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# Green Supply Chain Management in Malaysian Aero Composite Industry

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**Graphical abstract**

| Items | | CTRM (N=14, Cronbach Alpha = 0.771) | | | ACM (N=11, Cronbach Alpha = 0.686) | | | Total Average (%) |
|---|---|---|---|---|---|---|---|---|
| | | Agree (%) | Strongly Agree (%) | Total (%) | Agree (%) | Strongly Agree (%) | Total (%) | |
| GR1. | Environment-friendly raw materials | 71.4 | 7.1 | 78.5 | 63.6 | - | 63.6 | 71.1 |
| GR2. | Substitution of environmental questionable materials | 92.9 | - | 92.9 | 72.7 | - | 72.7 | 82.8 |
| GR3. | Choice of suppliers by environmental criteria | 42.9 | 14.3 | 57.2 | 63.6 | - | 63.6 | 60.4 |
| GR4. | Urging/pressuring supplier(s) to take environmental actions | 64.3 | 7.1 | 71.4 | 45.5 | - | 45.5 | 58.5 |
| GR5. | Taking environmental criteria into consideration | 78.6 | - | 78.6 | 72.7 | 9.1 | 81.8 | 80.2 |
| GR6. | Design considerations | 42.9 | - | 42.9 | 90.9 | - | 90.9 | 66.9 |
| GR7. | Optimization of processes to reduce solid wastes | 64.3 | 7.1 | 71.4 | 81.8 | - | 81.8 | 76.6 |
| GR8. | Optimization of processes to reduce water use | 71.4 | 7.1 | 78.5 | 36.4 | - | 36.4 | 57.5 |
| GR9. | Optimization of processes to reduce air emissions | 64.3 | 7.1 | 71.4 | 90.9 | - | 90.9 | 81.2 |
| GR10. | Optimization of processes to reduce noise | 57.1 | 14.3 | 71.4 | 81.8 | - | 81.8 | 76.6 |
| GR11. | Use of cleaner technology processes to make savings (energy, water, wastes) | 57.1 | 21.4 | 78.5 | 45.5 | - | 45.5 | 62.0 |
| GR12. | Recycling of materials internal to the company | 57.1 | 28.6 | 85.7 | 18.2 | - | 18.2 | 52.0 |
| GR13. | Use of waste of other companies | 35.7 | - | 35.7 | - | - | 0 | 17.9 |
| GR14. | Use of alternative sources of energy | 64.3 | 7.1 | 71.4 | - | - | 0 | 35.7 |
| GR15. | Helping suppliers to establish their own EMS | 42.9 | - | 42.9 | 27.3 | - | 27.3 | 35.1 |
| GR16. | Recovery of the company's end-of-life products | 78.6 | 7.1 | 85.7 | 45.5 | 9.1 | 54.6 | 70.2 |
| GR17. | Eco-labeling | 71.4 | - | 71.4 | 36.4 | - | 36.4 | 53.9 |
| GR18. | Environmental improvement of packaging | 78.6 | 7.1 | 85.7 | 36.4 | - | 36.4 | 61.1 |
| GR19. | Taking back packaging | 71.4 | - | 71.4 | 9.1 | - | 9.1 | 40.3 |
| GR20. | Providing consumers with information on environmental friendly products and/or production methods | 85.7 | - | 85.7 | 27.3 | 9.1 | 36.4 | 61.1 |
| GR21. | Change for more environmental-friendly transportation | 71.4 | - | 71.4 | 18.2 | - | 18.2 | 44.8 |

**Abstract**

Green supply chain management (GSCM) is a concept that gaining popularity in the most region in the world. For many organisations, it is a way to demonstrate their sincere commitment to environment sustainability. This paper is then, to investigate GSCM practices in aero composite manufacturing companies, as an initiative for environmental enhancement of green management programme in Malaysia which has the potential to offer greater economic value especially in manufacture of composites material components and sub-assemblies for aircraft application. Two major companies in the sector were chosen as the location of the study. The findings show that GSCM practices in the two companies are currently moderate; and, most of the practices have significant relationship to each other. Lean manufacturing system was became most preferable approach to support the development of green supply chain practices.

*Keywords*: Green supply chain management; aero composite manufacturing; Malaysia

**Abstrak**

Pengurusan rantaian bekalan hijau (GSCM)merupakan suatu konsep yang semakin mendapat perhatian di peringkat dunia. Ia juga merupakan satu pendekatan yang digunakan untuk melestarikan kepentingan alam sekitar. Kajian ini dijalankan untuk menyelidik pengamalan GSCM dalam industri pembuatan aero komposit di Malaysia. Dua syarikat utama dalam sektor berkenaan dipilih sebagai lokasi kajian. Keputusan kajian mendapati pengamalan GSCM di kedua-dua syarikat berkenaan adalah sederhana, malah, kebanyakan pengamalan GSCM tersebut mempunyai perhubungan yang signifikan antara satu sama lain. Sistem pembuatan *lean* dikenal pasti sebagai pendorong kepada pembangunan amalan pembekalan hijau.

*Kata kunci*: Pengurusan rantaian pembekalan hijau; pembuatan aerokomposit; Malaysia



## 1.0 INTRODUCTION

Supply chain management can be defined as a set of synchronized decisions and activities utilized to efficiently integrate suppliers, manufacturers, warehouses, transporters, retailers, and customers so that the right product or service is distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide cost while satisfying customer service level requirements [1]. Supply chain integration is difficult for two primary reasons: first, the supply chain is an integrated system that requires cohesive decisions to optimize the system profit and value. In practice, different facilities in the supply chain may have different, conflicting objectives. Second, the supply chain is a dynamic system, which has its own life cycle and continually evolves. When defining the scope for a supply chain effort, it is always advisable to adopt as broad a definition as possible. That way the most process steps are included and, therefore, the greatest opportunity for improvement is considered. The only caveat is to exercise caution and not make the scope so great that insufficient resources are available to reach effective conclusions [2-4].

Although the improvements have been achieved through the successfully traditional supply chain management practice, some of organisations are neglected to take care the environmental issues such as global energy, global warming, reverse logistic, etc. [5-6]. Environmental, ecological concerns in global competition attracted researchers in variety of disciplines [7]. The growing body of literature on the subject demonstrates a widespread appeal especially with regard to the application of ISO 14001 or Environmental Management System (EMS) standards. Simultaneously, the public's environmental awareness has increased through formal and informal environmental education channels [8]. As a result, a systematic approach, Green Supply Chain Management (GSCM), has been increasingly accepted and practices by forward-thinking organisation. For example, there are various streams of research that have made their focus the study of the dynamics and variables involved in the greening of business and supply chains, including reverse logistics, green purchasing, life cycle analysis and design for environment [7, 9-10].

GSCM is generally to be considered as the modern management model giving consideration of the environmental impact and resource efficiency in the whole supply chain. It involves suppliers, manufacturers, sales and users based on green manufacturing theory and supply chain management technology [11]. Its purpose is to enable products' negative impact on the environment to the smallest, use efficient of resources to the maximum in the entire process, then achieve sustainable development of the enterprises and the supply chain. The thought of green supply chain management comes from the increasing pressure on the enterprises to protect the environment. With the development of researches on the product's life cycle, it is gradually recognized that the actions of a single enterprise of the technologies for certain stage of a product's life cycle cannot effectively reduce the environmental impacts during the entire product life cycle [12-13].

The GSCM integrates the supply chain management in order to reduce the environmental impacts during the entire product life cycle by the harmony and the common actions of the partners in a supply chain [14]. Hervani *et al.* [15] believed that by adding the "green" component to supply chain management involves expressing the influence and relationships of supply chain management to the natural environment. Porter and Van der Linde [16] stated that the basics reasoning of GSCM are resource saving, waste elimination and productivity improvement. Adopting green technology in the whole direction of raw materials obtaining, processing, packaging, storage, transportation, products dealing with and recycling, can minimize the products' impact on environment, and utilize resources most effectively. Therefore, green initiatives can lower not only the environmental impact of a business but also raise efficiency, possibly creating major competitive advantages in innovation and operations.

This paper is an initial study (pilot study) on the green practices in supply chain management on Malaysia aero composite manufacturing industry. The selection of the industry is based on the business potential and government aims by 2015 to turn Malaysia into a major player in the global aerospace industry. The paper seeks to investigate the green practices, and companies' initiative on green suppliers. The following sub-title will describe the supply chain structure in aerospace industry, green supply chain challenges and opportunities, research methodology, findings, and conclusion which can be referred by other companies to define their green initiatives and other academician to explore what can be improved in green supply chain management and the sustainability.

## 2.0 SUPPLY CHAIN STRUCTURE OF THE INDUSTRY

The aerospace industry is dominated by a few large companies [17-18]. These include players such as Boeing and Airbus. These large players are supported by a vast supplier base globally, including fairly large and sophisticated engine and avionics manufacturers. These include suppliers such as Rolls-Royce, Honeywell and Pratt & Whitney. They are referred to as tier-one suppliers, and play a significant role in the aerospace industry. Tier 1 suppliers are further supplied by a large base of tier 2 and tier 3 suppliers, which serve multiple industries. These tier 2 and 3 suppliers supply all tier 1 suppliers, which share this common supply base. The tier 2 suppliers include companies such as CTRM, ACM, Spirit Aerosystems, etc. These are followed by tier 3 suppliers which include suppliers of machined components such as castings and raw materials suppliers for metals and rubber. Except for the first level of the supply chain who do not trade among themselves (aircraft manufacturers such as Boeing and Airbus), companies actively buy from and sell to each other. Hence, for example, CTRM and Spirit Aerosystems are competitors and might collaborate and trade between themselves too. Therefore, the industry is symbolized by collaborative programs and equity cross holdings between aircraft manufacturers (Boeing and Airbus) and its tier 1 suppliers. At tier 2, 3 and 4 levels, there is a large and diversified manufacturing base which is shared by the consuming supply chain tier above it.

## 3.0 GSCM CHALLENGES AND OPPORTUNITIES

As mentioned in the earlier, the biggest challenge facing the industry is supply chain dynamics and its link to environmental pressure in changing firm behaviour. While many suppliers may not be under environmental pressure, they are often under considerable pressure from their customer firms for other issues. This defines the opportunity for operational improvements at each layer of the supply chain because the survival of each company depends on whether it can deliver a better quality product at a lower cost, and on time to its customer base.

## 4.0 MALAYSIA AERO COMPOSITE INDUSTRY: AN OVERVIEW

Malaysia's success in industrial development is also due to the government's pro-business policies and its ability to respond to investor needs by ensuring facilities and incentives for investments are in place to support smooth business operational activities in Malaysia [19]. The expansion of the aerospace industry has wide potential in the nation's industrialisation programmed and technological development. The main activities include the assembly of light aircraft, manufacture of parts and components, maintenance and repair of aircraft, as well as modification and conversion activities. The current emphasis is on the manufacture of avionics components, composite material parts and the design or development and assembly/ production of light aircraft. This paper is only focused on the greening supply chain in manufacturing composite material part which also called as aero composite product. To date, only two companies are seriously involved in producing aero composite product: first, CTRM-AC Sdn Bhd (CTRM) which situated in Melaka, Malaysia is equipped at least 1200 employees has international standard manufacturing facilities produce components for aircraft industries for Boeing, Airbus, Sprit Aerospace, and Goodrich. Second, ACM Sdn Bhd (ACM) which situated in Kedah, Malaysia is a joint venture company between Boeing and Hexcel Corporation has at least 700 employees also expert in aero composite manufacturing. Both CTRM and ACM are the major players in aerospace industry in Malaysia.

## 5.0 RESEACRH METHOD

This study focused on sampling the perceptions of green practices in the Malaysia aero composite manufacturing industry. The questionnaire, comprising 21 items (which adopted from Rao [20] with permission), was distributed to company's senior management which have more than 2 years working experience. Respondents were asked to rate each item under a four-point Likert-type scale (e.g. 1 = strongly disagree, 2 = disagree, 3 =

agree, 4 = strongly agree), to indicate the extent to which each items was practiced in their respective organisation. A total of 20 questionnaires were distributed for each organisations, only 14 were valid for CTRM meanwhile 11 were valid for ACM. In addition, the research methodology comprises semi-structured interviews for the top management and direct observation of the plant in operation to collect the primary data.

## 6.0 FINDINGS

Table 1 shows the green practices statistical result. Each of these items was evaluated on a four-point scale. From these data, for each of the items, the percentage of respondents which said "agree" and the percentage of respondents which said "strongly agree" were determined. Considering both "agree" and "strongly agree", the item which had the highest percentage (82.8 percent) is "substitution of environmental questionable materials". This implies that 82.8 percent of the both companies in aero composite manufacturing industry had said "agree" or "strongly agree" to this item. On the other hand, top management of CTRM agreed that the item is most practice in supply chain management compared to others item with 92.9 percent. In contrast, the items which had the highest percentage (90.9 percent) in ACM are "design considerations" and "optimization of processes to reduce air emissions".

**Table 1** GSCM practices in CTRM and ACM

| Items | | CTRM (N=14, Cronbach Alpha = 0.771) | | | ACM (N=11, Cronbach Alpha = 0.686) | | | Total Average (%) |
|---|---|---|---|---|---|---|---|---|
| | | Agree (%) | Strongly Agree (%) | Total (%) | Agree (%) | Strongly Agree (%) | Total (%) | |
| GR1. | Environment-friendly raw materials | 71.4 | 7.1 | 78.5 | 63.6 | - | 63.6 | 71.1 |
| GR2. | Substitution of environmental questionable materials | 92.9 | - | 92.9 | 72.7 | - | 72.7 | 82.8 |
| GR3. | Choice of suppliers by environmental criteria | 42.9 | 14.3 | 57.2 | 63.6 | - | 63.6 | 60.4 |
| GR4. | Urging/pressuring supplier(s) to take environmental actions | 64.3 | 7.1 | 71.4 | 45.5 | - | 45.5 | 58.5 |
| GR5. | Taking environmental criteria into consideration | 78.6 | - | 78.6 | 72.7 | 9.1 | 81.8 | 80.2 |
| GR6. | Design considerations | 42.9 | - | 42.9 | 90.9 | - | 90.9 | 66.9 |
| GR7. | Optimization of processes to reduce solid wastes | 64.3 | 7.1 | 71.4 | 81.8 | - | 81.8 | 76.6 |
| GR8. | Optimization of processes to reduce water use | 71.4 | 7.1 | 78.5 | 36.4 | - | 36.4 | 57.5 |
| GR9. | Optimization of processes to reduce air emissions | 64.3 | 7.1 | 71.4 | 90.9 | - | 90.9 | 81.2 |
| GR10. | Optimization of processes to reduce noise | 57.1 | 14.3 | 71.4 | 81.8 | - | 81.8 | 76.6 |
| GR11. | Use of cleaner technology processes to make savings (energy, water, wastes) | 57.1 | 21.4 | 78.5 | 45.5 | - | 45.5 | 62.0 |
| GR12. | Recycling of materials internal to the company | 57.1 | 28.6 | 85.7 | 18.2 | - | 18.2 | 52.0 |
| GR13. | Use of waste of other companies | 35.7 | - | 35.7 | - | - | 0 | 17.9 |
| GR14. | Use of alternative sources of energy | 64.3 | 7.1 | 71.4 | - | - | 0 | 35.7 |
| GR15. | Helping suppliers to establish their own EMS | 42.9 | - | 42.9 | 27.3 | - | 27.3 | 35.1 |
| GR16. | Recovery of the company's end-of-life products | 78.6 | 7.1 | 85.7 | 45.5 | 9.1 | 54.6 | 70.2 |
| GR17. | Eco-labeling | 71.4 | - | 71.4 | 36.4 | - | 36.4 | 53.9 |
| GR18. | Environmental improvement of packaging | 78.6 | 7.1 | 85.7 | 36.4 | - | 36.4 | 61.1 |
| GR19. | Taking back packaging | 71.4 | - | 71.4 | 9.1 | - | 9.1 | 40.3 |
| GR20. | Providing consumers with information on environmental friendly products and/or production methods | 85.7 | - | 85.7 | 27.3 | 9.1 | 36.4 | 61.1 |
| GR21. | Change for more environmental-friendly transportation | 71.4 | - | 71.4 | 18.2 | - | 18.2 | 44.8 |

Next came the "taking environmental criteria into consideration" (80.2 percent) on the average total percentage, followed by "optimization of processes to reduce solid wastes" and "optimization of processes to reduce noise" (76.6 percent). Environment-friendly raw materials to the companies was preffered in almost majority cases (71.1 percent). Among the items which were least implemented were use of waste of other companies (17.9 percent), helping suppliers to establish their own EMS (35.1 percent) and use of alternative sources of energy (35.7 percent). The Cronbach's alpha values, ranging 0.686 to 0.771 show the high internal consistency.

Commenting on the results, the respondents in CTRM were satisfied with the achievement of most of the items of the green practices in supply chain management compared to ACM management team. On average nearly half of the items had respondents agreeing and strongly agreeing. Besides, it was not surprisingly that 92.9 percent of the CTRM was implementing measures to substitution of environmental questionable materials into consideration because the industry is most depended on their customer. In contrast, design consideration is highly importance to green practice in ACM. As a strategic partner of Boeing, ACM must have critical consideration into product.

Optimization of process to reduce solid waste, water, etc. are very much practice because the companies are aware that it is much more productive to prevent production of waste using raw materials and energy, all of which are costly. The respondents disagreeing the use of waste of other companies due to some customers' regulation and limited resource can be used as direct material in production line from outside especially in different industry. The items that referred to greening the suppliers such as helping suppliers to establish their own EMS, urging/pressuring supplier(s) to take environmental actions, etc. also lack of agreeing from the respondents. On the other hands, the customer in this industry has right to decide preferred supplier of supplies. In other words, the industry only has better opportunity to improve green practices internally.

Lean manufacturing system (LMS) was launched to support the development of green supply chain practices. Besides, the approach is compulsory or prerequisite for any suppliers to survive in aerospace industry. In addition, both CTRM and ACM are encouraging the lean manufacturing implementation in any continuous improvement activities which linked to EMS and other green practices as per requested from their customers. From the observation during industrial visit, both companies have shown better result in productivity improvement and developing green awareness through lean manufacturing. Besides, lean manufacturing had became a work culture where every single activity was driven by green practices and cost saving.

The findings proved that LMS is not only the practice of eliminating waste in every area of production including customer relation (sales, delivery, billing, service and product satisfaction), product design, supplier networks, production flow, maintenance, engineering, quality assurance and factory management. LMS enhances the companies to utilize less human effort, less inventory, less time to respond to customer demand, less time to develop products and less space to produce top quality products in the most efficient and economical manner possible. Besides, LMS is identified as a manufacturing strategy aimed at achieving the shortest possible cycle time by eliminating waste, and a comprehensive term referring to manufacturing methodologies based on maximizing value and minimizing waste in the manufacturing process. Such strategies enable companies to improve quality, reduce costs, and improve service to customers as traditional batch and queue mass production and supply chain approaches are transformed [21-22].

### 6.1 Spearman Correlation Test

Spearman correlation test is performed to identify the relationship among the green supply chain practices in both companies. Table. 2 shows the correlation coefficients result.

Based to the Table 2, 19 items were correlated in CTRM while 16 items of the GSCM have significant result in ACM at the level 0.05 and 0.01. It's mean that the correlated green practices are significant at confident level at least 95 percent. In ACM, optimization of processes to reduce solid wastes (GR7) is the most higher significantly correlated with optimization of processes to reduce noise (GR10) (r= 1.000) at the significant level 0.01. In other words, the optimization of processes to reduce solid wastes is positively influenced by optimization of processes to reduce noise with 100% chances. In contrast, optimization of processes to reduce water use (GR8) able to influence optimization of processes to reduce air emissions by 91.4 percent chances in CTRM. The result also proved that most significant GSCM practices have strong correlation at the 0.01 significant level. The range of significant result in CTRM are between 0.668 to 0.914 at the significant level 0.01 and 0.536 to 0.709 at 95 percent confident level. In ACM, the correlated GSCM practices were significant at the 0.01 level between the range of 0.724 to 1.000 and 0.610 to 0.699 at the 0.05 significant level.

**Table 2** Spearman correlation coefficient

| | | CTRM | ACM |
|---|---|---|---|
| GR1. | Environment-friendly raw materials | GR7 (0.727**); GR8 (0.536*); GR9 (0.727**); GR12(-0.552*) | GR2(0.851**); GR21(-0.699*) |
| GR2. | Substitution of environmental questionable materials | - | GR1(0.851**); GR16(0.635*) |
| GR3. | Choice of suppliers by environmental criteria | GR4(0.638*); GR5(0.564*); GR17(0.683**); GR21(0.676**) | GR13(0.624*) |
| GR4. | Urging/pressuring supplier(s) to take environmental actions | GR3(0.638*); GR15(0.605*); GR20(0.708**); GR21(0.604*) | - |
| GR5. | Taking environmental criteria into consideration | GR3(0.564*) | GR18(-0.610*) |
| GR6. | Design considerations | GR12(-0.609*); GR13(0.816**) | GR13(0.671*) |
| GR7. | Optimization of processes to reduce solid wastes | GR1 (0.727**); GR8(0.719**); GR9(0.818**); GR13(0.573*); GR15(0.703*) | GR9(0.671*); GR10(1.000**); GR17(-0. 624*) |
| GR8. | Optimization of processes to reduce water use | GR1 (0.536*); GR7(0.719**); GR9(0.914**); GR14(0.585*) | - |
| GR9. | Optimization of processes to reduce air emissions | GR1 (0.727**); GR7(0.818**); GR8(0.914**) | GR7(0.671*); GR10(0.671*); GR13(0.671*) |
| GR10. | Optimization of processes to reduce noise | GR12(0.594*); GR16 (0.633*) | GR7(1.000**); GR9(0.671*); GR17(-0.624*) |
| GR11. | Use of cleaner technology processes to make savings (energy, water, wastes) | - | - |
| GR12. | Recycling of materials internal to the company | GR1(-0.552*); GR6(-0.609*); GR10(0.594*) | - |
| GR13. | Use of waste of other companies | GR6(0.816**); GR7(0.573*); GR15(0.699*) | GR3(0.624*); GR6(0.671*); GR9(0.671*); GR15(0.724**) |
| GR14. | Use of alternative sources of energy | GR8(0.585*); GR15(0.706*) | - |
| GR15. | Helping suppliers to establish their own EMS | GR4(0.605*); GR7(0.703*); GR13(0.699*); GR14(0.706*) | GR13(0.724**) |
| GR16. | Recovery of the company's end-of-life products | GR10 (0.633*); GR18(0.817**) | GR2(0.635*) |
| GR17. | Eco-labeling | GR3(0.683**); GR18(0.602*); GR19(0.650*); GR21(0.668**) | GR7(-0. 624*); GR10(-0.624*); GR19(-0.610*); GR20(0.631*) |
| GR18. | Environmental improvement of packaging | GR16(0.817**); GR17(0.602*); GR19(0.602*); GR21(0.646*) | GR5(-0.610*) |
| GR19. | Taking back packaging | GR17(0.650*); GR18(0.602*); GR21(0.668**) | GR17(-0.610*); |
| GR20. | Providing consumers with information on environmental friendly products and/or production methods | GR4(0.708**) | GR17(0.631*) |
| GR21. | Change for more environmental-friendly transportation | GR3(0.676**); GR4(0.604*); GR17(0.668**); GR18(0.646*); GR19(0.668**) | GR1(-0.699*) |

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

The analysis shows that substitution of environmental questionable materials (GR2) and use of cleaner technology processes to make savings (energy, water, wastes) (GR11) are independent variables which not influenced by any GSCM items in CTRM. Besides, the use of cleaner technology processes is not significant with other 20 GSCM practices in ACM. On the other hand, urging/pressuring supplier(s) to take environmental actions, recycling of materials internal to the company, optimization of processes to reduce water use, and use of alternative sources of energy are also not significant with any GSCM practices in ACM.

Although some of the listed variables are not significant, the applications are very crucial. According to respondent in the both companies, all the applications are measured specifically to ensure the successful of the GSCM practices. Quality, cost, delivery and continuous improvement or QCDC are main preferred performance measures. Effectiveness of LMS tools used in the companies are also influenced a lot of improvement in the GSCM. The tools that were used focus on eliminating wastes which adds cost and hidden problems. However, the companies still struggling to ensure the staffs understand and able to use the tools in order to eliminate wastes and improve the shop floor. In addition, the companies are also tried to explore the others tools which are useful and easy to use for GSCM decision making and improvement from time to time.

## ■7.0 CONCLUSION

As a conclusion, the authors found that the respondents were satisfied with the achievement of most the green supply chain practices. However, the green practices were different between companies. Some of the items that most practiced in the company were less practiced in other company. Besides, at least 16 items in the GSCM practices were significant each others. However, the items which involved supplier or third parties were received low response from companies due to customer decisions. Nevertheless, the authors believe that the research results may prove useful in helping manufacturing firms to identify an effective approach towards the successful of green supply chain practices.

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