Impact of Green Logistics Activities on Circular Economy: Panel Data Evidence from ASEAN

Chonmapat Torasa[*1], Witthaya Mekhum[#2]

[*1] *Suan Sunandha Rajabhat University, Bangkok, Thailand*
Corresponding author: E-mail: chonmapat.to@ssru.ac.th
[2]witthaya.me@ssru.ac.th

Abstract- **Green logistic considers those actions which can minimize the ecological impact of logistics activities. The purpose of this paper is to examine the impact of green logistics activities on the circular economy indicators of ASEAN. This study has considered four ASEAN members including Malaysia, Indonesia, Thailand, and Singapore, from 2000 to 2015 with yearly observations. For analyzing the relationship between selected factors of green logistics activities and circular economy, three panel models under the title of ordinary least square OLS, fixed effect and random effect was applied. The main findings of the study show that there is significant influence of Transportation and communication (TC) on recycling rate of selected economies under all three panel models. However, the factor of mining, manufacturing, and construction has shown their significant and positive impact on the recycling rate in ASEAN. Similarly, the effect of TC on specific waste streams is found to be significant and negative under all panel estimators. Further, the factor of MMC is significantly and positively influencing on contribution of recycled materials to raw material demands in selected regions. However, trade of recyclable raw materials has shown an adverse influence from TC under full sample of the study. The findings of the study would be of significant support to the policymakers and various stakeholders in ASEAN economies while exploring the relationship between green logistics activities and selected indicators of circular economy. To the best of author's knowledge, there has been a dearth of research studies specifically with empirical findings, examining the association between green logistics and circular economy. Therefore, this research could be assumed as tentative addition to the literature of economics. However, present study has some limitations which could be addressed in future studies. First, study has considered limited number of logistic indicators for analyzing their impact on the circular economy. Second, application of some advanced panel models like GMM is missing which may provide some different findings in future research. Third, only four ASEAN members are selected from the entire population. It is suggested that future studies can also conduct a cross-sectional or time series analysis on a similar topic too.**

Keywords; *green logistic, circular economy, panel regression, ASEAN*

1. Introduction and Review of Literature

The idea of logistic is observed as the set of various actions which can minimize the business cost and increase its revenue [1-4, 47-48]. The term logistic is widely used in the business field and presented under financial reporting. Whereas green logistic is also under significant attention of the researchers in the past and recent decade [5-7]. As per the findings of [8], green logistic is defined as the overall supply chain management practices and similar strategies which can reduce the environmental impact. Additionally, it is observed that green logistic focuses on those activities which are under the title of material handling, management of the waste, packing and transportation, eco-efficiency, its management, and flow of products and information between the various channels [9-12]. Moreover, green logistic also includes the reduction of energy usage, reduction of waste and its proper treatment, and work for sustainable development in the global environment [13-17]. Besides, green logistic indicates the production and distribution of the goods in a sustainable way while considering the natural environment and other social factors as well [8, 18].

In recent times, the interest in the financial-economic and other activities has been increased in the academic field both at micro and macro level. The reason for this significant change in the researchers' interest specifies that government role is under observation for defining and implementing the procedures and policies to mitigate the environmental impact of these activities [19-21]. However, positive steps from the government not only increase the overall economic outcomes but can provide more social wellbeing too. The contemporary trends in the world economy have affected the economies and business firms while insisting on more work on sustainable development [22, 23]. In this regard, the role of green logistic is very important as it represents all activities which can provide range of benefits. Meanwhile, authors have widely admitted the fact that green logistic is a cutting edge for the business and regional economies for the financial and sustainable development mechanisms [23-25]. Authors like [8] has widely explained the fact that green logistic is the intensification of various efforts to explore the methods and standards for the cost reduction and creating a balance between environment, economic and social components. However, another new term in the literature is known as reverse logistic, considering the flow of product and services to the customer before they are finally shipped to the local or international market [26-28]. This idea provides the

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business with the core benefit of lower cost with minimum time to approach their customers. Additionally, it includes the reduction of operational cost, saving the other expenses and providing the more benefit to the natural environment as well.

Besides, the role of circular economy (CE) for sustainable development is also explored in the existing literature [49]. For instance, [29] have explained the fact that circular economy is increasing its significance through variety of ways for a sustainable future. They indicate that CE modeled as industry can act in various ways, and there is a substantial benefit from it. In the contemporary literature, contribution by [30] has specified the fact that CE is observed as an industrial system which became an alternative paradigm for the global welfare with its lower environmental impacts. For better understanding, authors have adopted two theoretical assumptions under the title of resource efficiency and product life extension. In addition, one of the significant contributions in the literature is provided by [31] who focused on green logistics and circular economy. It is claimed that green logistic is primarily a developing trend in the modern world which covers the condition and basic system for the CE. Meanwhile, CE is accepted as a mean for realizing the closed loop of flow of materials in overall economic system. Therefore, the concept of CE is assumed to be under new horizon when its relationship is observed for the various activities of green logistic.

To the best of the author's finding, this research may assume among the initial contributions in the field of green logistics activities and their impact on the various indicators of circular economy in ASEAN region. The rest of the paper is developed in the following sections. Variables and their description are provided under section two, research methodology under section three, discussion of the results in section four, and conclusion under section five.

2. Description of the Variables

The present study has considered the factor of green logistics and its impact on the circular economy in ASEAN region. For a better understanding, Table 1 provides the description of the variables, their measurement, and literature sources as well.

Variable Title	Indicators	Operational Measurement	Literature Source
Green Logistic activities	Transportation and communication (TC)	Measured as percentage of overall economic activities	[32]
	Mining, manufacturing, and construction (MMC)	Measured as percentage of overall economic activities	[33]
	Fuel and energy (FENERG)	Measured as overall percentage of consumption in the economy	[34]
	Social security and welfare (SSW)	Measured as a percentage of gross domestic product	[35, 36]
	Cultural and religious affairs (CRA)	Number of activities in a year	[36]
	Subsidy on the soft loans to the private sector (SSLPH)	Measured as total amount provided by the government as subsidy	[36]
	Government support for electricity (GSE)	Percentage of total GDP	[37]
	Recycle Rate (RR)	Measured as a percentage of total waste recycled	[38]
	Specific waste streams (SWS)	Measured in terms of tones per capita	[39, 40]
	Contribution of recycled materials to raw materials (CRMRM)	Measured as a percentage of total raw materials	[41, 42]
	Trade of recyclable raw materials (RCRM)	Measured as percentage of total trade in the economy	[43]

3. Research Methodology

Based on the dimensions of time series and cross-sectional units of observations, this study has applied the panel regression models, covering the title of ordinary least square, fixed effect, and finally the random effect models. These regression models are widely applied in the literature of finance and economics and similar other fields as they provide some good coefficients with robust standard errors in the models [43-46]. In addition, these panel models help to reduce the problem of heterogeneity, serial correlation, and some other potential issues in the data set so that researchers can reasonably generalize the findings, based on the stated population and the sample size of their research. Followings are the regression equations which are applied in the present research, covering the title of CE as main dependent variable, while various factors of green logistic are observed as main explanatory variables of the study. Additionally, for comparing the various regression models, Figure 1 provides a better understanding of the application of Hausman and Lagrange Multiplier test accordingly. Furthermore, Equation I-III considers the panel models for the RR, Equation IV-VI for the SWS, equation VII-IX for CRMRM, and equations X-XII for RCRM, respectively.

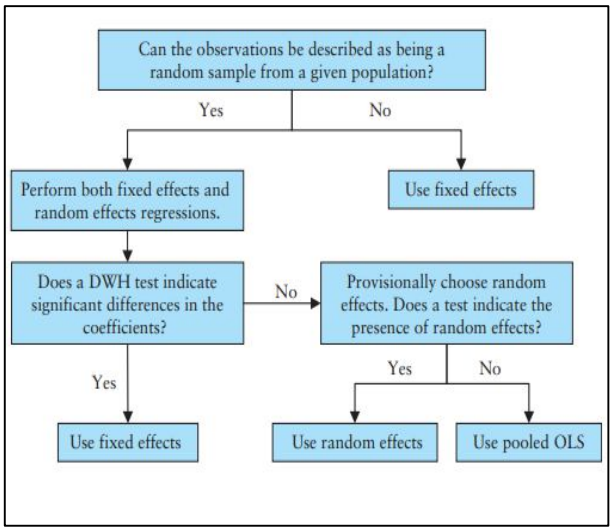

Figure 1. Comparison of the Panel Models

$$RR = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GSE + e.....EQ - I$$

$$RR = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + Y2E2 + Y4E4 + e.....EQ - II$$

$$RR = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + u + e.....EQ - III$$

$$SWS = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GSE + e.....EQ - IV$$

$$SWS = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + Y2E2 + Y4E4 + e.....EQ - V$$

$$SWS = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + u + e.....EQ - VI$$

$$CRMRM = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GSE + e.....EQ - VII$$

$$CRMRM = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + Y2E2 + Y4E4 + e.....EQ - VIII$$

$$CRMRM = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + u + e.....EQ - IX$$

$$RCRM = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GSE + e.....EQ - X$$

$$RCRM = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + Y2E2 + Y4E4 + e.....EQ - XI$$

$$RCRM = b0 + b1TC + b2MMC + b3FENERG + b5SSW + b6CRA + b7SSLPH + b8GS + u + e.....EQ - XII$$

4. Results and Discussion

Descriptive findings are reasonably presented under Table 2 with the total observations for each of the variables, their mean score with standard deviation, and min-maximum observation of the data set. For RR and SWS mean score is 11.05 and 15.97, with the standard deviation of 17.25 and 41.23, respectively. It explains that standard deviation in SWS comparatively more than two times higher than the value of RR under full sample of the study. For CRMRM and RCRM mean score is 25.59 and 17.44, respectively. However, for the deviation from the mean, both of these indicators have provided a score of 28.91 and 28.33 accordingly. Also, the mean score for TC and MMC is 22.6 and 1330.1, with a deviation of 298 and 1552 approximately. Besides, factors like FENERG and SSW have provided a score of 2.18 and 3.76 with the standard mean score as a core measure of central tendency under current observations. For SSLPH and GSE the relative mean score is 6220000 and 9.53 accordingly. For a better understanding of these variables. Table 1 has described their relative description.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
RR	60	11.054	17.254	-32.37	55.52
SWS	60	15.973	41.233	.304	182.416
CRMRM	60	25.599	28.911	.173	82.727
RCRM	60	17.44	28.339	.003	113.948
TC	60	226.173	298.777	.018	880.341
MMC	60	1330.1	1552.144	.112	4099.706
FENERG	60	2.181	2.724	.05	13.063
SSW	60	3.76e+07	6.68e+07	384.595	2.79e+08
CRA	60	594.018	749.307	.008	2533.253
SSLPH	60	6220000	1.13e+07	8.684	3.99e+07
GSE	60	9.53e+08	5.31e+08	-1.85e+09	8.55e+07

Note: *Variables are defined under Table 1*

Table 3 shows the findings for the impact of green logistic on the circular economy in terms of the recycling rate in all four ASEAN regions. It is observed under all three regression models, the effect of TC on recycling rate is negatively significant at 5 percent and 1 percent respectively. It shows that recycling rate in ASEAN and green logistic as measured through transport and communication (TC) is adversely affected, where more increase in TC is showing a decline in recycling rate. Whereas, the factor of MMC is positively and significant related to recycling rate with the coefficient of 0.0108 and 0.00984 as observed under fixed effect and random effect models of the study. However, the effect through FENERG and SSW is found to be insignificant in all three panel models, except for SSW which shows a positive and significant impact of 3.59 with RR under full sample of the study. In addition, cultural and religious affairs (CRA) has also shown its positive but insignificant effect on RR as observed through OLS and FE models. However, it is observed that RE model is showing a positive and highly significant impact of 0.00603 on RR.

Meanwhile, factors like soft loans to housing society (SSLPH), and GSE or government support to electricity sector have provided no significant influence on RR in ASEAN. In terms of robust R-square, the value of variation in RR under OLS estimator is 51.2, 22.6 through fixed effect, and finally 66.4 percent through random effect findings. However, as per the comparative analysis of the model, it is observed that HM test favors the random effect model (p-value=0.129) and LM test provides the significant p-value (0.010), hence defending the argument that random effect is more appropriate to analyze the impact of green logistic on recycling rate of ASEAN region.

Table 3. Impact of Green Logistic on Circular Economy: Recycling Rate

	(1)	(2)	(3)
VARIABLES	Model 1: OLS	Model 2: FE	Model 2: RE
TC	-0.0417**	-0.0393***	-0.017***
	(0.0186)	(0.00518)	(0.00573)
MMC	0.00975	0.0108*	0.00984***
	(0.00651)	(0.00398)	(0.00326)
FENERG	-0.413	0.554	-0.323
	(0.959)	(0.587)	(0.708)
SSW	3.59e-08*	2.31e-08	3.68e-08
	(1.99e-08)	(4.52e-08)	(3.18e-08)
CRA	0.00603	0.00591	0.00603**
	(0.0117)	(0.00398)	(0.00291)
SSLPH	1.13e-07	-4.05e-08	1.23e-02
	(1.15e-07)	(1.34e-07)	(1.32e-08)
GSE	6.32e-09	-3.09e-09	7.252e-08
	(6.79e-09)	(4.60e-08)	(1.22e-08)
Constant	8.814***	-2.723	9.114**
	(3.239)	(45.53)	(4.468)
Observations	60	60	60
R-squared	0.512	0.226	0.664
Number of IDs	4	4	4
Hausman (1978) specification test Chi-square test value= 8.404 p-value 0.129 *Breusch and Pagan Lagrangian multiplier test for random effects: Estimated results* Chi-square test value= 14.038 p-value 0.010**			

Note: *Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Table 4 observes the effect of green logistics activities on the circular economy indicator as measured through specific waste streams (packaging waste, biowaste, e-waste). It is observed that TC is showing its adverse and significant impact on second indicator of circular economy under all three panel regression models of the study. It means that transport and communication are negatively impacting the specific waste stream in ASEAN region. Meanwhile, the impact of MMC on specific waste stream is positively significant with the coefficients of 0.0375 and 0.0197 respectively. It means that both fixed and random effect models are in favor of the assumption that MMC has its direct impact on specific waste streams.

Similarly, FENERG indicates the fact that increasing fuel and energy has its highly significant and direct impact on specific waste stream under OLS estimator only. On the other hand, the factor like social security and welfare SSW shows a negative and significant impact under OLS model, comparatively to fixed and random effect models. However, factors like CRA and SSLPH has shown their insignificant influence on specific waste streams. Similarly, government support to electricity sector has also shown its insignificant influence on second indicator of circular economy.

Table 4. Impact of Green Logistic on Circular Economy: Specific waste streams (packaging waste, biowaste, e-waste, etc.)

	(1)	(2)	(3)
VARIABLES	Model 1: OLS	Model 2: FE	Model 3: RE
TC	-0.192***	-0.228**	-0.102**
	(0.0540)	(0.0618)	(0.0869)
MMC	0.0177	0.0375*	0.0197**
	(0.0140)	(0.0149)	(0.00889)
FENERG	8.555***	6.664	9.255
	(2.301)	(3.058)	(6.594)
SSW	-1.28e-07***	-1.04e-07	-1.32e-07
	(4.71e-08)	(6.08e-08)	(9.79e-08)
CRA	0.0107	0.0133	0.2027
	(0.0240)	(0.0287)	(0.1249)
SSLPH	-6.57e-08	-2.75e-08	-7.25e-08
	(1.09e-07)	(1.08e-07)	(1.32e-07)
GSE	-3.64e-08	-5.73e-08	-3.98e-08
	(2.47e-08)	(4.07e-08)	(3.22e-08)
Constant	-18.54**	-55.37	-16.68
	(7.664)	(31.72)	(17.76)
Observations	60	60	60
R-squared	0.795	0.695	0.723
Number of ID	4	4	4
Hausman (1978) specification test Chi-square test value= 7.368 p-value 0.452 *Breusch and Pagan Lagrangian multiplier test for random effects: Estimated results* Chi-square test value= 9.364 p-value 0.000**			

Note: *Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Table 5 observes the effect of green logistic factors on the third indicator of circular economy as measured through the contribution of recycled material on raw material demands. It is observed that transport and communication show a negative and significant impact on third indicator of CE with the coefficients of -0.0158 and -

0.0268, respectively. It means that there is an adverse impact of TC on circular economy when it is contributed to the recycled raw material demand in ASEAN. Additionally, the factor of MMC has shown its positive and direct impact on third indicator of circular economy. It explains that mining, manufacturing, and construction is causing an increasing demand for recycled material under all three panel models. Besides, the factor of cultural and religious affairs (CRA) has shown their positive and significant impact on CE under Table 5 (coefficients= 0.0116, 0.0142). However, the remaining factors have shown their insignificant impact on contribution of recycled material to raw material demand. Furthermore, HM test specifies the significance of chi-square, hence favoring the fixed effect model of the study.

Table 5. Impact of Green Logistic on Circular Economy: Contribution of recycled materials to raw materials demand

	(1)	(2)	(3)
VARIABLES	Model 1: OLS	Model 2: FE	Model 3: RE
TC	-0.0158*	-0.000867	-0.0268***
	(0.00860)	(0.00912)	(0.00278)
MMC	0.0131**	0.00598***	0.0132***
	(0.00526)	(0.000651)	(0.00155)
FENERG	0.578	1.400	0.628**
	(0.443)	(0.870)	(0.249)
SSW	2.75e-09	-7.54e-09	3.25e-09
	(7.78e-09)	(1.66e-08)	(4.35e-09)
CRA	0.0140	0.0116**	0.0142***
	(0.00836)	(0.00301)	(0.00326)
SSLPH	4.07e-09	-2.91e-09	4.07e-09
	(2.92e-08)	(1.76e-08)	(2.20e-08)
GSE	-1.83e-09	-5.76e-09	-1.83e-09
	(2.83e-09)	(9.29e-09)	(3.21e-09)
Constant	0.304	2.722	0.404
	(1.392)	(5.367)	(1.267)
Observations	60	60	60
R-squared	0.758	0.688	.639
Number of ID	4	4	4
Hausman (1978) specification test Chi-square test value= 14.368 p-value 0.011**			

Note: *Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Table 6 shows the effect of green logistic on the fourth dimension of a circular economy named as trade of recyclable raw materials. It is found that TC has provided a significant and adverse influence on trade of recyclable raw materials in all four selected regions. It means that for the transportation and communication activities adverse the influence on trade of recyclable raw materials and vice-versa. However, the factor of mining, manufacturing, and construction MMC have shown its positive and significant influence on the trade of recyclable raw materials under fixed and random effect models of the study. It explains that higher MMC and related activities, more the trade of recyclable raw materials. Moreover, the effect of fuel energy (FENERG) is also found to be highly significant under OLS while significant under both FE and RE with the coefficients of5.249, 4.0282 and 6.129 respectively. Meanwhile, the factor of SSW has also shown its negative influence but only under the findings of robust OLS estimator.

Similarly, CRA indicates that there is a significant and positive impact on trade of recyclable raw materials in ASEAN region. Meanwhile, the factor of SSLPH has shown its insignificant influence on fourth indicator of circular economy. The impact through GSE on trade of recycling raw materials is significant negative under OLS, while insignificant under fixed and random effect. It is observed that for the generalization of the findings, fixed effect is more appropriate (chi-square=12.195***).

Table 6. Impact of Green Logistic on Circular Economy: Trade of Recyclable Raw Materials

	(1)	(2)	(3)
VARIABLES	Model 1: OLS	Model 2: FE	Model 3: RE
TC	-0.0714**	-0.0965**	-0.0212***
	(0.0268)	(0.0172)	(0.0082)
MMC	0.000958	0.0154***	0.0528***
	(0.00882)	(0.000175)	(0.00471)
FENERG	5.249***	4.082*	6.129**
	(1.275)	(1.474)	(1.907)
SSW	-8.65e-08***	-7.20e-08	-9.12e-08
	(2.76e-08)	(3.17e-08)	(5.54e-08)
CRA	0.0243	0.0261***	0.0253***
	(0.0158)	(0.00377)	(0.00260)
SSLPH	-7.91e-08	-8.21e-08	-8.36e-08
	(7.98e-08)	(4.65e-08)	(7.18e-08)
GSE	-2.63e-08***	-4.33e-08	-1.73e-08
	(8.48e-09)	(2.75e-08)	(1.92e-08)
Constant	-14.82***	-43.73	-15.38
	(4.443)	(22.43)	(10.48)
Observations	60	60	60
R-squared	0.837	0.812	0.635
Number of ID	4	4	4
Hausman (1978) specification test Chi-square test value= 12.195 p-value 0.000**			

Note: *Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

5. Conclusions and Recommendations

This research work has examined the impact of green logistic on the circular economy indicators in the ASEAN region. For a better understanding, panel data models like OLS, fixed effect, and random effect are applied along with the descriptive findings of the study. Detailed analysis is presented, covering the significance of the research models and the causal impact of green logistic factors on circular economy. It is observed that the factor of TC has its negative and significant influence on RR under all three panel models. While MMC is found to be a significant determinant of RR as observed through fixed and random effects. Meanwhile, fuel and energy, SSLPH, and GSE have provided evidence of no impact on RR in overall ASEAN region of the study. However, the effect of SSW on RR is positively significant under OLS regression estimator only. For the second indicator of circular economy (SWS), it is examined that TC has its highly significant and negative influence, while FENRG and MMC are found to be positive determinants of SWS under fixed-random and OLS regression models. Besides, the effect of selected indicators of green logistic on CRMRM is also observed and empirically presented. It is found that TC has its significant and negative influence on CRMRM under OLS and random effect models, while MMC is found to be a positive and highly significant determinant of CRMRM in overall ASEAN region.

Lastly, the impact of green logistics activities on trade of recyclable raw material is observed and presented. It shows that TC has its negative impact, while FEERG is found to be a significantly positive determinant of RCRM. These findings are providing a good understanding of the causal impact of green logistics activities and their influence on CE. Policymakers significantly can utilize these findings while developing strategic rules and regulations for both green logistic and circular economy indicators. Meanwhile, students in their relevant fields can reasonably use the empirical contribution of this research in their upcoming research-related activities. However, present study has some limitations which could be addressed in future studies. First, study has considered limited number of logistic indicators for analyzing their impact on the circular economy. Second, application of some advanced panel models like GMM is missing which may provide some different findings in future research. Third, only four ASEAN members are selected from the entire population. It is suggested that future studies can also conduct a cross-sectional or time series analysis on a similar topic too.

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