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BARRIERS IN IMPLEMENTING REVERSE LOGISTICS IN CHINESE MANUFACTURING SECTORS: AN EMPIRICAL ANALYSIS

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Barriers in Implementing Reverse Logistics in Chinese Manufacturing Sectors: An Empirical Analysis

Abstract

This study attempts to empirically understand various barriers in reverse logistics implementation from firms' perspective in different Chinese sectors. This study identifies major barriers related to management, finance, policy and infrastructure. Contingency analysis is carried out to understand the similarities and differences in barriers among multinational firms and domestic firms.

Keywords: Reverse logistics, Barriers, China, Empirical study

1. Introduction

Reverse logistics is gaining momentum worldwide due to global awareness and consequences of resource depletion and environmental consequences. It is well known that RL is mandatory in European countries where standards such as the Restriction of Hazardous Substances (RoHS), Waste Electrical and Electronic Equipment directive (WEEE) and the Registration, Evaluation, Authorization and restriction of Chemical substances (REACH) strictly enforced. These regulatory standards make it mandatory for original manufacturers of such products to undertake the responsibility for the collection, treatment, and recycling and/or safe disposal of end-of-life (EoL) of their products and materials used for their manufacture (Lai and Wong, 2012; Zhang et al, 2011). Literature have reported several benefits that could be achieved with RL such as efficient resource utilization and environmental protection (Gunasekaran and Spalanzani, 2011; Fernandez et al., 2010; Tsai et al., 2009).

China has become the 'global factory' and the world's top consumer of natural resources and selected finished products due to its rapid industrialization, urbanization and modernization and presence of 22% of world population. The resulting impact has, since 1993, shifted China from net exporter to net importer of raw materials such as steel, plastics and other minerals (Cunat, 2010). This extremely high resource consumption has resulted in serious environmental pollution such as contaminated water and solid waste per unit of GDP in China which is much higher than developed countries (Ma 2004; World Bank, 2005). In particular, waste electrical and electronics equipment (WEEE) is reported to be three times greater than common waste in China with annual growth rate of around 20% (Veenstra et al., 2010; Wang et al. 2009). The consequence of all these wastefulness is that China is now

second in the world after the USA in landfilling and incineration of e-waste residues (Zoeteman et al., 2010).

However, scarcity of resources and increasing international markets regulatory pressures has forced Chinese manufacturers to realize the importance of improving their environment and to implement sustainable practices that reuse/recycle critical resources (Lai and Wong, 2012; Zhu and Zhao, 2004). While scarcity of resources and environmental-based trade barriers may have forced China into enacting environmental laws similar to those in developed world above, Chinese central government is soft-pedaling on the imposition of such stringent environmental legislations, for the fear that it might overly restrain economic growth and competitiveness or even survival of majority of the country's manufacturing firms that are largely SMEs (Lau and Wang, 2009). Are Chinese companies really interested in implementing RL as part of sustainable practices, and if so what are the challenges they face from different stakeholders internally and externally?

Few studies have been carried out to understand in general RL implementation in Chinese context with most of them related to e-waste sector (Ongondo et al., 2011; Yang et al., 2008; Veenstra et al., 2009; Wang et al, 2010; Lau and Wang, 2009). To the best of our knowledge these studies have used case study in particular as a method to study the issues and this has the limitations of small samples which restricts the generalization of finding to reflect the circumstance of whole population.

The dearth of empirical research on RL implementation in Chinese context is the motivation of this research. Specifically, the purpose of this research is to extend the existing research on barriers to effective implementation of RL in Chinese manufacturing sectors. The manufacturing sectors included in this study are steel and construction, automotive, plastics, electronic waste, textiles and paper and paper based products. We categorized RL barriers into four major factors such as management, financial, policy and infrastructure. Beyond this contingency analysis on effect of ownership is carried out to understand the similarities and differences in barriers among multinational firms and Local (domestic) firms operating in China.

The paper proceeds by briefly reviewing literature in respect of RL implementation barriers and presents the significance of the manufacturing sectors considered in this study. The

second section presents the research methods and respondent profile. The section that follows presents our data analysis and results. The last section provides discussions and concluding remarks.

2. RL Implementation Barriers

There are quite few studies which analyzed the major barriers in the context of developed countries. Even though enough evidence in terms of regulations, awareness, public participation, resources and government support exist in Europe they found few criticalities in implementing RL. It is well known that RL is mandatory in European countries, however we find few key barriers in implementing RL in European context such as little senior management attention, difficulties in extended producer responsibility across countries, little recognition of RL as competitive factor, lack of appropriate performance management system, tax issues, little collaboration, limited forecasting and planning, lack of clear return policies, lack of awareness in environmental regulations (PricewaterhouseCoopers',2008).

In Chinese context the scenario is entirely different and it is obvious that nearly 60% of the generated E-wastes were sold to private individual collectors and passed to informal recycling processes. More than 90% of Chinese citizens are reluctant to pay for the recycling of their e-waste (Liu et al., 2006). Given this background we intend to study the real barriers according to manufacturers' view to establish the major issue in RL implementation. To study these issues we identified few barriers reported in the literature with respect to our classification as shown in Table 2.

Table 2: Various barriers in RL implementation

Barriers	Type of barriers	Source
Management	Importance of reverse logistics relative to other issues	Rogers and Tibben-Lembke (2001); PWC (2008); Zhou et al. (2007); Ravi and Ravishankar (2005); Chung and Zhang (2011)
	Company polices	
	Competitive issues	
	Management commitment / little senior management attention	
	Personnel resources (Training, poor level of technical knowledge)	
	Difficulties in extended producer responsibility across countries	

	lack of appropriate performance management system	
	Lack of shared understanding of best practices	
	Lack of strategic planning and structure for reverse logistics	
Financial	Financial resources / Constraints / funds for training / return monitoring system/ storage and handling	Rogers and Tibben-Lembke (2001); Zhou et al. (2007); Lau and Wang (2009); Ravi and Ravishankar (2005)
	Preferential tax policies	
Policy	Legal issues / lack of supportive policies	Rogers and Tibben-Lembke (2001); Zhou et al. (2007) Chung and Zhang (2011) ;Lau and Wang (2009); Ravi and Ravishankar (2005)
	Loop holes in Chinese WEEE regulations	
	Lack of enforceable law / lack of waste management practices	
	All-inclusive consideration and consultation and lack of inter-ministerial communication	
	Regulations or directives to motivate manufacturers'	
	Lack of awareness in environmental regulations	
	Customers not informed of take back channels	
Infrastructure	Lack of systems / EDI standards / Underdevelopment of recycling technologies	Rogers and Tibben-Lembke (2001); Zhou et al. (2007); Chung and Zhang (2011); PWC(2008); Lau and Wang (2009); Ravi and Ravishankar (2005)
	Coordination and support / collaboration / reluctance of support from members	
	Limited forecasting and planning/	

	Lack of In-house facilities	

We find most of the barriers in management category compared to the other three categories. It is also interesting to note that there are lots of barriers under policy aspects next to management barriers category. We find quite few barriers related to financial aspects. We also thought of studying the influence of ownership with respect to barriers. We did a separate contingency study on firms from all sectors with foreign ownership and domestic to compare and contrast the influence of barriers. We certainly believe that firms with foreign ownership would have less barriers compared to domestic firms.

3. Significance of the sectors considered in this study

The selected manufacturing sectors considered in this study (automobile, steel/construction, electronic/computer, textile, plastics and paper/paper based products) are the major drivers of China's unparalleled economic development. For example, China is now the largest automobile producer in the world and a key market for global players in the automobile industry. The automobile sector which employs about 3 million people is "set to become a global point of reference in terms of technology and industry practices for the global automobile industry" (CEIBS, 2011). Similarly, China's iron and steel sector is one of the largest in the world and plays a key role in China's economy with construction and manufacturing industries sustaining its growth. China's steel consumption has increased from by 15% p.a. over the last decade to reach a total of 556 million tons in 2009, accounting for 51% of total global consumption (Cunat, 2010). The country also boast of a vibrant textile sector that employs about 6.17 million people and generated total export value of US $ 167.02 billion in 2009. This textile industry is thinking of extracting valuable raw material by reusing the recoverable waste in future. The paper industry provide 1.5 million employment in 2009, with a total export value of US $ 3.14 billion in same year, while the plastics manufacturing sector employs 2.6 million workers and generate a total export value of US $ 14.40 billion in 2009.

These sectors all have long-term relationship with international businesses through exporting or as suppliers of parts and components to foreign buyers and collaborators.

The waste generation from these sectors is enormous due to high-speed urbanization. Rampant consumerism has resulted in serious environmental pollution such as contaminated water and high solid waste per unit of GDP that is much higher than in developed countries (Fang et al., 2011). Literature reveals that no other country has ever experience as large and as fast an increase in solid waste quantities that China is now facing (Zhang, et al, 2010; Xue and Chen, 2007; World bank, 2005; Ma, 2004).

There is a growing pressure on the sectors to take-back end of life (EoL) products, reuse/ recycle and/or engage in environmentally sustainable waste management practices. Certainly each of these sectors would have different drivers, pressures, experiences and capability in coping with the sectors' exponential growth rates, upgrades and innovation, high rate of obsolescence and waste. Each sector will therefore have varying degrees of implementation in RL practices and which needs detailed investigation.

4. Methodology and sample

4.1 Research samples

To evaluate barriers to RL implementation in Chinese manufacturing industry, we selected manufacturing firms that demonstrated or appears to have demonstrated a certain level of RL practices from the literature and are located in cities with certain levels of logistics infrastructures. Consequently, the sample of companies who participated in this study was selected from key coastal cities of China with the highest concentration of the major industries: Ningbo, Shanghai, Guangzhou, Foshan and Shenzhen were selected for study. These cities have the most advanced industrial and well-developed infrastructure, advanced communications network and highly developed logistics facilities than most other Chinese cities; criteria that are critical for meaningful and successful reverse logistics to take place. The industrial sectors chosen for this study all have long-term international experiences through exporting finished products or as suppliers of parts and components to foreign buyers and collaborators. The implementation of RL based on the above selection criteria was expected to be widespread (Zhu et al. 2007) and hence we targeted the automobile, steel/construction, electronic/computer, textile, plastics and paper/paper based products industrial sectors.

4.2 Scales and measures

The survey questionnaire administered to Chinese manufacturing includes four sections with seventeen items on barriers to RL implementation developed on the basis of expert opinions and the literature (Rogers and Tibben-Lembke, 1999; Lau and Wang, 2009). The four categories of barriers investigated are management, financial, policy and infrastructure. Few key variables were used to measure each category of barrier that included amongst others: lack of initial capital and lack of funds for storage and handling EoL products (financial); low commitment and lack of RL expert at management level (management); lack of enforceable laws and directives on take-back of EoL products and RL not being considered critical to business performance (Policy) and; lack of in-house facility – storage, equipment and

vehicles - and lack of RL technology (infrastructure). Tables 6-9 provides detailed variables used.

A five point Likert scale (1 – Strongly disagree, 5 – strongly agree) was used to measure the degree to which listed barrier variables in the four sections of the questionnaire: management, financial, policy and infrastructure impede implementation of reverse logistics in the target companies.

We carried out a pilot test to evaluate and refine the survey questionnaire. The test was conducted during a workshop for Ningbo entrepreneurs at the University of Nottingham Ningbo China. Based on the feedback from 17 CEO respondents at the workshop, minor modifications were made to the questionnaire.

4.3 Data collection

Data collection was conducted through personal administration of the survey instrument at selected organizations using intermediaries who were either representatives of private entrepreneur associations or local government officials during a three month period from August to October 2011. The use of intermediaries was informed by past studies that highlights the challenges faced in using representative sampling techniques in China, where a general distrust of outsiders results in low response rate to mail-based surveys (Tabachnick and Fidell, 2000; Zheng et al., 2006). The intermediaries were used to provide introductions to the research team, aid the understanding of the questionnaire items and to assure the respondents that replies would be kept confidential and used for academic research only. Respondents were also promised a summary report of the final research findings. Details of respondent are shown in table 3. The targeted manufacturing companies were identified and randomly chosen from the China manufacturer directory (china-manufacturer-directory.com) with focus on the six industrial sectors mentioned above.

Among the participants, 31.8 percent were from steel and construction industry, 24.7 percent from electronics and computer industry, 13.8 percent from the automotive industry, 6.3 percent from plastics industry, 10 percent from the paper and paper based products industry, and 13.4 percent from the textile industry.

Over 36 percent of manufacturers who took part in this survey employed between 100 and 500 employees while over 38 percent employee between 500 to over 3000 employees. Based on China's guidelines on enterprise scale standards, a company is classified as SME if its business volume is less than 300 million RMB (currently, US$1 I equals RMB 6.34) (Rahman and Wu, 2011). Among the returned samples (with Ningbo (37.24%), Shanghai (9.21%), Guangzhou (15.48%), Foshan (28.45%) and Shenzhen (9.62%) cities), when judged

by their business volume, most of the companies fell into the SMEs category (over 87%), while over 12 percent of the respondents were their larger counterparts. Over 44 percent of the companies have been established for over five years. The questionnaires were mostly answered by middle line managers (approximately 52 percent), followed by top managers (approximately 29 percent). Out of a total of 650 questionnaires distributed, a total of 315 were returned out of which, due to mission responses, 239 were included in the final analysis (36.76% response). The response rate is far better than previous empirical study which has 16.75% carried out by Lai and Wong (2012) in Chinese context with respect to green logistics management and performance.

Table 3: Respondent profile

Industry	**Sample**	
	n	%
Steel and Construction	76	31.8
Electronics and computer	59	24.7
Automotive	33	13.8
Plastics	15	6.3
Paper and paper based products	24	10.0
Textiles	32	13.4
Respondent Position		
First line manager	44	18.4
Middle line manager	126	52.7
Top manager	69	28.9
Ownership		
Local	167	69.9
Foreign	72	30.1
Years since establishment		
< five years	49	20.5
Five to ten years	106	44.4
Eleven years to 20	66	27.6
> 20 years	18	7.5
Annual sales (recent fiscal year)		
< 50 million	93	38.9
50 to 100 million	74	31.0
100 ~300 million	42	17.6
300 ~500 million	10	4.2
> 500 million	20	8.3
Employees		
< 100 workers	59	24.7
100 ~500 workers	88	36.8
501 ~1000 workers	55	23.0
1001 ~3000 workers	24	10.0
> 3000 workers	13	5.4

Annual sales for Locally owned		
< 50 million	74	44.3
50 to 100 million	56	33.5
100 ~300 million	22	13.2
300 ~500 million	6	3.6
> 500 million	9	5.4
Annual sales for Foreign owned		
< 50 million	19	26.4
50 to 100 million	18	25.0
100 ~300 million	20	27.8
300 ~500 million	4	5.6
> 500 million	11	15.3

5. Data analysis and results

Two analyses were carried out examining all respondents' collective significant RL barriers in all sectors investigated and contingency effects of ownership on RL barriers for each sector investigated. Descriptive statistics, alpha coefficients, and item-total correlation were used to initially analyze the survey data and its consistency. Table 4 shows the barriers in the RL implementation, the number of items which measure them, the mean, standard deviations, reliability values based on Cronbach's alpha, and the item-total correlation coefficients. All the factors in the RL barriers have reliability values ranges from 0.70 – 0.88, well above the threshold value as recommended by literature (Churchill, 1997; Nunnally and Bernstein, 1994). Additionally, all the factors have high item-total correlation values, i.e., > 0.53. Exploratory principal component analysis using varimax rotation was used to extract the underlying factors. The factor analysis produces four underlying factors with a total of 64.28 per cent of the observed variances as shown in Table 5, summarised as management, finance, policy, and infrastructure barriers.

Table 4: Descriptive statistics

Barrier/Factors	No. of items	Grand Mean	SD	Cronbach's alpha	Range of item-total correlation
Management	5	3.32	1.37	0.86	0.61 – 0.74
Financial	4	3.35	1.36	0.88	0.69 – 0.78
Policy	5	3.56	1.38	0.83	0.55 – 0.65
Infrastructure	3	3.42	1.38	0.76	0.53 - 0.67

Table 5: Factor Analysis of Barriers to RL

Factors	Factor loads	Eigenvalue	%Variance explained	Cumulative per cent
Factor 1: Management		11.18	29.25	29.25
Lack of RL expert at mgt. level	0.641			
Lack of trained personnel	0.728			
Low commitment	0.658			
Lack of waste mgt. practices	0.624			
Lack of shared understanding of best practice	0.781			
Factor 2: Financial		1.89	13.82	43.07
Lack of initial capital	0.723			
Lack of funds for training	0.651			
Lack of funds for storage and handling	0.617			
Lack of funds for return monitoring systems	0.768			
Factor 3: Policy		1.24	13.32	56.40
Lack of enforceable laws and directives on take-back of end-of-life	0.658			
Lack of govt. supportive economic policies	0.771			
RL not consider critical to performance	0.581			
Customers not informed of take-back channels	0.636			
Lack of public awareness on EP	0.581			
Factor 4: Infrastructure		1.105	7.886	64.28
Lack of systems (hardware/software) to monitor returns	0.768			
Lack of in-house facilities (storage, equipment & vehicles)	0.684			
Lack of Coordination with 3PL providers	0.648			

Notes: Principal components factor analysis with varimax rotation
K-M-O Measure of sampling Adequacy = 0.915
Bartlett's Test of Sphericity = 3186.890; $p < 0.0000$

5.1 All respondent analysis

5.1.1 Management barrier

In general our results show that the key management barrier to the implementation of RL in Chinese manufacturing sector is the low commitment to RL practices and lack of RL expert at management level in the manufacturing firms. Low commitment as management barrier to

RL is reported as major barrier in 4 out of 6 sectors (automobile, steel/construction, electronic/computer and textile) investigated. Surprisingly, lack of waste management practices is not reported as a major barrier to RL implementation in most of the sectors investigated in this study.

5.1.2 Financial barrier

Lack of initial capital and lack of funds for returns monitoring systems for RL implementation is the major financial barrier to the implementation of RL in different Chinese manufacturing sector. Lack of funds for storage and in-house handling of returns is not a major barrier to many of the sector in this study.

5.1.3 Policy barrier

Two key policy barriers to the implementation of RL in the Chinese manufacturing sector are reported as the lack of enforceable laws, regulations and directives on take-back of EoL products and lack of government supportive economic policies for RL implementation. Lack of public awareness of environmental protection and customers not informed of take-back channel for EoL products were not reported as a significant barrier in any of the sectors investigated.

5.1.4 Infrastructure barriers

Lack of systems (hardware/software) to monitor returns is the major barrier to RL implementation in the Chinese manufacturing sectors investigated. Surprisingly, lack of RL in-house facilities such as storage, handling equipment and vehicles for the movement of EoL products did not appear to be of significant barrier to any of the sectors investigated.

5.2 Contingency effect of ownership

We examined the effect of ownership on barriers to RL implementation in the local and foreign funded firms surveyed to identify if differences exist between the two groups and to find out what are the major differences. The key results of our analysis with respect to ownership are discussed below.

5.2.1 Management barriers

Results shows that lack of RL expert at management level is the key barrier to RL implementation in foreign manufacturing firms in China while local manufacturing firms suffers from low commitment to RL practices as their biggest barrier to RL implementation in Chinese manufacturing firms. Interestingly, only foreign and local manufacturers in plastic sectors reported that the lack of waste management practices as a major barrier to their RL implementation.

5.2.2 Financial barriers

As expected, lack of initial capital for RL implementation is reported as a major financial barrier to RL in all sectors and for both local and foreign firms investigated. The second major RL implementation barrier for both local and foreign manufacturing in China is the lack of funds for return monitoring systems. Two minor but interesting findings are that only local manufacturing firms in 3 of 6 sectors investigated reported the lack of funds for training as a barrier to their implementation of RL. Similarly, only foreign manufacturing firms in 3 of 6 sectors investigated reported the lack of funds for storage and handling of returns as a barrier to RL implementation in their firms.

5.2.3 Policy barriers

The key policy barriers to Chinese manufacturing with respect to ownership indicated that lack of enforceable laws, regulations and directives on take-back of end-of-life product is the biggest barrier to RL implementation in both local and foreign Chinese manufacturing sector. Interestingly however, all local Chinese manufacturers reported the lack of lack of government supportive economic policies as a major barrier to their RL implementation. Only foreign Chinese firms in the plastics sector reported same finding as a barrier to their RL implementation.

5.2.4 Infrastructure barriers

All foreign and local firms investigated reported the lack of systems (Technology) to monitor returns and lack of in-house facilities (storage, equipment and vehicles) as the two key barriers to their RL implementation. Only textile manufactures (both local and foreign) indicated that lack of in-house facilities is not a significant barrier to the sector.

6. Concluding remarks

Based on empirical study of 239 Chinese manufacturing companies located in five major coastal cities with the most advanced logistics infrastructures in China, we identified few reverse logistics implementation barriers with respect to management, financial , policy and infrastructure in six of China's key manufacturing sectors: automotive, electronic/computer, plastics, steel / construction, textiles and paper and paper based in industries.

Our study findings indicate at both sectorial and ownership levels, lack of financial resources such as lack of lack of initial capital and lack of funds for returns monitoring systems for RL implementation that constitute major financial obstacle to the implementation of RL in different Chinese manufacturing sector. Low commitment and lack of RL expert at business management levels constituted major management barriers to RL implements in Chinese manufacturing. The lack of financial resources

As revealed by this study, a set of comprehensive and concerted efforts are required from both manufacturing industry and government to remove some of the external barriers identified in this study because of their close linkage. For example external barriers such the lack of enforceable legislations on take-back of EoL products and lack of economic incentives from government reduce motivation and initiative to invest in RL training infrastructure and technology by companies.

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