

# Survey of Sustainable Logistics Services via Text Mining

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**Abstract:** Environmental sustainability has recently become more and more of a concern in logistics service industry. Although studies on sustainable initiatives among logistics service providers (LSP) have been increasing in the extant literature, still little investigation has been performed between LSPs and shippers. The present paper aims to demonstrate award-gained sustainable logistics service initiatives implemented during the period 2006-2017 in Japan. Different with questionnaire- and interview-based studies employed in literature, we use text mining technique to explore the co-occurring links of data, i.e. connections of the practices, to present the collaborative sustainability actions carried out through providing and requiring logistics services. In contrast to the research regarding green supply chain management focused on manufacturing perspective, this study is positioned in the dual sides of consignors and logistics business operators, to depict their combined effort in achieving sustainability goals. The results of the study showed that text mining technique is useful for summarizing and presenting data in this research area. However, much remains to be learned about how to deal with the data more means-end logically for revealing more indirect associations between the data.

**Key words:** Green logistics initiative, text mining, shipper, logistics service provider, collaborative logistics, sustainability development.

## 1. Introduction

In common with many other areas of human endeavor, “sustainability” has become a catchword in our economic society. It grew out of more and more environmental considerations, particularly with well-documented issues such as global warming, greenhouse gas emissions and stringent governmental regulations [23]. As such, sustainable development (SD) as a goal in global supply chains, has prompted the rise of interest in environmental burden reduction from logistics activity, known as green logistics (GL) as the transport and logistics industry is a major contributor to environmental degradation with its modes, infrastructures and traffics [18, 25]. Due to logistics activities strongly responding to government regulations, sustainable logistics seemed to be a strictly environmental interpretation of SD [14]. However, given SD ultimately seeks to reconcile the conflict between economic growth, environmental protection and social change [23], implementation of

green initiatives plays a vital role in strategic integration of environmental goal into business operations going beyond “being environmentally conscious” [13, 17, 21, 22].

Compared with studies on sustainability directed towards manufacturing companies in the product-focused supply chain management [14], research concerning green initiatives adopted in logistics service market has been a small number published in literature [5, 7, 12, 20]. Recently, some empirical studies have reported green actions taken by LSPs in Europe and Asia e.g. Refs. [13, 20, 21, 22], indicating that green initiatives are growing in adoption and practices commonly undertaken range from operational optimization to behavioral aspects of management control, however, those are mostly of internal character, as the findings from Refs. [5, 21, 22] revealed that most of GL practices were carried out intra-organizationally, for example, mode choice, vehicle loading improvement, alternative fuel while those related to inter-organizational practices such external collaboration as recycling and packaging, and collaboration with other actors in the supply chain

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were rarely observed. On the other hand, some studies take the perspective of LSP-shipper relationships, for example, Ref. [15] explored environmental practices as reflected in offerings and requirements of the logistics services. Ref. [3] focused on sustainability activities in dyadic buyer-supplier relationships of logistics services. Moreover, Refs. [4, 19] provided taxonomies of green initiatives and investigated diffusion of sustainable logistics services among LSPs. As in the previous empirical research, it seems that sustainable logistics activities undertaken by LSPs-shippers are in lower priority and the cooperative and collaborative GL initiatives have much less been explored although research attention has been increasing in the LSP-shipper contribution to sustainable logistics.

To this end, this paper aims to present sustainability initiatives performed by collaboration of LSPs and shippers. Different with the studies using questionnaire-based survey and interviews in the extant literature, this paper applies text mining approach to analyze award-gained sustainable initiatives in logistics services implemented from 2006 to 2017 in Japan. Furthermore, due to the cross-functionality of logistics service, and the nature of data source, we primarily focus on the relative connections between the sustainable practices. For doing so, the remainder of the paper is organized as follows: next section provides a review of the related previous works, followed by a description of research data and approach used. And then the results of the exploration are summarized and discussed. In the end, a conclusion is conducted.

## 2. Related Previous Research

This section briefs the studies related to GL, and GL initiatives/practices, particularly by LSPs and shippers. In two seminal papers in GL [18, 25], a survey in Ref. [18] found that 60% of logistics managers in companies with “formal or written environmental policies”, while in the same publication, Ref. [25]

stated that “because the nature of logistics management is cross-functional and integrative and since so many logistical activities impact on the environment, it makes sense for logistics managers to take the initiative in this area”. Ref. [25] takes the perspective of the trade-off between logistics activities and its impact on environment, indicating that logistics, both forward flows and reverse flows of the supply chain, should take the responsibility for providing green product and service to end-consumers. Ref. [25] referred the logistics as an environmentally responsible system.

As Ref. [6] asserted, “a holistic view of the entire supply chain is essential when planning a move towards green” initiatives. This can be said to be same with respect to greening logistics. For example, the terms, green logistics and green transportation may be regarded as the same concept, but logistics itself focuses also on such areas as warehousing, distribution and among others.

Ref. [2] reviewed 10 journals on logistics, transport and supply management over the period 1995-2004. The findings state that only 45 papers of 2,026 addressed environmental issues indicating a range of different measures to evaluate environmental logistics performance and concluding that logistics standardization and information system and technology (IS/IT) solutions allowing vast restructuring of logistics systems would need to be implemented. However, Refs. [18, 25] pointed out that it is not enough to introduce new technology such as IS/IT solutions, but the fact that companies must re-evaluate where facilities are located, whom they cooperate with, and the whole logistics structure, and at a more fundamental level, it requires changes in management culture and strategic priorities.

In Ref. [23], the root of carbon emission, measures and green benefits of adoption of IT solution such as radio frequency identification (RFID) technology are summarized on the basis of Refs. [6, 9, 10, 16] shown in Table 1, the root of carbon emissions in road freight

**Table 1** The root of carbon emissions, measures and green benefits of RFID [2].

Nature of the vehicle	Measures	Green benefits of RFID
Vehicle type and age (class, engine, transmission)		
Tyres	Continue to improve the efficiency of the goods transport vehicles; Newer fuel-efficient vehicles against older end-of-life vehicles	
Type of fuel		
Body type		
Maintenance		
How it is used	Measures	Decrease idling times; Monitor speed and generate alerts when vehicles are not operating at peak efficiency; Maximize load efficiency; Provide expense-management capabilities via gas-card integration; Offer valuable intelligence on when to upgrade to fuel-efficient vehicles; Maintain up-to-the-minute diagnostic status; Provide real-time tire pressure data; Optimize routes and scheduling.
Road transport demand		
*Tonnes lifted	Truckload and vehicle fill optimization;	
*Activity location	Reduce the distances travelled, relative to the goods transported;	
Management of transport resource	Utilize and share network capacity better;	
*Load factor	Fleet management and route optimization;	
*Empty running	Shift freight towards the least polluting mode of transport;	
Traffic condition	Waste recollection, treatment and reverse logistics;	
*Congestion	Change management and continuous improvement;	
*Weather condition	Provide economic incentives and penalties for polluting behavior.	
Deriver behavior		
*Driver skills		
*Time pressures		

transportation is divided into two: the nature of the vehicle, and how it is used [16], combined with the measures of reducing emissions suggested by Refs. [6, 9], and along with the green benefits of RFID applications highlighted by Ref. [10].

Ref. [12] conducted a case study and explored the issues on green initiatives in third-party logistics (3PL) in terms of awareness of sustainability, adoption of green initiatives in 3PLs, and internal and external factors affecting the adoption of green supply chain initiatives in large 3PLs. From the viewpoint of commitment of green initiatives in 3PLs, it was indicated that there was very little evidence of concrete green initiatives undertaken by 3PLs or their customers which share with the findings in Ref. [7] of literature review over the period of 2000-2016 with respect to environmental sustainability in 3PLs service. Ref. [20] was based on the green supply chain practices to investigate 15 case companies in the Italian 3PL market, in terms of green supply, distribution strategies and transportation, warehousing and green building, reverse logistics, cooperation with customers, investment recovery, eco-design and packaging,

internal management. The samples showed that the green supply chain practices adopted had less impact on the 3PLs' operational performance.

Conversely, some studies take the perspective of LSPs to explore GL initiatives. For example, Ref. [21] investigated green intentions of 3PLs toward regulatory pressure, customer demand and social concern, in order to understand how changes in the 3PLs' sustainability strategy influenced the development of sustainability in physical distribution network in the Dutch market. The authors surveyed 145 logistics companies which were willing to participate in award scheme of the *Lean and Green* program with the goal of CO<sub>2</sub> reduction by 20% within a 5-year-period. Six hundred and eight green initiatives of physical distribution were classified into four combinations, namely, optimizing-internal approach, optimizing-external approach, innovating-internal approach, and innovating-external approach. The survey results showed that most of the 3PLs initiatives were focused on internal approaches of either optimizing or innovating. Ref. [8] investigated 13 Italian transports and LSPs, and distinguished the

sample companies into three groups: seven mainly providing transport and warehousing services with interest in adoption of green vehicle operation; four adopting “reactive” approach to environmental sustainability with customers; and two taking on more collaborative actions to green issues. The survey results, similarly to the findings in Ref. [21], indicated that most of green actions were taken internally. Ref. [1] conducted an interview-based case study investigating three small, three medium-sized and four large LSPs in the Scandinavian countries. they found that most of the LSPs’ sustainable activities were intra-organizational adoptions and grouped them into three: internal resources efficiency, effectiveness and utilization; sustainability behavioral cautiousness; and measurement and assessment, whereas activities such as “efficient utilization of external logistical infrastructure”, “vertical and horizontal collaboration” with other LSPs and stakeholders were less observed from the samples. In addition, as future sustainable activities were to be questioned, collaboration with other actors in supply/value chain was also less emphasized.

Moreover, some studies concentrated on examining the factors influencing the adoption of green practices. For instance, Ref. [13] investigated adoption behavior of energy saving practices in 322 small- and medium-size Chinese logistics companies with respect to the factors of technical innovative, environmental and

organizational. It was indicated that the sample companies may be willing to adopt those “more helpful for improving environmental and economic performance”, and those “more compatible to their existing business operations”. And more recently, Ref. [22] surveyed 311 LSPs indicating that “eco-driving”, “alternative energy” and “green packaging” are ranked mostly, and those contribute to both cost reduction and environmental protection to the LSPs operating in Thailand market.

To summarize, the subject of environmental sustainability focusing on activities of LSPs has been gaining increasing interest as reviewed above. Some previous research discuss green supply chain practices adopted by 3PLs [12, 20]; others examine the LSPs commitment to environmental sustainability [1, 8, 21]; still others investigate factors influencing GL adoption behavior of LSPs [13, 22]. However, It is notable that there are few evidences coming from collaborative GL initiatives to be studied [5]. Thereby, before moving next to explore GL initiatives with joint goals, several GL practices mentioned by the previous research, are summarized with four aspects [21] as presented in Table 2: internal approach (actions organized within LSP/shipper), external approach (actions cooperated with others outside the organization), innovating (actions previously unknown by LSP/shipper), and optimizing (actions for improving the efficiency), which works as referential examples.

**Table 2** Examples of sustainable logistics initiative/practices.

	Internal approach	External approach
Optimizing	Eco-driving; Improving vehicle loading phase; Minimizing transport distances; Multimodal transport; Changes of vehicle types; Energy saving program; Environmental management system; green warehousing and green building; Alternative fuels; Packaging management; Reducing waste and water usage; Using recycling materials and eco-packaging;	Improving transport planning; Information on carbon footprint; Increasing efficiency; Improving cooperation with supply chain partners; Setting lower GHG targets; Recycling materials and packaging; Calculating carbon footprints;
Innovating	Uses of new types of vehicles; Intermodal; Electrical vehicles; Improving loading capacity; New IT solutions; Distribution strategies and transportation execution	Green ordering; Eco-design; Green packaging; Cooperation with competitors; Developing new concepts for delivery

### 3. Data and Approach

The logistics sector is of importance to economy of Japan, accounted for about 5% of Japan GDP, 3% of laborers out of the whole industry work labor in transport and logistics industry. According to the government report, among the transport and logistics companies, truck transport is ranked the most by 62,936, followed by the second most which is warehousing by 6,059 companies in 2012. Responding to the *Paris Agreement*, the new international framework for the reduction of greenhouse gases after 2020, Japan has submitted a reduction target of reducing 26% by 2030 (compared with the fiscal 2013 level) to the United Nations in July 2015. Transport sector accounts for less than 20% of the total CO<sub>2</sub> emissions (after electricity distribution), among which about 6% (trucks for business use and private use) is from trucks transportation.

The development of green initiatives in collaboration of shippers and LSPs has been incorporated into practices for decades in Japan in pursuit of CO<sub>2</sub> emissions reduction contributed from the transport and logistics sector. In order to overview the effort combined by not only LSPs/shippers, also by the cooperation and collaboration among LSPs, shippers and other partners of the supply chain, the award-gained green initiatives are chosen as data source to be analyzed, which has not been studied in the extant literature [5]. Due to the nature of this exploratory study, the data analysis goes on with the following steps.

First, the original abstracts of the GL initiatives are collected from the resources provided by GL partnership conference that is an organization aiming at expanding the collaborative GL initiative and raising public awareness of GL based on partnerships between consignors and logistics business operators. Second, the data are formatted as textual data source for analysis. Since the data are goal-oriented in the context of what/how did for achieving the reduction in CO<sub>2</sub> emissions, we intend to focus on the

co-occurrence network of words, where nodes indicate words, and the edges present co-occurrence of words. Herein, hierarchical cluster analysis is conducted to depict the holistic extraction feature represented in a dendrogram, which is preferred to the scatter graphic output from such as multidimensional scaling or self-organized map and others in this study. And then we explore the words co-occurring, also take a further step to re-explore the graphic expressions associated with several features, which are demonstrated in the next section. The results coming out of each step are visualized by using KHcoder [11].

### 4. Results and Summary

The data used are 52 in total. On the basis of ward method and Jaccard coefficient, 80 words with more than 5 occurring frequency were grouped into nine clusters as shown in Fig. 1. For convenience, we reprocessed the obtained dendrogram with the occurring frequency of respective word as shown in Table 3. In addition, Fig. 2 presented the graphic expression reflecting the implemented GL initiatives in the words network: a large cluster (A, see in Table 3) with many connected nodes, reflecting the initiatives of CO<sub>2</sub> emission reduction in transport and distribution through modal shift, road-rail transport; linked to “used + shippers” (involving shippers), and “rail + container + ft” (levelling container various size). Overall, among seven un-linked clusters, one revealed that the initiatives were conducted through cross-industrial cooperation and collaboration. The remaining clusters showed green actions through adoption of IS/IT and improvement of logistics efficiency.

Moreover, Fig. 3 depicted the network associated with word “truck”, resulting in two connected and 8 un-linked groups. Within the connected groups, green partnership seemed to work well in the truck transport in terms of consolidation, standardization of shipping size, and reduction of empty running. On the other hand, the un-linked groups presented the GL initiatives

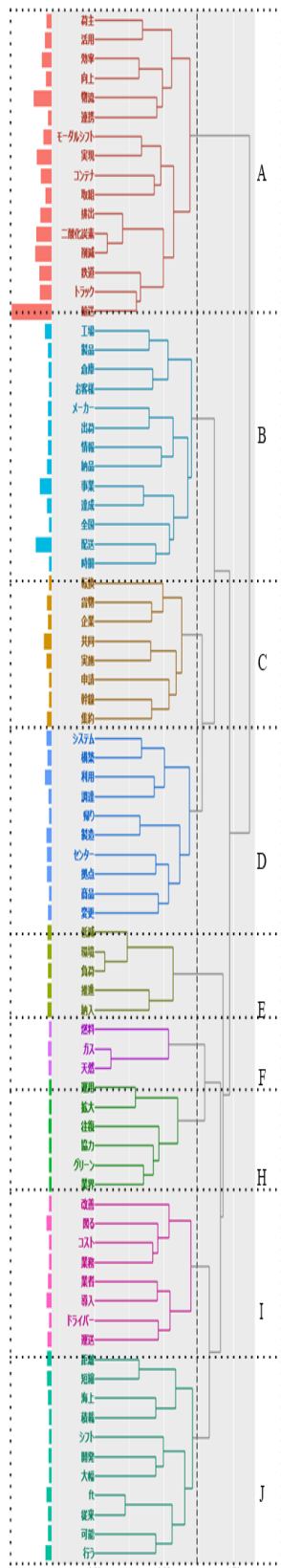


Table 3 The result of cluster.

Cluster A		帰り	5
荷主	12	製造	11
活用	15	センター	10
効率	24	拠点	10
向上	13	商品	5
物流	45	変更	7
連携	7	Cluster E	
モーダルシフト	20	低減	9
実現	37	環境	9
コンテナ	27	負荷	7
取組	14	推進	9
排出	28	納入	9
二酸化炭素	39	Cluster F	
削減	42	燃料	5
鉄道	30	ガス	7
トラック	29	天然	6
輸送	105	Cluster H	
Cluster B		運用	5
工場	15	拡大	5
製品	7	往復	6
倉庫	6	協力	5
お客様	5	グリーン	5
メーカー	7	業界	5
出荷	7	Cluster I	
情報	8	改善	5
納品	10	図る	11
事業	29	コスト	5
達成	10	業務	5
全国	5	業者	7
配送	40	導入	12
Cluster C		ドライバー	5
転換	5	運送	9
Cluster J			
貨物	10	距離	10
企業	7	短縮	10
共同	18	海上	8
実施	12	積載	5
申請	5	シフト	5
幹線	5	開発	6
集約	10	Cluster D	
Cluster D		大幅	5
システム	12	ft	11
構築	9	従来	8
利用	15	可能	7
調達	6	行う	14

Fig. 1 Hierarchical cluster dendrogram.

\*The numbers in Table 3 show the frequencies of the words, and the order of words is the same as in Fig. 1.

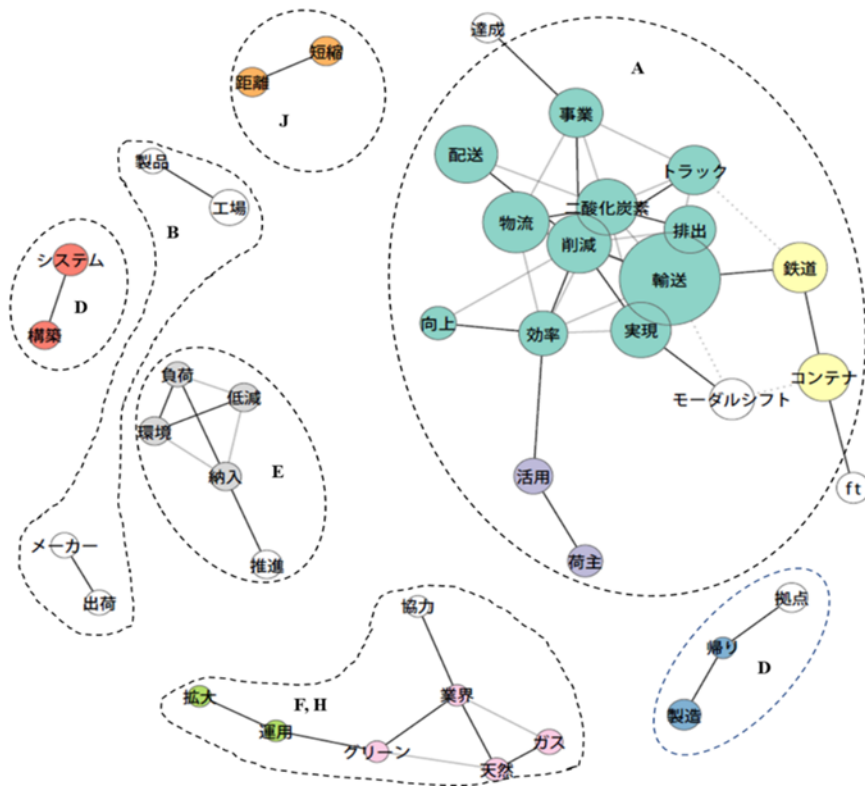


Fig. 2 The word co-occurring network.

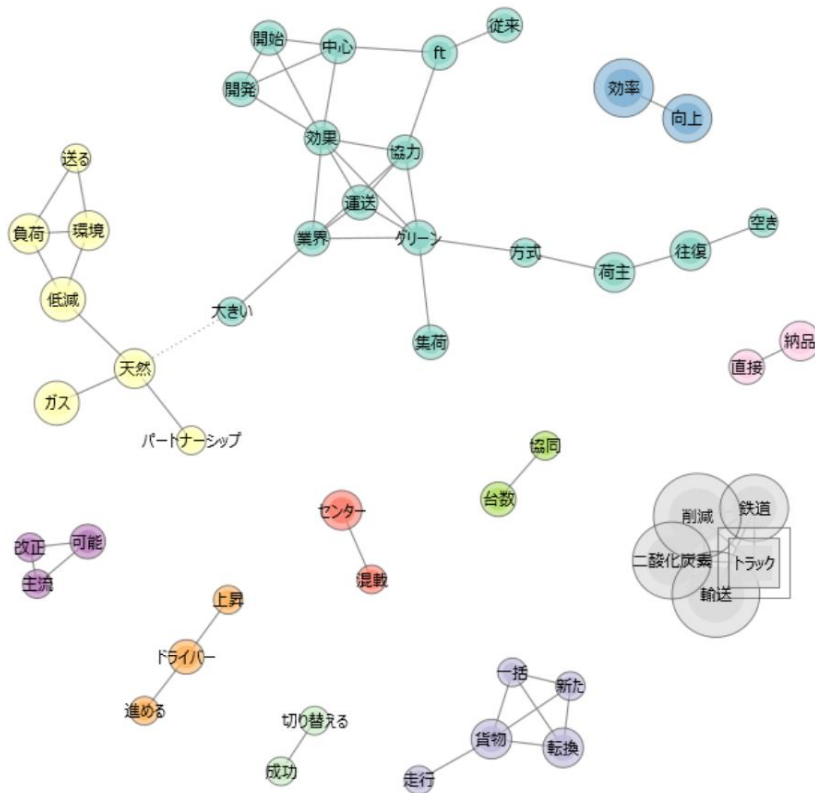


Fig. 3 The co-occurring network associated with “truck”.

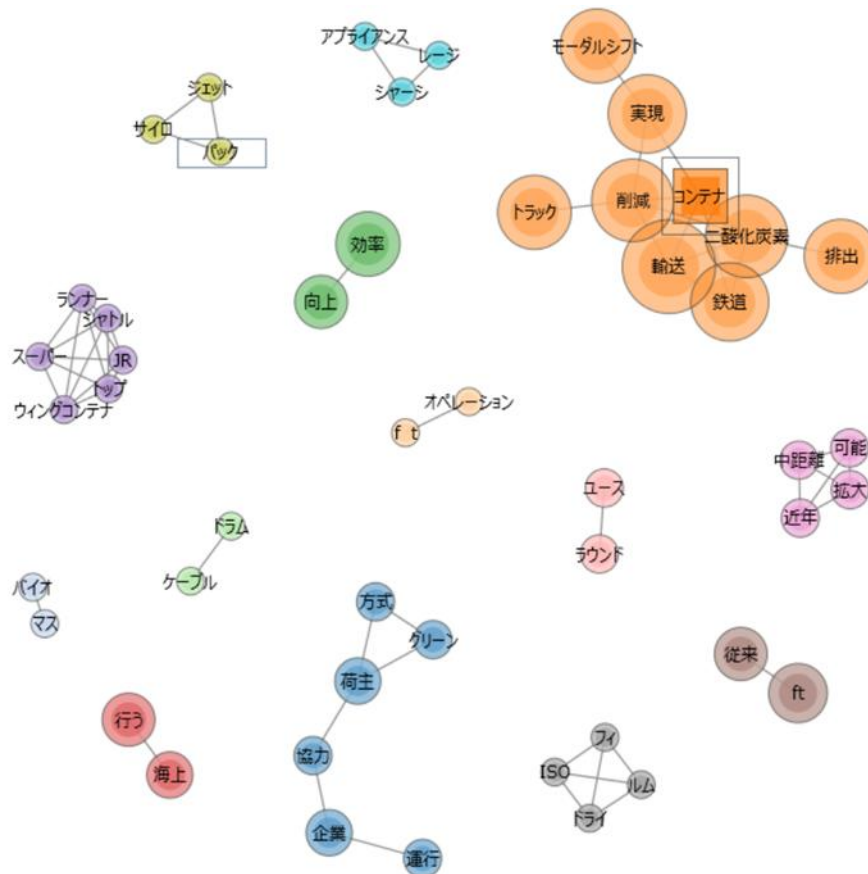


Fig. 4 The co-occurring network associated with “container”.

through direct delivery (reduction of transport distance), joint transport (reduction of vehicle numbers), increasing mixed load, training eco-driving skill and among others. So next step we take is to associate the word of “container” to create the co-occurring relations between words.

Associated with “container”, Fig. 4 displayed the initiatives such as container round use, improvement in size and capacity, and related facilities. In addition, associated with the word “distribution” shown in Fig. 5, besides the GL initiatives on direct delivery, joint transport, consolidation, and empty running that are already depicted in Fig. 3, Fig. 5 also demonstrated the integrated logistics of production, sales and procurement, reducing waiting time through cooperation, and support for driver such as using customer’s facility.

Furthermore, we take into account “joint” + “consolidation” since they were not presented in the

work co-occurring network in Fig. 2, on the other hand, they seemed to be related as shown in Figs. 3 and 5. Fig. 6 depicted the result using the word “joint”, which displayed the implemented GL initiatives in terms of pick-up delivery, wing container, joint shipment and system utilization.

In addition to what have been seen in Fig. 5, Fig. 6 showed the “system” utilized among LSPs and shippers, and also related with “container”. Therefore, word “RFID”, instead of “system”, as described in the preceding study, is used to see the association links among words. Fig. 7 depicted that the RFID contribution relates to the efficiency of operations in logistics center such as loading control, material and crate-traceability and among others.

Draw on the step-by-step study in the above, and based on the previous research in Section II, herein we highlight the GL initiatives on three without organizational boundary: (i) use of technology (e.g.



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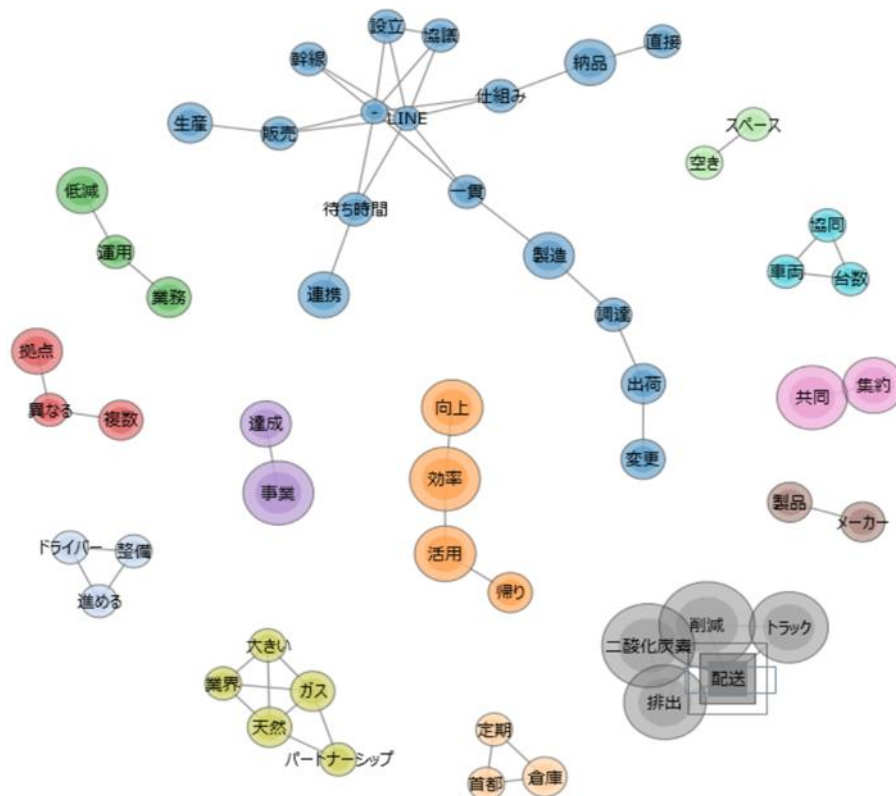


Fig. 5 The co-occurring network associated with “distribution”.

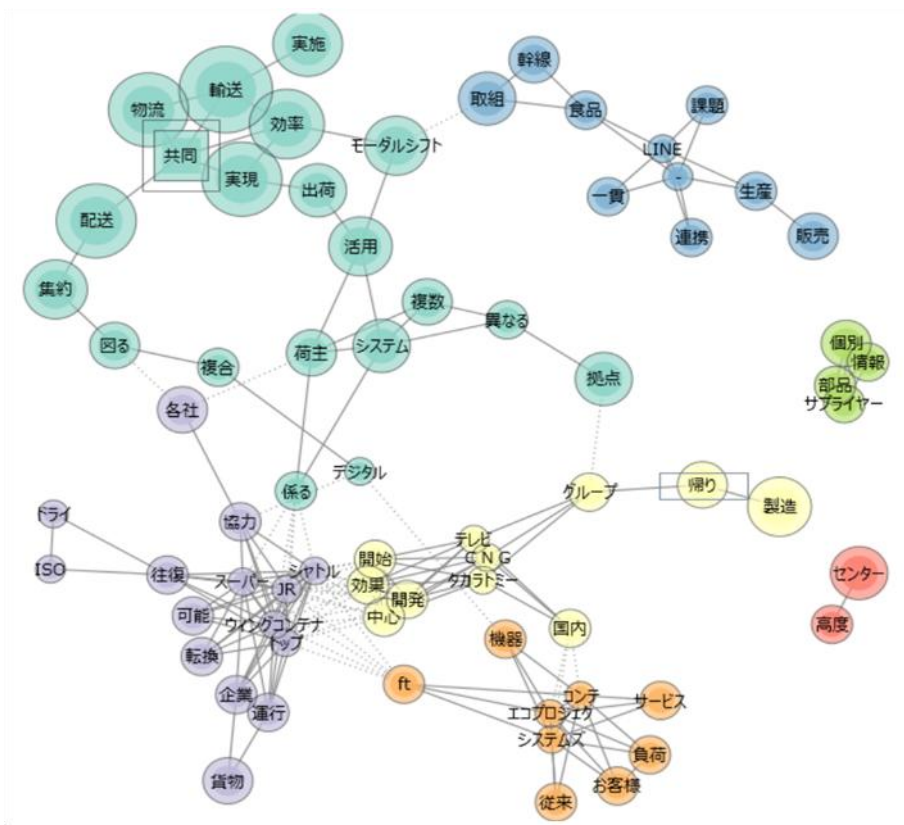


Fig. 6 The co-occurring network associated with “joint”.

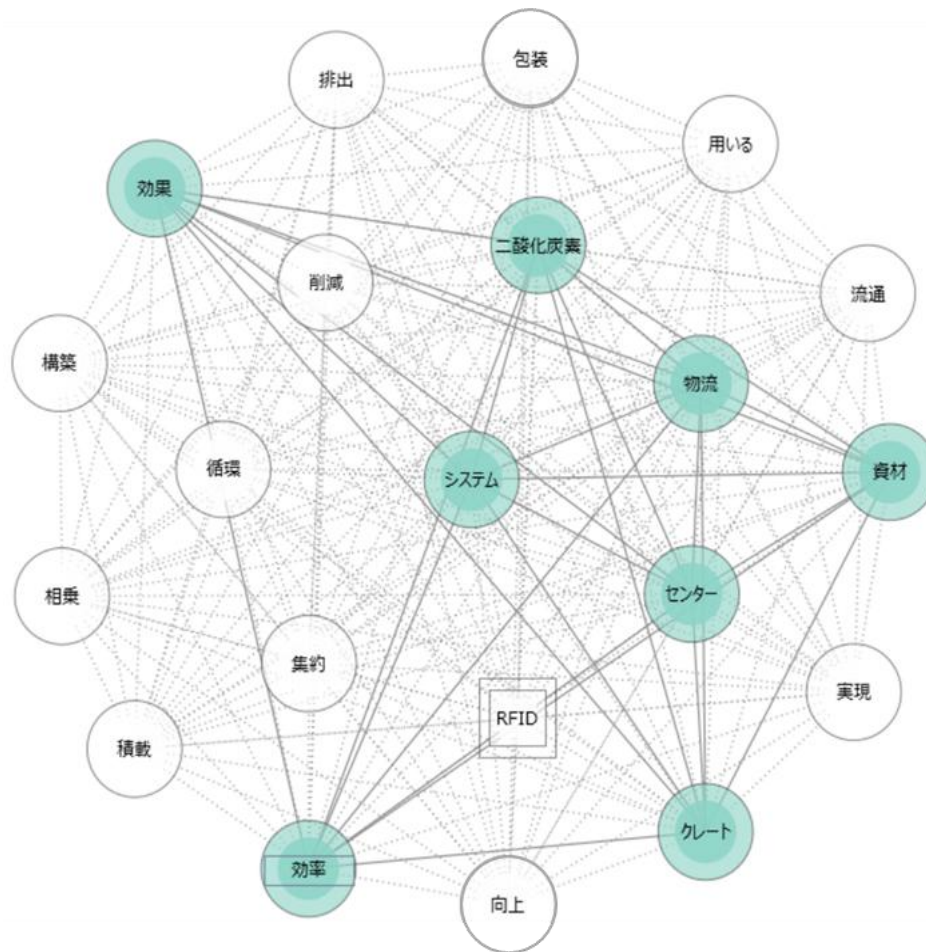


Fig. 7 The co-occurring network associated with “RFID”.

RFID, container design, system adoption, etc.); (ii) loading rate improvement (e.g. consolidation, levelling amount, standardization, etc.); and (iii) transportation volume increase (e.g. multimodal, joint transport, joint distribution, etc.). As for improvement in loading rate and transport volume, there was much done than use of technologies, for example, among the data source, 2 cases were RFID usage. It is noted that the model building is in progress, and should be complemented continually.

#### 4. Conclusion

This paper explored GL initiatives implemented in the logistics service industry in Japan, with which LSPs and shippers combined efforts towards reduction of CO<sub>2</sub> emissions. The study was performed through text-mining the data of 52 award-gained GL initiatives

between 2006 and 2017. Due to the multidisciplinary nature of GL and the collaborative implementation as a process of integrating the ideas of environmental protection into logistics operations, the analysis focused on the connections between the GL practices on the co-occurring network, rather than the feature of what have been conducted. Based on the co-occurring network and the networks with associated words study, the results were depicted with three measurable aspects contributing to explain the data in a more structural way. Furthermore, from this work, it was possible to use text mining as a tool to visualize the multidisciplinary data in the research area. This study serves as an initial step, and much remains to be learned in the future, for example, how to process the data more means-end logically could be helpful to reveal the indirect-to-direct connections network.

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