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Propensity to green logistics initiatives diffusion in the road freight networks

Abstract

Effective supply chain sustainability plan to protect and preserve scarce productive resources manifests epitome of propensity to create a greener economy. Collaborative companies depict an exigency discernment to adopt green logistics initiatives within the extended supply chain networks. This study examines the extent of propensity to collaborative green-driven logistics initiatives to which the trading supply chain partners relate green logistics diffusion to supply chain logistical road freight operations and activities. The study further attempts to establish whether the interrelationship of dimensions between the internal and/or external factors influence the diffusion of green logistics initiatives. The sample of 160 respondents was drawn from the target population and the interrelationship dimensional modelling was used on factor analysis method. Broad green initiatives are associated with an improvement in a business's image, and reduced routing schedules through a central distribution hub to minimize unnecessary transportation. However, accessible technological advancements along the entire value chain pose a challenge to the adoption of extended green enterprise initiatives. The potential diffusion of green logistics business efficiency and sustainability implies the entrenched collaborative awareness and greater access to the technology.

Keywords: green logistics, green initiatives and drivers, information technology, network theory.
JEL Classification: L91, Q51, Q52.

Introduction

The dynamic challenges of greening logistics operations and activities influence the impetus to communicate the green logistics initiatives overtime through the extended social system in the road freight industry. In the supply chain logistics network, the inbound, and the outward movement of products constantly attract considerable scrutiny in terms of the expected effect on the environment. Chiou, Chan, Lettice and Chung (2011) focus on the incorporation of environmental considerations into decision making at each stage of the organization's materials management and logistics functions through post-consumer disposal. The multiple network firms deem to collaborate on leveraged strategic greenlogistics positioning and to improve eco-efficiency operations as economies continue to integrate for sustainability. Nevertheless, the scope of a green supply chain goes beyond sustainability, and the properly developed policies and sound strategies bring forth the environmentally-friendly product and process design, and the extension of a product's life-cycle.

Zhu and Sarkis (2007, p. 4333) examined the moderating effects of implementing green supply chain practices and noted that the existence of market (normative) and regulatory (coercive) pressures will influence organizations to adopt improved environmental performance. Kudla and Klaas-Wissing (2012, pp. 261-300) highlight that it might be prudent for production managers and strategists to champion certain practices down their supply chain and broaden their insights on normative influences while acknowledging regulatory and mimetic pressures. Proactive management of sustainability and environmental issues have encouraged the sincere transparent use of profound adoption decisions to enhance the successful introduction of innovative green initiatives diffusion. According to Rogers (2003), adoption refers to the decision of any person or organization to use an innovation while diffusion is the process in which an innovation is communicated over time through certain channels among members of a social system.

Problem statement and objectives

The phenomenon of greening logistics may present opportunities and entrench collaboration among trading partners; however the magnitude of opportunistic and synergistic effect within the road freight industry is yet to be assessed. There is a need for road freight operators to examine the extant logistics activities that impact the environment and broader social structures within the contextual paradigm of triple bottom line. This study focuses on green initiatives diffusion that these companies are tentatively implementing and/or adopting to reduce the environmental effect of road freight logistics activities. This study aims to achieve the following research objectives:

- To examine the extent of propensity to green-driven logistics initiatives to which the trading supply chain partners relate green logistics diffusion to supply chain logistical road freight operations and activities.

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- To establish whether the interrelationship of dimensions between the internal and/or external factors influence the diffusion of green logistics supply chain initiatives.

Green interface on logistics management

When the phenomenon of green and the science of logistics are joined together, they suggest a transport and distribution system that is both environmentally friendly and eco-efficient. Although the green supply chain management (GSCM) entrenches "the coordination of the supply chain in a form that integrates environmental concerns and considers inter-organizational activities" (Green Jr., Zelbst, Meacham and Bhadauria, 2012, pp. 290-298). Eventually, the coordinated initiatives of GSCM have to contribute in the social network transition towards eco-efficiency and sustainability (Govindan, Sarkis, Jabbour, Zhu and Geng, 2014; Zhu, Sarkis and Lai, 2013). When supply chain management principles are applied to logistics, this is known as supply chain logistics. Bowersox, Closs, Cooper and Bowersox (2013, p. 4) assert that logistics is "the process that creates value by timing and positioning inventory while reflecting the combination of a firm's order management, inventory transportation, warehousing, material handling and packaging as integrated throughout a facility network". Similarly, Thiell (2010) describes green logistics as "a set of activities related to the eco-efficient management of the forward and reverse flow of products and information between the point of origin and the point of consumption whose purpose is to meet or exceed customer demand".

Therefore, making logistics sustainable in the future requires innovative measures which cross the boundaries of simply carbon emissions reduction through to the outbound logistics phase of post-consumer disposal and the concept of 'closing-the-loop' in reverse logistics (Lee, Ooi, Chong and Seow, 2014, p. 2). To a certain extent, Lai and Wong (2012, p. 268) interpret green logistics management (GLM) along the performance outcomes such as environmental performance related to reduction in emission, waste and pollution and operational performance related to improvement in product development and delivery. Integrated sustainable operations of product and process design can contribute value-creating on closed-loop-system network in the supply chain as customers become more environmentally conscious.

Theory underpinning the study

The network theory views any system as a set of interrelated actors or nodes (Tate, Ellram and Golgeci, 2013, p. 266) whereby the actors can represent entities at various levels of collectivity, such as persons, firms, countries and other participants in the network (Borgatti and Li, 2009, p. 2). Networks represent an important way to diffuse green logistics initiatives and environmental practices among nodes within the premises of network theory (Tate et al., 2013). Although the driving forces behind environmental business practices (EBP) include government regulation, customer requests, and costs savings (Rugman and Verbeke, 1998, pp. 159-174), collaboration in a supply chain network is required for extended enterprises to share knowledge and skills on consolidated diffusion of EBP and operational initiatives (Pagell and Murthy, 2007, p. 133-143).

Ho, Lin and Chiang (2009) analyze the organizational determinants influencing the implementation of green innovations in the logistics industry using technological, organizational and environmental drivers of logistics firms' willingness to adopt such initiatives. The results indicate that top management's support for innovation, the quality of human capital and organizational knowledge accumulation have a positive influence on the adoption of green initiatives. The need to transfer leadership from central authorities to the extended supply chain network including municipal authorities in order to move from the initiation to the implementation phase is imperative (Roumboutsos, Kapros andVaneslander, 2014, pp. 1-10). These significant findings and the strength of network theory have created rigorous premise to contextualize and conduct this study.

1. Literature review

1.1. Green initiatives diffusion. Supply chain greening is an ever growing concern for businesses worldwide and a challenge for logistics management in the 21st century. A number of studies have been conducted on green initiatives in the logistics industry, including those by Huge-Brodin, Evangelista, Isaksson and Sweeney (2011), and Geroliminis and Daganzo (2010). The environmental impacts are associated with the extraction of raw materials, use of water and energy, air emissions due to cargo transportation, as well as environmental impacts generated during the use of products and their disposal by consumers with implications to eco-efficiency (Govindan, Sarkis, Jabbour, Zhu and Geng, 2014, pp. 293-298). By adhering to higher maturity level of environmental management, organizations can take advantage of win-win opportunities where corporate performance and environmental performance are improved (Hart and Dowell, 2011, pp. 1464-1479). According to Jobbour, Jabbour, Latan, Teixeira and Oliveira (2014, p. 41) who describe the positioning of companies in one of the

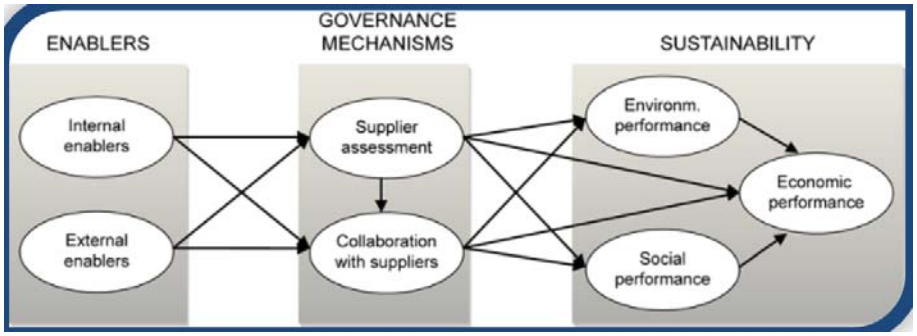
three environmental management maturity levels such as: firstly, reactive phase that concerns about the cost of failure to comply with environmental legislation and the focus is on the end of the process. Secondly, preventive phase that avoids or minimizes the generation of waste or the over use of inputs and the focus is on the pursuit of eco-efficiency. Finally, proactive phase that considers aspects of environmental management as a strategy for the company's competitive advantage, and the focus is to make considerable changes in the processes and/or products.

The level of environmental management relates to a set of environmental characteristics in companies which determines a dominant position regarding the adopted environmental management. Arimura, Darnall and Katayama (2011, pp. 170-182) observe companies that adopt an Environmental Management System (EMS) with a strong probability for improving the environment not only internally, but also throughout the supplier and customer network. This structured framework coordinates the management and assessment of an organization's environmental impact such as the management of waste and carbon emissions. The elements should continuously create value towards the management of day-to-day operations.

1.2. Environmental business practice and packaging. Lee and Klassen (2008), and Roa and Holt (2005) provide the evidence that firms may gain a wide range of benefits such as reduced costs and enhanced competitiveness, when their suppliers adopt environmental business practices. Environmental business practice (EBP) refer to "the set of activities employed to manage and advance a firm's environmental responsibilities" (Huppes and Ishikawa, 2005, pp. 2-5) and can include any business activity that serves the goal of advancing environmental sustainability (Tate, Ellram and Golgeci, 2013, p. 264).

However, Geroliminis and Daganzo (2010, p. 4) argue that there are inconsistencies between logistics and greening; the cost-saving strategies implemented by logistical parties are at odds with the environment since environmental costs are usually externalized. The rationale for the adoption of green initiatives takes the elements that constitute the triple bottom line into account in moving towards green-driven supply chain solutions. Drivers of green logistics initiatives such as Eco-efficiency Options, Policy frameworks, Internal and External Factors, Company Size and Customers-Suppliers Involvement should positively influence the green adoption beyond the principles of triple bottom line.

1.3. Challenges of green logistics initiatives. The extant literature on barriers to green initiatives diffusion in the logistics industry distinguishes between internal and external barriers. Huge-Brodin, Evangelista, Isaksson and Sweeney (2011) identify financial, technical, information, managerial and organizational factors as internal barriers, while external barriers include policy and market issues. In greening the transport and logistics industry, Information Communication Technology (ICT) seems to emphasis closed loop supply chain environmental sustainability throughout the sector's networks. Moreover, Giminez and Tachizawa (2012, pp. 531-543) suggest that while supplier assessment has little immediate effect on environmental performance, collaborative initiatives have more direct influence. However, the results also indicate that assessment alone is not enough, firms also need to adopt a collaborative approach using list of enablers to implement these practices that is, internal enablers (such as the firm's environmental commitment, senior management support and the availability of resources) and external enablers (such as trust and clarity objectives in the buyer-supplier relationship).



Source: Gimenez, C. and Tachizawa, E.M. (2012, pp. 531-543).

Fig. 1. Screening methodology

1.4. South African logistics sector perspective. In order to reduce its greenhouse gas emissions, South Africa needs to formulate a clear vision in the areas of policy, investment and technology. The South African domestic freight sector is confronted by high freight logistics costs, challenging road infrastructure (70.1% of the total tonne-km in 2012 was transported by road) and increasing concern about

the environmental impact of road transport (Havenga, Simpson and de Bod, 2012, p. 38). Freight transportation is a major enabler of economic activity, but relies heavily on high-cost road transportation that constrains the country's growth and competitiveness. The researchers found that the following factors influence costs: the condition of the country's road networks (73%); the availability of return loads and the costs associated with empty returns (66%); traffic congestion and associated delays (52%); and theft (53%). Companies in developed economies with a more mature understanding of supply chain management can voluntarily adopt sustainability initiatives as a strategic tool for business improvement, while emerging economies focus on reducing costs and increasing profits rather than investing in environmentally-friendly initiatives such as recycling waste and the reduced consumption of fuel, power and paper (Supply Chain Foresight, 2013, p. 18).

2. Research methodology

2.1. Research design. This empirical study was divided into two parts: firstly, the research was based on theoretical framework, as well as literature review that were summarized in the previous section. Secondly, the data collection phase involved the participation of a set of logistics service providers within the Durban region, South Africa. Between the two broad categories of research methodologies (quantitative and qualitative), this study has used quantitative research paradigm to achieve the objectives of the study. A cross-sectional, self-administered survey in the Durban region, province of KwaZulu-Natal, South Africa as the study site is used to collect desired data on the target sample frame of third party and/or fourth party road freight logistics companies.

Sampling design is defined as a process of selecting the number of units for a study in a way that represents the larger population from which they are selected (Sekaran and Bougie, 2010, p. 266). Castillo (2009) defines the target population as "the entire group of individuals or objects to which researchers are interested in generalizing the conclusions. The target population usually has varying characteristics and it is also known as the theoretical population." The employees occupying managerial positions at all three managerial levels along with those in non-managerial positions such as supervisors were selected based on the judgement of the researcher regarding the characteristics of a representative sample (Thomas and Brubakar, 2008; Simons, 2009). This study presented a challenge of accounting the precise target population in a tentatively fragmented combinatorial analytical figure. The underlying estimated numbers from the Durban road freight industry assisted on the process of selecting a consistent small portion of the tentatively representative target population. The snowball sampling also assisted in achieving considerable return rate of the distributed questionnaires and to able to pin those deemed to be key decision makers. A nonprobability sampling, known as purposive sampling, was chosen as a method where managers and supervisors were selected in the sample by researcher with a purpose in mind (Rubin, 2008). The sample of 160 respondents was drawn from the target population in the Durban region under eThekwini metropolitan Municipality. The measuring instrument in this empirical study commenced with basic biographical and general perceptions questions.

Eventually it utilized a five-point Likert scale where respondents (supervisors and managers) expressed their levels of agreement or disagreement regarding their perceptions of green logistics initiative diffusion. The questionnaires were delivered to the respondents and a total of 160 out of 200 distributed questionnaires constituted a return rate of 80%. All responses were carefully scrutinized for completeness, consistency and errors, and to eliminate questionable data. The relevant letters (gatekeeper's letter, ethical clearance certificate, and consent letter to ensure confidentiality and anonymity) were shown to the gatekeepers whenever the researcher was given a permission to enter their domain.

2.2. Assessment of reliability and validity. Reliability is being tested using Cronbach's Alpha which is a test for internal consistency. Cronbach's Alpha values (0.66) (rounded-off to 0.7) shows construct validity and that the constructs are measured with sufficient reliability. This figure is congruent with the minimum of 0.7 suggested by Nunnally and Bernstein (1994) as a rule of thumb and it also confirms the reliability of the instrument. Validity can be determined by applying certain validity tests in order to measure the right concept (Bryman and Bell, 2007, p. 165). Content validity measured the adequacy of the sample (McBurney and White, 2007, p. 129) while criterion validity looked at the relationship between scale scores and some specified scores and construct validity measured the degree to which the scale measures the underlying concept it claims to measure (Beins and McCarthy, 2012, p. 68).

2.3. Results analysis. Data analysis is a crucial stage of research, where, having gathered the data, the researcher conducts statistical analysis to achieve the objectives set out in the theoretical framework. Statistical analysis was performed using two types of software, SPSS and Excel.

2.4. Factor analysis. This method replaces the predictor-criterion relationship from the context of a dependence situation into a matrix of intercorrelations among several variables with no dependence (Cooper and Schindler, 2010). Principal component analysis ensures the transformation of a set of variables into a new set of composite variables. The reliability of factor structures and the sample size requirements are congruent with major factor loading above 0.70. The statistical measures helped to assess the factorability of the data with Bartlett's test of sphericity, and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970, 1974). The measure indicates that the Kaizer-Meyer-Olkin (KMO) score of 0.811 (indicates sampling adequacy) obtained in this factor analysis is suitable with Bartlett's test of sphericity (788.357) at degree of freedom (78), significance level, p = 0.000 suggesting that the data matrix has sufficient correlation to factor analysis. The factor model indicates four distinct factor loadings without any misclassifications (a total of 13 items are reduced to four underlying factor loadings).

Table 1. Factor analysis on KMO and Bartlett's test, rotated components and Alpha

KMO and Bartlett's test						
Kaiser-Meyer-Olkin measure of sampling adequacy						.811
Bartlett's test of sphericity			Approx. chi-square			788.357
Degree of freedom						78
			Sig.			.000
Rotated component matrix[a]						
	Factor loading	Eigenvalues	% of variance	Cumulative %	Communalities extraction	Initial
Factor 1: Green Logistics Practices						
Green image business transactions	.801	4.848	37.293	37.293	.818	1.000
Routing schedules	.711				..601	1.000
Environmentally friendly goods transportation	.702				.607	1.000
Distribution hub	.699				.652	1.000
Environmentally friendly business transactions	.690				.793	1.000
Green supply chain management initiatives	.658				.610	1.000
Factor 2: Green Logistics Efficiency						
Flexible delivery time	.794	1.296	9.97	47.263	.667	1.000
Green initiative diffusion	.689				.687	1.000
Green logistical costs	.651				.634	1.000
Factor 3: Green Logistics Collaboration						
Company logistics and supply chain partners	.777	1.228	9.449	56.712	.644	1.000
Factor 4: Green Logistics Technology						
Supply chain logistics	.803	1.101	8.47	65.182	.735	1.000
Technological challenges	.691				.620	1.000

Notes: Extraction method: Principal component analysis, Rotation method: Varimax with Kaiser normalization, a. Rotation converged in 22 iterations. Reliability statistics: Overall Cronbach's alpha = .842, and Number of items = 31.

The principal components method of factor extraction and varimax method of rotation generated four factors that account for 65.182% of the variance. Principal components analysis is used to extract factors with eigenvalues greater than one (Podsakoff and Organ, 1986), while Kaiser's rule (Kaiser, 1970) recommends that all components with eigenvalues under 1.0 be dropped. Factor 1 accounts for 37.293%, factor 2 for 9.970%, factor 3 for 9.449% and factor 4 for 8.470% of the variance. Table 1 indicates that these four factors accounted for 65% of the variance in the original 13 variables. All four factors have eigenvalues above the customary cut-off point of one. While the logic of naming the factors has been relatively easy and theoretically sound, the ultimate goal is to derive a set of factors that are theoretically meaningful, relatively easy to interpret, and account for as much of the original variable as possible.

Factor 1: The first component comprises of items related to a business's green image, routing schedules, distribution hub points, green initiatives, eco-friendly transportation and business transactions. These six items encourage a company to adopt green initiatives and are thus appropriately interpreted as *Green Logistics Practices*.

Factor 2: Component two is interpreted as *Green Logistics Efficiency* and comprises the items such as flexible delivery time, green initiative diffusion and green logistical costs. These items contribute to the efficiency of a business when it pursues green methods.

Factor 3: This component is interpreted as *Green Logistics Collaboration* where the company and its supply chain trading partners strive to reduce their carbon footprint, thereby securing the business's future existence.

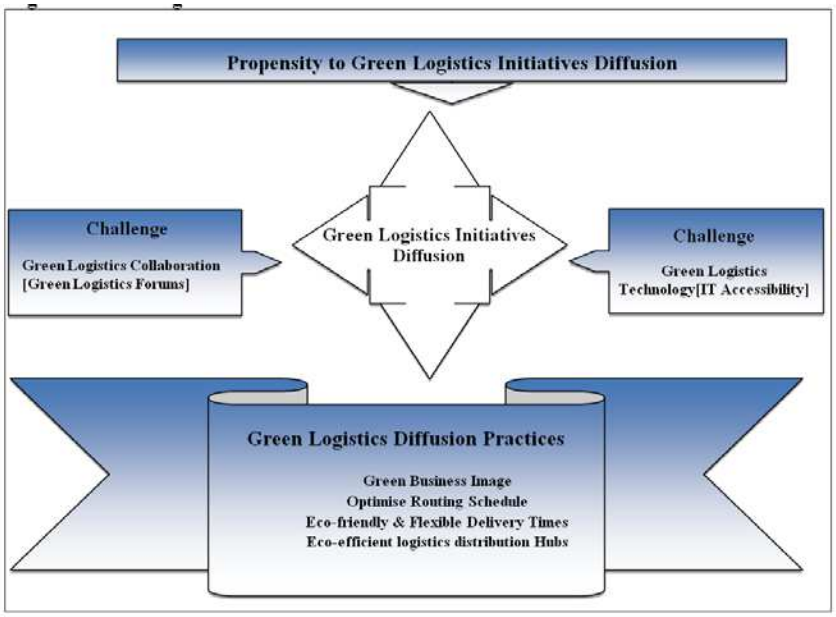
Factor 4: This critical component relates to items from supply chain logistics and technological challenges; hence it is interpreted as *Green Logistics Technology*. If green information and technological advances are easily accessible, companies will be in a favorable position to control their carbon footprint.

Discussion and conclusion

While sustainability programs that reduce carbon emissions are required, recycling waste material has become a common green practice with technology advancing the integration of green logistics initiatives across industries. Despite integration and shared knowledge and information, constraints to greening supply chains and limited initiatives diffusion reflect the lack of economic incentives for green initiatives and the investment costs of tracking the carbon footprint and associated environmental impacts. From a broader perspective, green initiatives enable organizations to do business with customers that are concerned about the company's green image, although it has not scientifically proven in this study. Such organizations view the environmental effect of their logistics activities as an integral part of decision-making on business image, strategic scheduling routes and consolidated distribution hubs. These green logistics practices do not exploit the market by appearing to be active green participants, or a constraint imposed by government regulations and/or social pressure.

Green logistics initiatives have propensity to improve central supply chain distribution hub points and routing schedules in the road freight industry. Strategic consolidation hubs would reduce the unnecessary routing of trucks to promote eco-friendly road freight transport practices. Organizations should pay attention to environmental impacts across the entire value chain, including those of suppliers, distributors, partners and customers. Green supply chain initiative diffusion has indication to assist with reduction of production and transportation costs by optimizing delivery times and minimising the waste related to transportation activities. This study notes that access to technological advancements is a challenge in the adoption of green initiatives by organizations across the entire value chain. The alignment of goals can thus act as a catalyst for organizations to measure and monitor their performance against world class standards; innovation has to be driven by transparency and visibility across the supply chain network.

Broad green initiatives are associated with an improvement in a business's image, and reduced routing schedules through a central distribution hub to minimize unnecessary transportation. Quak (2008) observes that distribution centres are among the logistics initiatives to improve the sustainability and mitigate environmental effects by changing the physical infrastructure used by the urban freight transport. Central supply chain distribution hubs has propensity to elevate the flexible delivery times, while efficiency absorbs the costs of green logistical operations in road freight transportation. The Durban road freight system is dependent on the logistics facilities (the positioned distribution centres) that are situated in relatively close proximity to the viable geographic areas that are serving (city centre, shopping malls – urban and townships), from which consolidated deliveries are carried out within that areas. The optimized synergistic network to practice better green logistics initiatives can reduce congestion on inbound and outbound movement, absorb frequently scheduled road freight transport and alleviate carbon emission with moderated logistics activities inside and outside the Durban region. These green initiatives consider the initial phase to reduce the carbon footprint for sustainable supply chains. Presumably, the awareness and technological accessibility tend to entrench the cutting-edge supply chain sustainability programs and ameliorate their carbon footprint. The green logistics knowledge sharing is one of the most value-adding decisive factors capable of offering competitive advantage through eco-friendly and eco-efficient for supply chain partners. Figure 2 depicts the key interrelated dimensions such as collaborative sustainability (forming the green logistics forums) and better logistics information technology accessibility as challenges hampering the green logistics initiatives diffusion in road freight industry. Despite these hindrances, this study highlights the critical green logistics practices as business image-driven practices, optimized routing schedules and hub-based distribution system to expedite flexible delivery times.



Source: designed by the researcher from this study's findings.

Fig. 2. Green logistics initiatives diffusion

Managerial implications. Organizations that are committed to sustainability should be genuinely environmentally conscious in their business, social and ethical practices. Achieving organizational objectives relating to green initiative diffusion depends on proper green logistics costs containment while optimizing routing schedules by means of supply chain realignment. The extent of these challenges depends on many external factors, including government participation, legislation and regulation as well as supply chain collaboration. At present, logistics providers are challenged in implementing green logistics initiatives primarily due to, among other factors, the high cost of green adoption, limited access to technology and the lack of state intervention.

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