewaters with PES/PVA thin film composite nanofiltration membranes, *Separation and Purification Technology*, **183**, 66-72.

Baskaran V., Nachiappan S., Rahman S., (2012), Indian textile suppliers' sustainability evaluation using the grey approach, *International Journal of Production Economics*, **135**, 647-658.

Belkhir M., Boubakri N., Grira J., (2017), Political risk and the cost of capital in the MENA region, *Emerging Markets Review*, **33**, 155-172.

Belpaire C., Reyns T., Geeraerts C., Loco J.V., (2015), Toxic textile dyes accumulate in wild European eel *Anguilla Anguilla, Chemosphere*, **138**, 784-791.

Bernal D., (2018), A conceptual model for decentralized municipal wastewater management, *Water Practice & Technology*, **13**, 134-142.

Bhuiyan M.A.R., Rahman M.M., Shaid A., Bashar M.M., Khan M.A., (2016), Scope of reusing and recycling the textile wastewater after treatment with gamma radiation, *Journal of Cleaner Production*, **112**, 3063-3071.

Bilinska L., Gmurek M., Ledakowicz S., (2016), Comparison between industrial and simulated textile wastewater treatment by AOPs – Biodegradability, toxicity and cost assessment, *Chemical Engineering Journal*, **306**, 550-559.

Brasil M.V.O., Abreub M.C.S., Filhob J.C.L.S., Leocádio A.L., (2016), Relationship between eco-innovations and the impact on business performance: an empirical survey research on the Brazilian textile industry, *Revista de Administração*, **51**, 276-287.

Busi E., Maranghi S., Corsi L., Basosi R., (2016), Environmental sustainability evaluation of innovative self-cleaning textiles, *Journal of Cleaner Production*, **133**, 439-450.

Butnariu A., Avasilcai S., (2014), Research on the possibility to apply Ecological Footprint as environmental performance indicator for the textile industry, *Procedia - Social and Behavioral Sciences*, **124**, 344-350.

Cámara S.B., Fuentes J.M., Marín J.M.M., (2016), Supply chain integration through community cloud: Effects on operational performance, *Journal of Purchasing & Supply Management*, **22**, 141-153.

Chapman P.M., McDonald B.G., Ohlendorf H.M., Jones R., (2009), A conceptual selenium management model, *Integrated Environmental Assessment and Management*, **5**, 461-469.

Chavan R.B., (2014), Environmental sustainability through textile recycling, Chavan, *Journal of Textile Science and Engineering*, **S2-007**, 1-5.

Chen M., Liu H., Wei S., Gu J., (2018), Top managers' managerial ties, supply chain integration, and firm performance in China: A social capital perspective, *Industrial Marketing Management*, **74**, 205-214.

Choudhury A.K.R., (2017), *Sustainable Chemical Technologies for Textile Production, Sustainable Fibres and Textiles: The Textile Institute Book Series*, Woodhead Publishing UK, 10, 267-322.

Chuah T.G., Jumasiah A., Azni I., Katayon S.Y., Choong T., (2005), Rice husk as a potentially low-cost biosorbent for heavy metal and dye removal: an overview, *Desalination*, **175**, 305-316.

Conway P., (2009), Trade liberalization in textiles: Policy effects in an import-competing industry, *Journal of Policy Modeling*, **31**, 664-680.

Costantini V., Crespi F., Paglialunga E., (2018), The employment impact of private and public actions for energy efficiency: Evidence from European industries, *Energy Policy*, **119**, 250-267.

Cui H., Zhao T., Wu R., (2018), CO_2 emissions from China's power industry: policy implications from both macro and micro perspectives, *Journal of Cleaner Production*, **200**, 746-755.

Dahlbo H., Aalto K., Eskelinen H., Salmenperä H., (2017), Increasing textile circulation - Consequences and requirements, *Sustainable Production and Consumption*, **9**, 44-57.

David P., Ealender M., Watson D., Kiorboa N., Salmenpera H., Dahlbo H., Moliis K., Lyng K.A., Valente C., Gíslason S., Tekie H., Rydberg T., (2014), *Towards a Nordic Textile Strategy: Collection, Sorting, Reuse and Recycling of Textiles*, Nordic Council of Ministers, Ved Stranden 18 DK-1061, Copenhagen K.

Dey S., Islam A., (2015), A review on textile wastewater characterization in Bangladesh, *Resources and Environment*, **5**, 15-44.

Dimakis A.A., Alexandratou A., Balzarini A., (2016), Value chain upgrading in a textile dyeing industry, *Journal of Cleaner Production*, **138**, 237-247.

Diodato D., Neffke F., O'Clery N., (2018), Why do industries coagglomerate? How Marshallian externalities differ by industry and have evolved over time, *Journal of Urban Economics*, **106**, 1-26

Duranton G., Puga D., (2004), Micro-foundations of urban agglomeration economies, *Handbook of Regional and Urban Economics*, **4**, 2063-2117.

Edilberto T. de A., Roberta de M.R., (2018), Labor pooling as an agglomeration factor: Evidence from the Brazilian Northeast in the 2002–2014 period, *Economi A*, **19**, 236-250.

Evangelinos K., Allan S., Jones K., Nikolaou I.E., (2013), Environmental management practices and engineering science: a review and typology for future research, *Integrated Environmental Assessment and Management*, **10**, 153-162.

Fan D., Zhou Y., (2018), Operational safety: The hidden cost of supply-demand mismatch in fashion and textiles related manufacturers, *International Journal of Production Economics*, **198**, 70-78.

Fan Y., Wu S., Lu Y., Wang Y., Zhao Y., Xu S., Feng Y., (2016), An approach of measuring environmental protection in Chinese industries: a study using input-output model analysis, *Journal of Cleaner Production*, **137**, 1479-1490.

Fedderke J.W., Hill A.J., (2011), Industry structure and labor market flexibility in the South African manufacturing sector: A time series and panel data approach, *Economic Modelling*, **28**, 1291-1302.

Fischer A., Pascucci S., (2017), Institutional incentives in circular economy transition: The case of material use in the Dutch textile industry, *Journal of Cleaner Production*, **155**, 17-32.

Fortuna M.E., Simion I.M., Ghinea C., Petraru M., Cozma P., Apostol L.C., Hlihor R.M., Fertu D.T., Gavrilescu M., (2012), Analysis and management of specific processes from environmental engineering and protection based on sustainability indicators, *Environmental Engineering and Management Journal*, **11**, 333-350.

Fujita M., Thisse J.F., (2013), *Economics of Agglomeration: Cities, Industrial Location, and Globalization*, Cambridge University Press, New York.

Gardas B.B., Raut R.D., Narkhede B., (2018), Modelling the challenges to sustainability in the textile and apparel (T&A) sector: A Delphi-DEMATEL approach, *Sustainable Production and Consumption*, **15**, 96-108.

Gebrati L., Achaby M.E., Chatoui H., Laqbaqbie M., Kharraz J.E.l., Aziz F., (2018), Inhibiting effect of textile wastewater on the activity of sludge from the biological treatment process of the activated sludge plant,*Saudi Journal of Biological Sciences*, doi.org/10.1016/j.sjbs.2018.06.003.

Ghinea C., Campean T., Gavrilescu M., (2017), Integrating sustainability indicators for tracking anthropogenic pressure on the earth the footprint family, *Environmental Engineering and Management Journal*, **16**, 935-948.

Guedes G., Ferreira F., Urbano L., Marques A., (2017), Corporate social responsibility: competitiveness in the context of textile and fashion value chain, *Environmental Engineering and Management Journal*, **16**, 1193-1202.

Güyer G.T., Nadeem K., Dizge N., (2016), Recycling of pad-batch washing textile wastewater through advanced oxidation processes and its reusability assessment for Turkish textile industry, *Journal of Cleaner Production*, **139**, 488-494.

Hasanbeigi A., Price L., (2012), A review of energy use and energy efficiency technologies for the textile industry, *Renewable and Sustainable Energy Reviews*, **16**, 3648-3665.

Hasanbeigi A., Price L., (2015), A technical review of emerging technologies for energy and water efficiency and pollution reduction in the textile industry, *Journal of Cleaner Production*, **95**, 30-44.

Hong G.B., Su T.L., Lee J.D., Hsu T.C., Chen H.W., (2010), Energy conservation potential in Taiwanese textile industry, *Energy Policy*, **38**, 7048-7053.

Hossain L., Sarker S.K., Khan M.S., (2018), Evaluation of present and future wastewater impacts of textile dyeing industries in Bangladesh, *Environmental Development*,**26**, 23-33.

Huang B., Zhao J., Geng Y., (2017), Energy-related GHG emissions of the textile industry in China, *Resources,Conservation and Recycling*, **119**, 69-77.

Jahanshahloo G.R., Khodabakhshi M., (2004), Suitable combination of inputs for improving outputs in DEA with determining input congestion Considering textile industry of China, *Applied Mathematics and Computation*, **151**, 263-273.

Jiang L., Folmer H., Bu M., (2016), Interaction between output efficiency and environmental efficiency: evidence from the textile industry in Jiangsu Province, China, *Journal of Cleaner Production*, **113**, 123-132.

Kenyon G.N., Meixell M.J., Westfall P.H., (2016), Production out sourcing and operational performance: An empirical study using secondary data, *International Journal of Production Economics*, **171**, 336-349.

Koligkioni A., Parajuly K., Sørensen B.L., Cimpan C., (2018), Environmental assessment of end-of-life textiles in Denmark, *Procedia CIRP*, **69**, 962-967.

Kovach J.J., Hora M., Manikas A., Manikas A., Patel P.C., (2015), Firm performance in dynamic environments: The role of operational slack and operational scope, *Journal of Operations Management*, **37**, 1-12.

Krugman P.R., (1991), *Geography and Trade*, MIT Press, Cambridge, MA.

Kulkarni M.G.J., Dwivedi A.K., Jahgirdar S., (2012), Textile mill sludge as fine aggregate in concrete, *Global Journal of Researches in Engineering: Industrial Engineering*, **12**, 21-26.

Kumar K.V., Porkodi K., (2009), Equilibrium and thermodynamics of dye removal from aqueous solution by adsorption using rubber wood saw dust, *International Journal of Environmental Technology and Management*, **10**, 295-307.

Küsters D., Praß N., Gloy Y.S., (2017), Textile Learning Factory 4.0 – Preparing Germany's textile industry for the digital future, *Procedia Manufacturing*, **9**, 214-221.

Lekshmi S., Sasidharan S., (2015), Experimental investigationon the use of textile sludge in concrete, *International Journal of Advances in Engineering & Technology*, **8**, 559-565.

Lenzo P., Traverso M., Mondello G., Salomone R., Ioppolo G., (2018), Sustainability performance of an Italian textile product, *Economies*, **6**, 1-12.

Li F., Huang J., Xiaa Q., Loua M., Yanga B., Tiana Q., Liu Y., (2018), Direct contact membrane distillation for the treatment of industrial dyeing wastewater and characteristic pollutants, *Separation and Purification Technology*, **195**, 83-91.

Lin B., Moubarak M., (2013), Decomposition analysis: Change of carbon dioxide emissions in the Chinese textile industry, *Renewable and Sustainable Energy Reviews*, **26**, 389-396.

Lin B., Moubarak M., (2014), Mitigation potential of carbon dioxide emissions in the Chinese textile industry, *Applied Energy*, **113**, 781-787.

Lin B., Zhao H., (2016), Technological progress and energy rebound effect in China's textile industry: Evidence and policy implications, *Renewable and Sustainable Energy Reviews*, **60**, 173-181.

Lin H.L., Li H.Y., Yang C.H., (2011), Agglomeration and productivity: Firm-level evidence from China's textile industry, *China Economic Review*, **22**, 313-329.

Lin K.J., Tan J., Zhao L., Karim K., (2015), In the name of charity: Political connections and strategic corporate social responsibility in a transition economy, *Journal of Corporate Finance*,**32**, 327-346.

Lin B., Chen Y., Zhang G., (2018), Impact of technological progress on China's textile industry and future energy saving potential forecast, *Energy*, **161**, 859-869.

Lo C.K.Y., Yeung A.C.L., Cheng T.C.E., (2012), The impact of environmental management systems on financial performance in fashion and textiles industries, *International Journal of Production Economics*, **135**, 561-567.

Long Y., Yoshida Y., Zhang R., Lu S., Yi D., (2018), Policy implications from revealing consumption-based carbon footprint of major economic sectors in Japan, *Energy Policy*, **119**, 339-348.

Lu X., Liu L., Liu R., Chen J., (2010), Textile wastewater reuse as an alternative water source for dyeing and finishing processes: A case study, *Desalination*, **258**, 229-232.

Lucato W.C., Costa E.M., Neto G.C.O., (2017), The environmental performance of SMEs in the Brazilian textile industry and the relationship with their financial performance, *Journal of Environmental Management*, **203**, 550-556.

Luthra S., Mangla S.K., (2018), Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies, *Process Safety and Environmental Protection*, **117**, 168-179.

Mair S., Druckman A., Jackson T., (2016), Global inequities and emissions in Western European textiles and clothing consumption, *Journal of Cleaner Production*, **132**, 57-69.

Malik P.K., (2003), Use of activated carbons prepared from sawdust and rice-husk for adsorption of acid dyes: a case study of Acid Yellow 36, *Dyes and Pigments*, **56**, 239-249.

Martínez C.I.P., (2010), Energy use and energy efficiency development in the German and Colombian textile industries, *Energy for Sustainable Development*, **14**, 94-103.

Meksi N., Moussa A., (2017), A review of progress in the ecological application of ionic liquids in textile processes, *Journal of Cleaner Production*, **161**, 105-126.

Mengdi L., Ron S., Bing Z., (2017), Does Environmental regulation affect labor demand in China? Evidence from the textile printing and dyeing industry, *Journal of Environmental Economics and Management*, **86**, 277-294.

Miller S.A., (2018), Natural fiber textile reinforced bio-based composites: Mechanical properties, creep, and environmental impacts, *Journal of Cleaner Production*, **198**, 612-623.

Monteiro H., Caldeira F., Pinto J., Varum H., (2018), Recycling textile residues into cement composites, *Environmental Engineering and Management Journal*, **17**, 1863-1868.

Moore S.B., Ausley L.W., (2004), Systems thinking and green chemistry in the textile industry: concepts, technologies and benefits, *Journal of Cleaner Production*, **12**, 585-601.

Mostafa H.M., Rashed E.M., Mostafa A.H., (2005), *Utilization of By-Pass Kiln Dust for Treatment of Tanneries Effluent Wastewater*, Ninth International Water Technology Conference, IWTC9 2005, Sharm El-Sheikh, Egypt.

Muthukumarana T.T., Karunathilake H.P., Punchihewa H.K.G., Manthilake M.M.I.D., Hewage K.N., (2018), Life cycle environmental impacts of the apparel industry in Sri Lanka: Analysis of the energy sources, *Journal of Cleaner Production*, **172**, 1346-1357.

Mwangi M.W., Thuo A.D.M., (2014), Towards conceptual and theoretical foundation for identifying problems, challenges and mechanisms for municipal waste management in developing countries, *International Journal of Innovation and Scientific Research*, **2**, 230-251.

Nadeem K., Guyer G.T., Dizge N., (2017), Polishing of biologically treated textile wastewater through AOPs and recycling for wet processing, *Journal of Water Process Engineering*, **20**, 29-39.

Nadiria M.I., Nandi B., Akoz K.K., (2018), Impact of modern communication infrastructure on productivity, production structure and factor demands of US industries: Impact revisited, *Telecommunications Policy*, **42**, 433-451.

Naud W., Rossouw R., (2008), South African quotas on textile imports from China: A policy error, *Journal of Policy Modeling*, **30**, 737-750.

Nimkar U., (2017), Sustainable chemistry: A solution to the textile industry in a developing world, *Current Opinion in Green and Sustainable Chemistry*, **9**, 13-17.

Njikam O., (2016), Trade liberalization labormarket regulations and labor demand in Cameroon, *International Review of Economics and Finance*, **43**, 525-541.

Nunes L.J.R., Matias J.C.O., Catalao J.P.S., (2015), Analysis of the use of biomass as an energy alternative for the Portuguese textile dyeing industry, *Energy*, **84**, 503-508.

Ozturk E., Cinperi N.C., (2018), Water efficiency and wastewater reduction in an integrated woolen textile mill, *Journal of Cleaner Production*, **201**, 686-696.

Palm D., (2011), *Improved Waste Management of Textiles*, IVL Swedish Environmental Research Institute Ltd., Stockholm.

Pattnaik P., Dangayach G.S., Bhardwaj A.K., (2018), A review on the sustainability of textile industries wastewater with and without treatment methodologies, *Reviews on Environmental Health*, **33**, 163-203.

Paul R., Adzet J.M., Brouta-Agnésa M., Balsells S., Esteve H., (2012), Hydrolyzed collagen: A novel additive in cotton and leather dyeing, *Dyes and Pigments*, **94**, 475-480.

Paz A., Carballo J., Perez M.J., (2017), Biological treatment of model dyes and textile wastewaters, *Chemosphere*, **181**, 168-177.

Prajogo D., Toy J., Bhattacharya A., Oke A., Cheng T.C.E., (2018), The relationships between information management, process management and operational performance: Internal and external contexts, *International Journal of Production Economics*, **199**, 95-103.

Resta B., Gaiardelli P., Pinto R., Dotti S., (2016), Enhancing environmental management in the textile sector: An organisational-life cycle assessment approach, *Journal of Cleaner Production*, **135**, 620-632.

Rossi T., Silva P.M.S., De Moura L.F., Araújo M.C., Brito J.O., Freeman H.S., (2017), Waste from eucalyptus wood steaming as a natural dye source for textile fibers, *Journal of Cleaner Production*, **143**, 303-310.

Sahinkaya E., Yurtsever A., Çınar Ö., (2017), Treatment of textile industry wastewater using dynamic membrane bioreactor: Impact of intermittent aeration on process performance, *Separation and Purification Technology*, **174**, 445-454.

Samuel S., (2018), A conceptual framework for teaching management accounting, *Journal of Accounting Education*, **44**, 25-34.

Sandin G., Peters G.M., (2018), Environmental impact of textile reuse and recycling - A review, *Journal of Cleaner Production*, **184**, 353-365.

Saraya M.E.I., Aboul-Fetouh M.E.S., (2012), Utilization from cement kiln dust in removal of acid dyes, *American Journal of Environmental Sciences*, **8**, 16-24.

Sawaf M.B.A., Karaca F., (2018), Different stakeholders' opinions toward the sustainability of common textile wastewater treatment technologies in Turkey: A Case study Istanbul province, *Sustainable Cities and Society*, **42**, 194-205.

Seyoum B., (2007), Trade liberalization and patterns of strategic adjustment in the US textiles and clothing industry, *International Business Review*, **16**, 109-135.

Shaid A., Osman M.S., Hannan M.A., Bhuiyan M.A.R., (2013), Direct reusing of textile wastewater in scouring-bleaching of cotton goods devoid of any treatment, *International Journal of Engineering Research and Development*, **5**, 45-54.

Shiwanthi S., Lokupitiya E., Peiris S., (2018), Evaluation of the environmental and economic performances of three selected textile factories in Biyagama export processing zone, *Environmental Development*, **27**, 70-82.

Shui S., Wohlgenant M.K., Beghin J.C., (1993), *Policy Implications of Textile Trade Management and the U.S. Cotton Industry*, Iowa State University, On line at: https://works.bepress.com/john-beghin/147/.

Silva L.G.M., Moreira F.C., Souza A.A.U., Souza S.M.A.G.U., Boaventura R.A.R., Vilar V.J.P., (2018), Chemical and electrochemical advanced oxidation processes as a polishing step for textile wastewater treatment: A study regarding the discharge into the environment and the reuse in the textile industry, *Journal of Cleaner Production*, **198**, 430-442.

Wadho W., Chaudhry A., (2018), Innovation and firm performance in developing countries: The case of Pakistani textile and apparel manufacturers, *Research Policy*, **47**, 1283-1294.

Wang R., (2018a), Energy efficiency in China's industry sectors: A non-parametric production frontier approach analysis, *Journal of Cleaner Production*, **200**, 880-889.

Wang S., Ma Y., (2018b), Influencing factors and regional discrepancies of the efficiency of carbon dioxide emissions in Jiangsu, China, *Ecological Indicators*, **90**, 460-468.

Wang M., Liu J., Chan H.L., Choi T., Yue X., (2016a), Effects of carbon tariff strading policy on duopoly market entry decisions and price competition: Insights from textile firms of developing countries, *International Journal of Production Economics*, **181**, 470-484.

Wang Y., Ge X., Liu J.l., DingZ., (2016b), Study and analysis of energy consumption and energy related carbon emission of industrial in Tianjin, China, *Energy Strategy Reviews*, **10**,18-28.

Wickramasinghe D., Hopper T., (2005), A cultural political economy of management accounting controls: a case study of a textile mill in a traditional Sinhalese village, *Critical Perspectives on Accounting*, **16**, 473-503.

Wong K.K., Lee C.K., Low K.S., Haron M.J., (2003), Removal of Cu and Pb by tartaric acid modified rice husk from aqueous solutions, *Chemosphere*, **50**, 23-28.

Yin J., Zheng M., Li X., (2016), Interregional transfer of polluting industries: a consumption responsibility perspective, *Journal of Cleaner Production*, **112**, 4318-4328.

Zabaniotou A., Andreou K., (2010), Development of alternative energy sources for GHG emissions reduction in the textile industry by energy recovery from cotton ginning waste, *Journal of Cleaner Production*, **18**, 784-790.

Zheng D., Shi M., (2018), Industrial land policy, firm heterogeneity and firm location choice: Evidence from China, *Land Use Policy*, **76**, 58-67.

Zhou L., Xu K., Cheng X., Xu Y., Jia Q., (2017), Study on optimizing production scheduling for water-saving in textile dyeing industry, *Journal of Cleaner Production*, **141**, 721-727.

Zhu L., Chen L., Wu X., Ding X., (2018), Developing a greenhouse gas management evaluation system for Chinese textile enterprises, *Ecological Indicators*, **91**, 470-477.