Research Paper Management

A Successful Case to Adopt Green Purchasing System

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ABSTRACT

In recent years, public attention to environmental protection has grown to an unprecedented level. Many international textile brands have switched to purchasing textile materials that comply with environmental standards. Brand companies in EU, US, Japan, and many other advanced nations will release their restricted substance lists (RSLs) on a regular basis to indicate the substances they restrict using and the content of substances of very high concern (SVHC). However, with the rapid growth of the list of restricted substances and SVHC, the requirement for constant updating and confirming RSLs with buyers has become a serious burden on Taiwan's textile industry. This paper introduces a successful case of adoption of Green Textile Cloud Services (GTCS) in Taiwan. This company uses GTCS to enhance its efficiency in managing RSLs of different customers and establish effective green supply chain purchasing and outsourcing policies.

KEYWORDS Restricted Substance Lists; Cloud Service; Green Purchasing; Textile Industry

1. Research Background

The textile industry is the earliest staple industry in Taiwan. In 2004, it became the fourth largest industry with a trade surplus, generating a total value of export of US$11.7 billion. The weaving and dyeing companies in this industry are the locomotive of export of textile products, as the value of export it created in 2014 reaches as high as US$7.318 billion. The weaving and dyeing sector plays a key role in value creation in Taiwan's textile industry. It utilizes specialized chemicals, such as liquid polymers and surfactants, in its manufacturing processes to increase the value added to textile products. With the rise of environmental awareness and the emergence of the notion of corporate social responsibility (CSR) in recent years, businesses around the world are making an effort in promotion of environmental protection and eco-friendly products. Many international textile companies, such as Marks & Spencer, Patagonia, Timberland, Nike, Adidas, and Gap have switched to using eco-friendly textile materials. Other companies in EU, USA, Japan, and many other advanced nations also update their Restricted Substance Lists (RSLs) on a regular basis. This trend toward environmental protection has caused an impact on businesses in the chemistry industry. For example, EU restricts the use of Alkylphenol Ethoxylates (APEO). All products sold to the market in EU must be APEO-free and compliant with Oeko-Tex Standard 100. The Regulation on Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) went into force in 2007. It is a regulation developed by EU for management of more than 30,000 chemicals. In April, 2011, The International Oeko-Tex Association released Oeko-Tex Standard 100, which is a testing and certification system for textile raw materials. It provides a candidate list of SVHC that includes 8 chemicals that were added into REACH in 2010. This global trend manifests two social expectations. First, in order to ensure product safety and consumer health, the content of harmful substances in end products must be lower than the specified minimum level. Second, in order to minimize adverse impacts on the environment, the textile industry should comply with environmental regulations throughout the life cycle of their products, from design, production, disposal to recycling.

Today's green supply chain management differs from traditional supply chain management. It integrates technologies of green design management, green production processes, sales, product recycling and reuse to create a circular economy. Hence, it has a significant meaning and impact on environmental protection and sustainable development. The main components of green supply chain management are as follows: (1) Green design: Roy (1994) pointed out that the aims of ecological designs are to increase product durability, improve energy efficiency, avoid use of toxic raw materials, and develop recyclable products. In industrial design, the core elements of green designs are 3Rs, namely reduce, recycle, and reuse. (2) Green supplier selection: The risk incurred by any environmental issue will ultimately be passed on from the supplier to downstream firms in the supply chain, and a green supply chain becomes ineffective without participation of all supply chain partners (Lee, 2008). According to Darnall (2006), as environmental regulations are becoming stringent around the world, more and more businesses are voluntarily devoted to compliance with ISO 14001 and also require their suppliers pass the certification within a specific time. Nagel (2002) mentioned that the operation of a supply chain requires participation and support of multiple suppliers. Because stricter regulations are imposed on choice of raw materials, it is necessary to consider environmental monitoring and improvement performance in supplier assessment. (4) Green purchasing: According to US Environmental Protection Agency (EPA), green purchasing is the procurement of products and services that have a reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. Zsidisin and Hendrick (1998) summarized 11 activities of green purchasing and identified 4 key factors of green supply chain management, including hazardous materials, investment recovery, product design, and supply chain relationship. (4) Green production: VoB et al. (2005) suggested that green production is a circular production system, and a redesign of the production model is necessary for companies planning to shift away from traditional production approaches to green production approaches. Goggin and Browne (2002) proposed Customer Order Decoupling Point for Recovery operation (R-CODP) to describe the production with recycled products under different recovery strategies. (5) Green logistics: Carter and Ellram (1998) defined reverse logistics as a process where a manufacturer accepts previously shipped products from the point for consumption for possible recycling, reusing, and reduction of use of raw materials.

Today, companies in the textile industry are in a situation where they have to comply with varying regulations and RSLs of their buyers and build efficient purchasing and outsourcing policies so as to produce green products that meet market demands. In this paper, we will investigate difficulties they have encountered in seeking compliance with environmental regulations and report the procedure and innovative method that a leading textile company in Taiwan has adopted to implement a cloud services system. The effectiveness of this system for this company will also be examined. Results of this study can be a reference for other textile companies seeking long-term development.

2. Introduction to the Case Company

The case company was established in 1970s. Its products can be divided by buyer type into two groups. For upstream firms, it produces nylon chips and nylon filament. For downstream firms, it produces trousers materials, nylon fabric, decorative fabric, shade fabric, fire-resistant fabric, Lycra fabric, micro-fiber fabric, artificial chamois leather, tight twist fabric, synthetic fiber fabric, and long-filament fabric. It also provides post-processing services, including dyeing and painting. In the present, it is the world's second largest and the Asia's first largest nylon production company. In Taiwan, it is the largest textile that offers comprehensive services from weaving to dyeing and also a well-known maker of recycled fiber.

The core idea behind the environmental policy of this company is to achieve harmonious existence with the natural environment and ecological systems. The management of this company is based on four pillars: (1) produce "more from less" and improve resource productivity: eliminate unnecessary waste of raw materials, processes, and energy and minimize waste disposal; (2) design for the environment: develop eco-friendly products; (3) pay attention to the life cycle of products: develop and utilize recyclable yarns; (4) seek compliance of subcontractors: demand all subcontractors to avoid or reduce use of toxic substances in the production process and pass certification of Oeko-Tex 100 Standard, OHSAS18001, and ISO14001 in 2000.

3. The Problems of Green Control in the Past

Generally, green control encompasses selection of raw materials, production, use, and disposal. Companies of international brands know how to apply environmental products but are still at the exploratory stage of life cycle management for eco-friendly textile products. In recent years, a few companies have switched their sources of eco-friendly materials to developing nations due to cost consideration but suffered a serious damage of reputation after their products were found incompatible with the spirit of environmental protection. Their loss was mainly associated with insufficient understanding of the life cycle control of eco-textile products. In the past, brand companies needed to evaluate whether the delivery and specification of a product meets market demands. In the era of environmental protection, in addition to the above-mentioned factors, they need to consider all the factors related to the life cycle of the product. The case company faces the following issues in green control:

- Control and distribution of regulations: In the past, when there was a change in the buyer's regulation, the company would use document or email to notify the Sales Department, and the sales department would directly hand the document to the Intellectual Property Office (IPO) for review. After the review was passed, the sales department would verify details in the document and send the letter of guarantee. This procedure has the following problems: (a) The sales department serves only as a window for data reception. IPO has to review each buyer's RSL, which is very time-consuming. (b) IPO has to perform the review based on their know-hows, so negligence is likely to occur. (c) Regulatory documents and letters of guarantee are stored in hard copy, which makes diffusion of information difficult. (d) Control of regulations, products, and use of materials is not integrated, adding risk of not meeting customer requirements.
- Control of green materials: In the past, IPO would manually confirm the product items involved in the change of regulations and then open the bill of materials (BOM) from enterprise resource planning (ERP) system to identify materials and suppliers that should be updated in the letter of guarantee. The Material and Equipment Office (MEO) was be responsible for updating the letter of guarantee. Staff in this office would send the updated data to the supplier by fax or email, and the supplier had to verify the data and affix an official seal to indicate agreement. The supplier would indicate materials that they could not guarantee at the remarks column. This procedure has the following problems: (a) Manual verification of product items involved in the change of regulations is time-consuming, effort intensive, and subject to human error. (b) In the absence of a lock mechanism to be imposed on the involved product items, continuous procurement of materials during the guarantee confirmation stage and the coping stage poses a high risk for the business. (c) Documents of materials (e.g. MSDS, manual, testing reports, and letters of guarantee) are not managed using an information system, so it is not easy to achieve an value-added application of the documents. (d) Due to insufficient knowledge of regulations, the supplier needs a longer period of time to evaluate the items to guarantee.
- Purchasing operation: In the past, staff of the Production Management Office (PMO) had to submit the purchase requisition form to their manager for approval. If approved, MEO would ask suppliers of the needed items to provide a quote or negotiate prices with them. After the supplier was confirmed, a purchase order would be created. The order had to be approved by MEO manager. If approved, the order would be placed. This procedure has the following problems: (a) In the absence of an abnormity notification mechanism, the procurement staff might not be able to confirm material numbers and regulatory compliance of the supplier. (b) Due to transmission of data via paper, the transparency of the progress is low, and so is the procurement efficiency. (c) Past quotes are not available for reference, so the cost of procurement is hard to control.
- Coping operation: For non-guaranteed materials that are viewed as abnormal materials, RD staff will launch a "coping project". In the past, sample approval request forms had to be reviewed by MEO manager. MEO manager and the manager of Analysis Office (AO) would verify the necessity of the change. After the coping project was created, AO would check up the SOPs in the company's internal system to determine the unit, content, and standard values for sample testing. The test results would be documented and delivered to the manager for verification. Finally, the results would be delivered to MEO, which would then register the data of the qualified supplier into the ERP system. This procedure has the following problems: (a) The reason for change is not documented in the sample approval request form, making information tracking difficult. (b) A moderator is not available to coordinate or make the final decision if MEO and RD units have inconsistent opinions. (c) All departments participating in the test compile the test reports independently and then submit them to AO for summarization. Manual typing is likely to occur in the summarization process. (d) This sequential operation is not efficient, and project information is not transparent.

4. A Cloud System for Supporting Green Control

Not only the case company is bothered by the above-mentioned problems, nearly all textile companies concerned about green production have similar experiences. Therefore, a cloud system called Green Textile Cloud Services (GTCS) was introduced to solve their problems. The development, implementation, and operation of this system has been funded by a civic organization in Taiwan based on its rich experiences in providing support to local textile companies. The system was developed in 2011 and went online in 2012. As of early 2015, this system has a total of 394 members, including 7 central textile firms, 1 central special chemicals firm, and 387 satellite firms.

This system uses a single channel to collect and manage RSLs of various international brand companies and distributors. Through subscription and comparison on this system, textile companies can enhance their efficiency in managing multiple RSLs and comparing differences between revisions. This system consists of the following modules: (1) Customer-end RSL management: regulations conversion, regulations classification and maintenance, RSL comparison and search; (2) Materials coping: green materials control and materials coping control; (3) Green purchasing management: online purchase requisition, online price quotation, comparison, and negotiation, online purchasing, materials traceability query, and billing management; (4) Green outsourcing management: subcontractor management, quotation, outsourcing, and instant online query.

The case company expected the following benefits from using GTCS:

1. Transparency of RSLs: As of today, a universally unified RSL is still unavailable. Different brands and markets have different standards for use of restricted substances. The revision time, content of the list, names of the substances (scientific and common names), restricted values, restricted units, and test methods also vary. While dyes are usually coded by Colour Index Number (CI No.), chemicals are coded by CAS Registry Number (CAS No.) or EC Number (EC No.). The case company expected to use this system to perform automatic comparison of substances based on CAS or CI numbers, so that users could identify differences in restricted value between regulations. When sales staff receives a market-end RSL, the staff can consult items requested by the consumer in the system and quickly confirm whether it is feasible to take the order.
2. Green supplier and green materials procurement management: There are associations between materials and regulations. For instance, alkylphenol polyethoxylate (APEO) is the main component of many auxiliaries commonly used in the textile industry, including emulsifiers, penetrants, and refined cleansers. When there is any change in a regulation on APEO use, the company has to confirm with suppliers of these auxiliaries respectively and request them to sign a new letter of guarantee. Besides, disinfectants are also related to restricted substances in agricultural chemicals. When there is any change in an RSL for agricultural chemicals, the company has to update their letters of guarantee. Deeply aware of the importance of the associations between materials and regulations, the company hoped to build an effective management mechanism to quickly get hold of the compliance of the materials they use. By creating associations between materials and regulations, the company is able to quickly identify materials whose letters of guarantee should be updated when there is a change in regulations. Through this mechanism, the company can be assured of the green compliance of the materials they use and their suppliers.
3. Green traceability information: In the past, brand companies (exporters) would compile green traceability information based on regulatory requirements of the importing country. The case company had to go through many communications with suppliers and cooperating firms to ensure regulatory compliance of the final green traceability information. The case company hoped to create green traceability documents for its products. Starting from the design stage, the company's business planners collected data based on customer demands and then linked all the related sample testing requests, specifications, material reports, sample testing reports, and the supplier's letter of guarantee to the project number and BOM. If any foreign consumer requests information about a product, the company only needs to log into the system and input the product number. The system will provide all the details on the materials used, production processes, and testing reports. Besides, with standardized or predesigned report templates, the system can also automatically generate reports, helping customers save a lot of time on information search and collection.

5. The Adoption Procedure for GTCS

Overall, the case company implemented GTCS in three stages as follows:

1. Pre-adoption preparation (2013/03~2013/05)

(1) Clarify green product policies: Green product policies provide the fundamental principles for green supply chain management. The case company had to consider eco-design concepts during product development and make sure that they use only additives and materials that are compliant with environmental standards. They sought to achieve "low toxic level", "extended durability", "energy reduction", and "high recyclability" while following the 3Rs, namely reduce, recycle and reuse.

(2) Build a consensus over adoption of GTCS among upstream and downstream firms

Supply chain members play a pivotal role in green management. The case company recognized the importance of building a consensus and a standardized operating process among them first, so it planned the following actions to ensure smooth implementation of the system:

(a) All the managers of affiliated businesses were asked to invite their suppliers to join a supplier conference or visit suppliers in person. They had to explain to their suppliers the importance and focuses of green control and build a consensus at executive level. During the adoption period, the case company held 4 supplier conferences (the number of participating firms reached 245 firms) and asked their managers to visit a total of 45 firms.

(b) In order to increase suppliers' intention to participate in this system, the case company shortened the maturity date of its payment checks from 1 month to 0.5 month. This indeed offered a strong incentive for suppliers to join the system. Later, the case company signed product and service agreements with the suppliers and also requested them to fill out the letter of commitment to nonuse of restricted substances and a restricted substances content survey. From upstream suppliers of raw materials to midstream production firms, downstream post-processing firms, and end-users, all these were the subjects in the case company's green supply chain management. The case company had to consider restricted substances in management of these members. For instance, the case company achieved a consensus with 245 suppliers. It demanded them to view compliance with standards for restricted substances as the first priority, sign letters of commitment to nonuse of these substances, and provide the restricted substances content survey results (including the test reports) for future references.

(c) As most members working with the case company had a low e-business activity level, the case company saw potential difficulty in exchanging information electronically with them. After several meetings with project members, the company decided to set up an information support team and offer US$667 to every supplier in the supplier chain. The goal was to bring up the e-business level of these firms and integrate the existing information systems among them.

2. Execution of the adoption plan (2013/05~2014/12)

(1) Set up standards for restricted substances based on customer specifications: When setting up internal standards for restricted substances, the case company would consider customers' specifications and the requirements of international regulations, such as Oeko-tex or Bluesign (which prohibits use of 6 chemical substances, including Pb, Cd,

Hg, and Cr6+, and two frame retardants, including PBB and PBDE, starting in July 1, 2006). The company applied the standards for restricted substances to procurement, quality test, and use of materials. The samples (homogeneous materials) of main materials and sub-materials must comply with Oeko-tex or Bluesign in the preprocessing selection. Now, the company's database of standards includes RSLs of thirty-two international brand companies and three international regulations, and this list is still growing.

(2) Filter currently used materials based on environmental regulations: The RD units and MEO of the case company checked all the currently used materials to see if any contains restricted substances. They found that a total of 2302 materials were compliant. Of these materials, 26% were sizing agents, 4% were knitting oils, 29% were preprocessing agents, 27% were dyeing agents, 11% were special processing agents, and 3% were functional chemicals.

(3) Identify main materials and sub-materials: During implementation of green products, the case company had to make use of information systems to differentiate green products and materials, including the main and sub-materials of restricted substances. The case company would separate materials of restricted substances from other materials to avoid misuse of them in green products.

(4) Design green management documents: The documents include the green process management performance record, design and development control sheet, the sheet of processing and storage processes for restricted substances, and the disqualified item record sheet.

(5) Compile green traceability information: Starting from the design stage, the company would compile green traceability documents according to customer needs and associate all the sample testing requests, specifications, material reports, sample testing reports, and the supplier's letter of guarantee based on project number and BOM. In the future, if any foreign consumer requests information about any product, the company only needs to log into the EIP system and input the product number. The system will then provide all the details on the materials used, production processes, and testing reports. Besides, with standardized or predesigned report layouts, the system can automatically generate reports, helping customers save a lot of time on information search and collection.

(6) Build a restricted substances content database: The case company performed a thorough check of the content of restricted substances in all the main materials and sub-materials and registered the results in the restricted substances content database. This database is constantly updated and can be used as a foundation for future procurement and testing of materials.

(7) Update RSLs: The case company developed a standardized process for identifying green products, semi-finished products, non-green semi-products, and the possibility of contamination. This process will be used to record the use of controlled main materials and sub-materials within the limited range.

3. Auditing and diffusion after adoption (2015~present)

(1) Supplier auditing: Supplier cooperation in meeting the requirements of the green product management system is critical to the success of the entire green supply chain. The goal of supplier auditing is to verify if the supplier can offer green products or to provide necessary help to the supplier while communicating the company's green policy. Currently, the case company audits suppliers of main materials once every six months and suppliers of MRO (maintenance, repair, and operations) components once a year.

(2) Internal green management system auditing: The case company audits the internal green management system on a quarterly basis. The auditing is intended to evaluate if the current environmental management processes comply with regulations and customer requirements and to ensure effective implementation of the green product policy of the company.

(3) Managerial review and performance reporting: All management staff in the case company are required to review the utilization and effectiveness of GTCS on a quarterly basis and decide how they will improve their performance in the future.

(4) Green optimization through elimination plans: In the product design or development stage, the case company would evaluate if the specifications of the product or its materials comply with customer and regulatory requirements on nonuse of restricted substances. If any restricted substance is used, the company would set up a material coping project based on the scope of use of the restricted substance and create a written elimination plan and quantitative goal, which includes the method to control the use of the restricted substance and the plan to replace/eliminate use of materials containing the substance. All of the environmental impact, public concern, technical consideration, financial and operational impact will be considered in the plan.

(5) Diffusion of the application: In this industry, brand companies of a considerable size usually have their own specifications. Although their specifications are generally similar but the content varies from one company to another. In the absence of unified forms, suppliers are required to fill out a variety of forms, and suppliers in upper stream usually have to deal with more complicated forms. The case company is considerable in size and has better knowledge of the specifications and technical conditions of its raw materials. It has a specialized team in the RD center to take charge of form conversion, data reporting, customer communication, and many other technical tasks. This specialized team is responsible for designing unified forms to ensure efficiency of data registration and conversion across the company. Besides, this team will also import data into GTCS and send key raw materials to a third-party test company for testing.

6. Current Green Control Process under GTCS

- Control and distribution of regulations: After adoption of GTCS, the sales assistant will file all the customers' regulations and letters of guarantee passed on to them along with the electronic files provided by customers. If the customer's request conforms to the RSLs of the company, the assistant can print out the letter of guarantee immediately; if not, the case will be handed over to the Special Project Section of IPO. The Special Project Section will use the platform to file the data and submit it to IPO, which will verify non-guaranteed items and release the results. The entire process is as illustrated in Figure 1. The mechanisms involved in this process include as follows. (a) The system automatically uses the set of most stringent restrictions as the RSL of the company. (b) The CAS NO. or CI NO. of the material must be provided, so that the system can summarize the RSL of the company. (c) If a regulation is pending maintenance, revision of the regulation is not allowed; (d) To simplify the items to evaluate, IPO will list items to verify according to the most stringent RSL of the company.
- Green material control: After IPO releases a new regulation, GTCS will summarize product items involved in the change of the regulation. It will also integrate ERP BOM to automatically lock the data of related materials and inform MEO and Production Management Office. When there is a need to update suppliers' letters of guarantee, MEO will use GTCS to inform suppliers online. Suppliers can download the form, sign it, and send it back to the company all via the system. MEO staff can use the system to verify the availability of letters of guarantee before deciding to unlock certain materials. The entire process is as shown in Figure 2. The mechanisms involved in this process include as follows. (a) Build associations between regulations, products, and materials to speed up automatic identification of materials in the event of regulatory change. (b) Set up an abnormality management

mechanism to provide reminders to buying staff during guarantee confirmation and coping periods. (c) Provide explanations of differences between versions of regulations and simplify items to evaluate on the supplier side. (d) Request suppliers to upload necessary documents of their materials (including MSDS, manual, testing reports, and letters of guarantee) to the system. These documents provide the traceable data of materials and are available for download by customers.

- Purchasing: Whenever IPO releases a new regulation, GTCS will summarize product items involved in the change of the regulation and integrate ERP BOM to lock data of related materials. Production managers will be notified that compliance of the materials is pending confirmation when they submit a purchase requisition form online. The same notification will be prompted at all approval stages. The quotation process will be assisted in the information system. Because the operation is performed online, the procurement can be faster and more efficient. The entire process is as illustrated in Figure 3. The mechanisms involved in this process include as follows. (a) Build associations between regulations, products, and materials to speed up automatic identification of materials in the event of regulatory change. (b) Set up an abnormality management mechanism to provide reminders to buying staff during guarantee confirmation and coping periods. (c) Provide historic quotes as a reference for buying staff; Provide transparent information on progress of the procurement.
- Coping: IPO staffs have to fill out an application for change and provide details on the material and reasons for testing the material. The application will be submitted to the supervisor for approval. If approved, the application will be handed over to AO for another approval. If approved, a coping project will be launched; if not, the deputy-director of Operation Support Office will exercise his/her final discretion. After the project is launched, the system will automatically provide the material number and the latest test data to simplify the process of data search across heterogeneous databases for AO. All the units participating in the test have to upload the test results to the system. After all the units have completed their tests, the system will notify AO manager to verify the sample testing results. No matter the manager's decision, the result will be delivered to MEO. If the material is qualified, the data of its supplier will also be input into the ERP system. The project is then closed. The entire process is as illustrated in Figure 4. The mechanisms involved in this process include as follows. (a) Documents are submitted and signed online, and the project progress is transparent. (b) The RD knowledge base is built and expanded with compilation of documents in electronic format. (c) For sample materials of the same type, the system will search heterogeneous databases only once and use previously used settings thereafter. (d) Data of materials that pass the test will be written into the ERP system synchronously.
- An example of pollution control: The case company sometimes needs to use alternative dyeing auxiliaries. Before adoption of GTCS, due to absence of RSLs control mechanisms and lack of knowledge of the content of these dyeing auxiliaries, the company's wastewater processing unit sometimes would fail to fully perform its biological functions. After auditing, the company found that two of the alternative dyeing auxiliaries contained toxic chemicals listed by international regulations. After introduction of GTCS' RSLs control mechanisms, the company will request suppliers of dyeing auxiliaries to provide a material safety data sheet and verify the main components of the dyeing auxiliaries to avoid use of restricted substances during the dyeing process. These substances include carcinogenic dyes, agents containing chloride, alkylphenol, APEO, toxic heavy metals, and high-concentration formaldehyde. The company will not use toxic chemicals specified in the RSLs. Besides, the company has also built an auxiliary pollution database. It analyzes COD, BOD5, and SS of each chemical agent to determine the degree of pollution and biodegradability of all the chemical agents. It also uses active carbon absorption and pulse electrolysis to reduce the pollution of wastewater. Table 1 shows the improvement in degree of pollution of wastewater after adoption of GTCS.

Table 1. Reduction in degree of pollution and toxicity of wastewater after adoption of GTCS

	Type of wastewater	pH		COD(mg/L)		BOD5(mg/L)		SS(mg/L)	
		Before (2012)	After (2014)	Before (2012)	After (2014)	Before (2012)	After (2014)	Before (2012)	After (2014)
Low concentration	1. Wastewater of Plant 1 and Plant 2 of nylon	7.15	6.71	123	25.9				
	2. Wastewater of Plant 1 of fabrics	7.06	6.92	109	31.3				
	3. Wastewater of Plant 2 of fabrics	7.11	6.94	98	28.7				
	General wastewater	7.51	7.1	176	44.3	38	8.2	10.4	4.2
High concentration	Polymeric wastewater								
	Filament wastewater								
	General wastewater	6.86	7.11	212	63.2	41	22.4	14.5	6.5

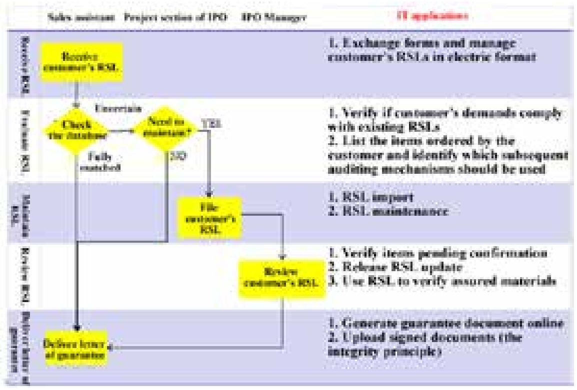

Figure 1. Regulation control and distribution process after adoption of GTCS

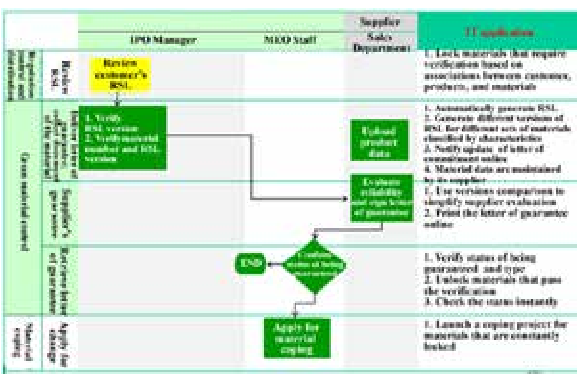

Figure 2. Green material control process after adoption of GTCS

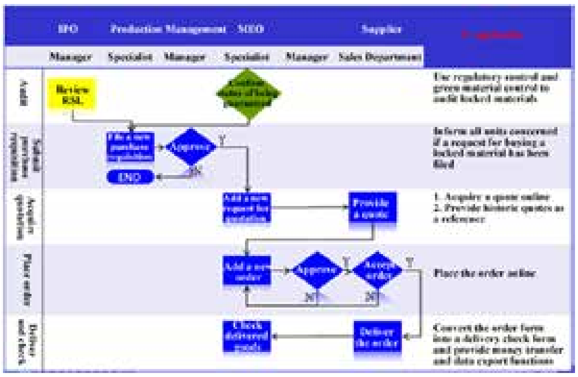

Figure 3. Procurement process after adoption of GTCS

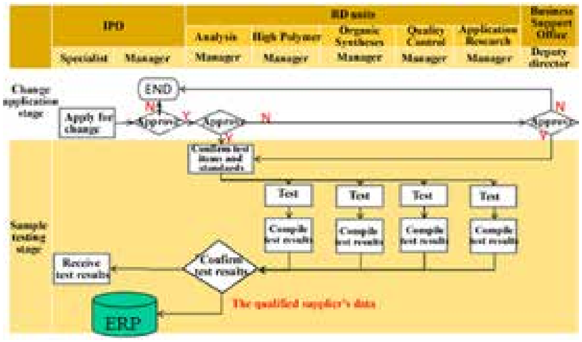

Figure 4. Coping process after adoption of GTCS

7. The Benefits from Adopting GTCS

After adopting GTCS, the case company saw improved operating efficiency, a higher product and service value, and other benefits for customers and suppliers. Table 2 summarizes the tangible benefits of adopting GTCS.

Table 2. The benefits of GTCS

Comparison Item		2012	2014	KPI definition	Data collection frequency
Increase in production value	The total export revenue of eco-textile products	$21,667 (thousand US dollars)	$81,667 (thousand US dollars)	The total revenue from eco-textile and fiber products of the year	Yearly
Costs reduction	Time needed to confirm compliance of existing materials with environmental regulations	3 days	Instant	The period of time from requesting to completing confirmation of compliance with environmental regulations	Monthly
	Time needed to acquire customer's approval of a new material	7 days	Within 1 day	The period of time from testing a new sample material to receiving customer's confirmation of the material	Monthly
	The cost of examination by a third party appointed by customers (cost of orders)	$217 (thousand US dollars)	$67 (thousand US dollars)	The total cost of examination by a third party requested by customers of the year	Yearly
	Number of materials confirmed compliant with environmental regulations	0	1023	The total number of materials listed in the compliant material database	Yearly
	The number of regulations listed in the online platform	0	45	Statistics	Yearly
	Time needed to acquire and confirm a quote	1.5 days (on average)	0.5 days (on average)	The period of time from requesting a quote to confirming the order	Monthly
	Number of product returns	2	0	The total number of serious customer complaints	Yearly

8. Conclusions

In this paper, we report a successful case of using a cloud green management system to assist green purchasing by a leading textile company in Taiwan. Before adoption of this system, this company had sufficient understanding of the characteristics of the industry, green trends of the market, and its position in the market. It then came up with an appropriate strategy and reengineered its regulation control process, green product research and development process, green purchasing process, and supplier's guarantee management process to build proper control mechanisms. It did not simply bring all the processes into an e-business model. It relied on strategic positioning, process reengineering, information utilization, and many managerial mechanisms to boost its competitive advantage in the green market.

Today, textile products manufactured by low labor-cost nations in Asia have posed a serious threat to the textile industry in Taiwan. However, with the rise of environmental awareness, more and more nations have recognized the importance of prohibiting the use or setting a limit on the content of the intermediate substances that may cause harms to human health during degradation. The textile companies around the world are now demanded to pass numerous certifications before selling and importing textile products. This system has become the largest trade threshold after the quota system. Textile companies have to acquire environmental certifications to temporarily escape the low-price competition and improve their competitiveness in the market. This GTCS adoption process reported in this paper can be a reference for other textile companies. We hope this paper can help other businesses in the industry escape low-price competition by taking a green management perspective.

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