Using GIS Techniques for Changing Spatial Distribution Patterns of Green Logistics Activities at Tourist Attraction to Current COVID-19 Situation: The Case of Muang Nakhonratchasima District

Yaowaret Jantakat[1], Pradeep Kumar Shrestha[2], Pongpun Juntakut[3] and Chomphak Jantakat[4]

[1] *Rajamangala University of Technology Isan; Nakhon Ratchasima 30000, Thailand*
[2] *Department of Civil Engineering, Pulchwok Campus, Tribhuvan University, Kathmandu 44618, Nepal*
[3] *Academic Division of Chulachomklao Royal Military Academic, Nakhon-Nayok 26001, Thailand*
[4] *Vongchavalitkul University, Nakhon Ratchasima, 30000 Thailand*

* Corresponding author e-mail: yjantakat@gmail.com
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Abstract

The aim of this study is to use Geographical Information System (GIS) techniques for spatial distribution patterns' change of green logistics activities at tourist attractions to current COVID-19 pandemic in Muang Nakhonratchasima district. This study compared data based on 49 purposive questionnaires in year 2016 and 2021 using high/Low clustering Getis-Ord General G in ArcGIS program. The results found were totally in pattern of complete spatial randomness in both year 2016 and 2021. These outputs demonstrate normative pattern in such 12 tourist attractions of Muang Nakhonratchasima district. It is interesting to find that green awareness and green service are high among 8 green logistics activity. The green awareness and green service has been found to change positively in 9 and 8 respectively out of 12 tourist attractions. Also, these public and private organizations have realized to reverse logistics, using barcode, electric email, and information online for facing the current pandemic. Consequently, the obtained results will be suggested for Tourism Authority Thailand (TAT) Nakhonratchasima and office of Nakhonratchasima City Municipality.

Keywords: Green logistics' activity, Tourist attraction, Spatial distribution pattern, The COVID-19 situation

1. Introduction

From the formal opening of the ASEAN Economic Community (AEC) in year 2015 to the current COVID-19 pandemic, the Asian tourism industry has been temporary stop. This pandemic has still continued from the end of 2019 to the present in every country, has to adopt inter-travel restrictions to prevent the spread. In Thai situation, there are both Thai and foreign tourists that have decreased by the same average 97% (Office of the National Economic and Social Development Council, 2021). The tourism industry is one of the important branches of economic integration under one of three AEC Pillars (i.e., ASEAN Political and Security Community (APSC), ASEAN Economic Community (AEC) and ASEAN Socio-Cultural Community (ASCC)) (Ministry of Tourism & Sports, 2016). At the same time, Thailand has preparation (countries e.g., a lot of workers, hub for connecting ASEAN region and distributing goods etc.) for govern, public and private sectors which have been stronger than other ASEAN countries (AEC Tourism Connectivity, 2016). Importantly, Thailand has importantly given to friendly environmental issue. One of national strategy is environmental development that is taken into account called 'Green Logistics' Activity'. This activity is sustainable logistics management that is one of three indicators for logistics sustain: economy, environment and society (Kamsingnork, 2014; Subsanguanboon, 2019). Currently, leading companies, large and small, are looking for ways to go green so as to reduce emissions, make the businesses more sustainable and ultimately move toward a Circular Economy (DHL, 2020). This is a reason why this study has taken interest in green logistics activities. Generally, green logistics refers to the set of sustainable policies and measures aimed at reducing the environmental impact caused by the activities of this business area (Interlake Mecalux, 2019). Best practices of green logistics activities can help a more sustainable balance between economic, environmental, and social objectives (Bradley, 2021). Similarly, Ministry of Tourism and Sports (2020) has set the promotion of green tourism in spatial tourism development who want to develop a group of areas according to their identity and local identity by maintaining the way of life of the community and conservation of natural resources and the environment which is consistent with the principle of green tourism for sustainable development. Similarly, promoting energy-efficient transportation and environmentally friendly have a strategy to support (1) more rail transport mode and more waterways, (2) developing technology for the use of energy and Clean and environmentally friendly vehicles and (3) environmental standards according to international principles and international cooperation frameworks (Ministry of Transport, 2018).

The aim of this study is to use Geographical Information System (GIS) techniques for spatial distribution patterns' change of green logistics activities at tourist attractions to current COVID-19 pandemic in Muang Nakhonratchasima district, Thailand. GIS is a spatial system for various location enabled services that is the various potential applications such as use of transportation issues (these have received a lot of attention) (Isitwa Inc., 2017). In Thailand, GIS has become mainstream that creates transportation system sustainable in terms of increasing social inclusion, reducing environmental limitations and being economically feasible. GIS applications is decision-makers that can edit spatial and geographic data in maps, analyze this data by creating interactive searches and visualize the conclusions of these processes (Balaman, 2018). This study focuses on comparing between the current results and the past results (year 2016) from the research project named, 'Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province', funded by Thailand Science Research and Innovation (TSRI). In comparisons, we have learned and understood which green logistics activities have been changed in 12 tourist attractions of Muang Nakhonratchasima district where were officially recorded by office of Tourism Authority of Thailand (TAT) Nakhonratchasima (2021) such as Thao Suranaree Monument and Chumphon Ancient Gate, Maha Weerawong National Museum, Phanomwan Castle, Khorat Fossil Museum, Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public, Korat Water Park, Arts of Korat Mirage Museum, Nakhonratchasima Zoo, Pa Salawan Temple, Sala Loi Temple, and Sala Thong Temple. This work presented GIS techniques for analyzing the spatial pattern and distribution of green logistics' activities. The spatial pattern and distribution in GIS generally helps to explain with three types such as clumped, uniform and random dispersion (Walker, 2011; Pacheco, 2006; Ludwig & Reynolds, 1988). Importantly, the results are obtained; they will help us know how green logistics activities in tourist attractions have changed among the COVID-19 pandemic. This information will help for developing tourism strategies in Muang Nakhonratchasima district to improve although we will still facing or not having the COVID-19 pandemic in the future.

2. Literature review

2.1 Green logistics activities

Today's leading companies, large and small, are looking for ways to go green because we reduce emissions, make our businesses more sustainable and ultimately move toward a Circular Economy (DHL, 2020). Thus, it is a reason why we have made it or interested in green logistics activities. Generally, green logistics is used for supporting environment in term of business. Thus, green logistics means supply chain management practices and strategies that reduce the environmental and energy footprint of freight distribution and it focuses on material handling, waste management, packaging, and transport (Rodrigue et al., 2020). The main goal of green logistics is to coordinate logistics activities and have them implemented in a way that benefits both the economy, the environment and the society (Jacobsen, 2020). However, there is a wide range of initiatives to make logistics as green as possible, and each organization should evaluate its own goals, capacities and plans to achieve them. Therefore, Bradley (2021) presents best practices of green logistics activities to help a more sustainable balance between economic, environmental, and social objectives as Table 1. Moreover, the best practices can explain with a pictorial concept of Rodrigue et al. (2020) as shown in Figure 1 to more understand. Consequently, there are compelling reasons why green logistics is gaining ground (Interlake Mecalux, 2019):

1) Green logistics policies represent a strategic advantage over the competition.

2) Energy saving measures are an effective strategy for coping with rising supply costs.

3) A company is prepared to comply with environmental regulations.

Table 1. A sustainable balance between economic, environmental, and social objectives (Bradley, 2021)

Area of activity	Actual situation	Steps to improve	Benefits
Transport	- Fleet causing high amounts of pollution, air quality reduced	- Measure the movements, costs and maintenance of transport to gather data about their use. Invest accordingly in proper maintenance depending of the needs and the selected strategy. This might include: redrawing shorter routes, investing in green vehicles, etc.	- Lowered emission transport units, well maintained and following repair plans that reduce environmental and economic cost by increasing the efficacy.
Distribution	- Distribution channels not well organized or with big inefficiencies	- Plan supply chain and procurement taking into account the cost to manage the waste produced. - Effectively connect places of production with the distribution points, including using proximity to storage/distribution points as a selection criterion. - Assess the production line or third level distribution channels of your suppliers for waste or misuse.	- Faster deliveries, increased flexibility for late requests, and time savings on managing waste.
Procurement	- Price based selection that potentially hides unethical or not environmentally friendly activities.	- Create and apply selection criteria that matches the ethical and environmental policies of the organisation. - Research initiatives that other organisations are putting in place and adapt them to your situation.	- Reputation increase.
Storage	- Product loss by degradation caused by poor storage condition, or damages during in-storage movements.	- Make improvements in the infrastructure to facilitate cargo movement. Use solar light and natural ventilation. - If the infrastructure is going to last more than two years, invest in solar or wind power sources and manage your power consumption. (Power Supply section).	- Save money and time.
Packing	Excessive use of non-biodegradable materials.	- Choosing the appropriate mode of transport with enough time, to be able to understand how the cargo is packed and labelled. Try to find a good compromise between safety and handling; Reduce packaging or/and use reusable or biodegradable materials. Example - corrugated cardboard and other forms of paper-based packaging.	- Resources saved.

2.2 GIS techniques for spatial pattern and distribution

The analysis of spatial pattern attempts to determine the underlying processes which lead to such patterns in points (e.g. Bishop et al. (2020), Jerram et al. (2018), Charlton (2009) and Nowak et al. (2007)), lines (e.g. Corvec et al. (2013)), and areas (e.g. Pian & Menier (2018)). Commonly, there are three types of spatial distribution in natural ecology such as clumped, uniform, and random dispersion (Walker, 2011; Pacheco, 2006; Ludwig & Reynolds, 1988). Furthermore, computing the density of a spatial pattern – perhaps the locations of residential burglaries or road accidents – usually involves GIS software (Charlton, 2009). GIS software lets you produce maps and other graphic displays of geographic information for analysis and presentation (Caliper, 2021). In other words, GIS software is used to support the collection, management, processing, analysis, and modeling and display of spatial data, so that complex planning and management problems can be solved (Hu and Liu, 2017). Moreover, the GIS is a computerized information system designed specifically for managing geographical data and can powerfully accelerate creative collaboration and innovation (Welty 2014). In GIS applications, decision-makers can edit spatial and geographic data in maps, analyze this data by creating interactive searches and visualize the conclusions of these processes (Balaman, 2018). There are various GIS techniques for spatial pattern and distribution that required clustering Getis-Ord General G in ArcGIS program as Table 2.

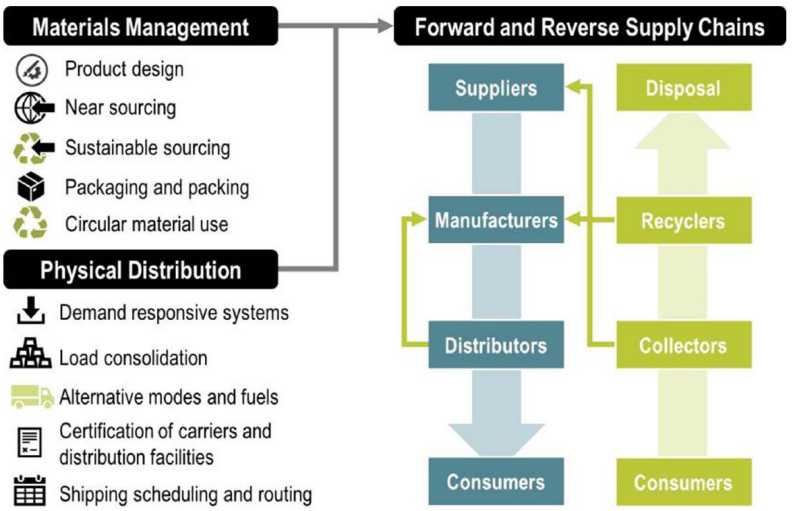


Figure 1. Logistic Activities and their Green Dimensions (Rodrigue et al., 2020)

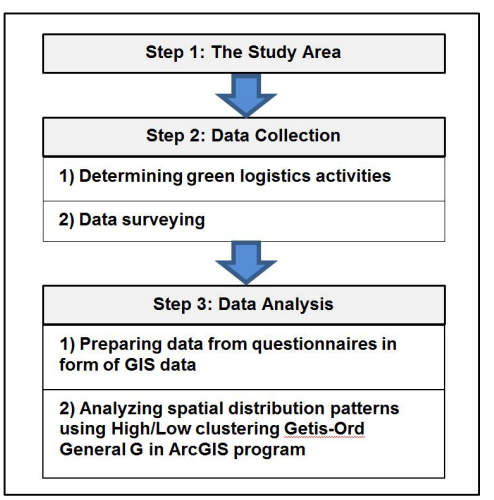


Figure 2. Flowchart of this methodology

3. Materials and methodology

The aim of this study is to use GIS techniques for spatial distribution patterns' change of green logistics activities at 12 tourist attractions from the past (year 2021) to the present time (year 2021) in Muang Nakhonratchasima district, Thailand. Therefore, this study built flowchart for methodology as Figure 2.

3.1 The study area

This study focuses on twelve tourism places in Muang Nakhonratchasima district, Nakhon Ratchasima province, Thailand which were officially recorded by office of TAT Nakhonratchasima (2021). The twelve-tourist attraction locates between 14°-16°N and 101°-103°E. In addition, these tourism places mentioned above are 1) Thao Suranaree Monument and Chumphon Ancient Gate, 2) Maha Weerawong

Table 2. GIS techniques for spatial pattern and distribution

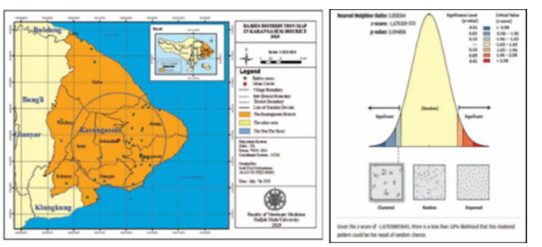
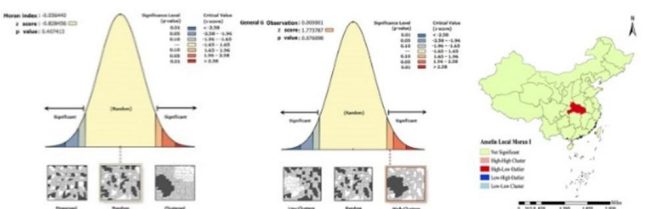
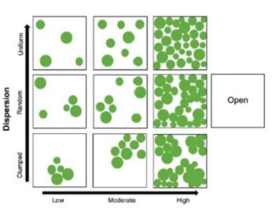
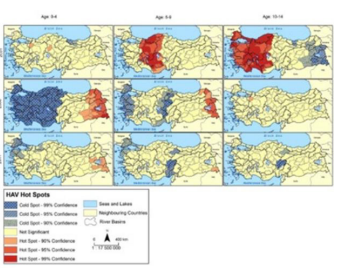
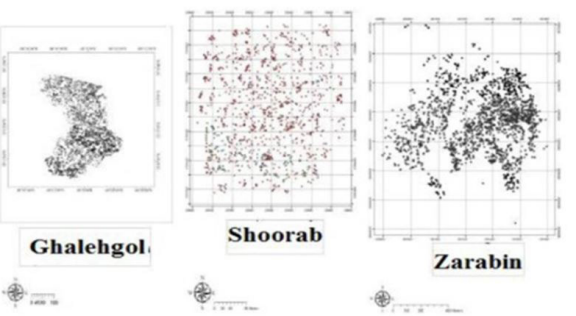
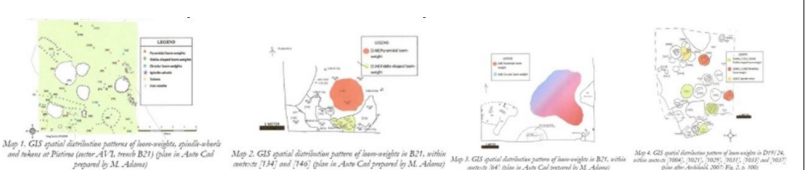
No.	Title and author	Details
1	The rabies distribution pattern on dogs using average nearest neighbor analysis approach in the Karangasem District, Bali, Indonesia, in 2019 by Melyantono et al. (2021)	- This research aimed to describe the spatial distribution of rabies in Karangasem district. - The ArcGIS version 10.3 (ESRI) was used to determine and analyze the distribution pattern using the average nearest neighbor (ANN) method as example as: 
2	Spatial statistical analysis of Coronavirus Disease 2019 (Covid-19) in China by Li et al. (2020)	- This paper characterized the spatial patterns of Covid-19 cumulative cases using ArcGIS v.10.4.1 based on spatial autocorrelation and cluster analysis using Global Moran's I (Moran, 1950), Local Moran's I and Getis-Ord General G (Ord and Getis, 2001) in the following order: 
3	Principles and Practices for the Restoration of Ponderosa Pine and Dry Mixed-Conifer Forests of the Colorado Front Range by Addington et al. (2018)	- This study analyzed tree density and dispersion at a single acre of land as follows:  - At this scale, tree density varies from low to high, and tree dispersion varies from uniform to highly aggregated (what is often referred to as "clumpy" or "groupy").
4	GIS based spatial pattern analysis: Children with Hepatitis A in Turkey by Dogru et al. (2017)	- This study aimed to provide an insight into the geographic distribution of Hepatitis A incidence considering their temporal distribution, spatial patterns, hot spots and clusters identification in three different age-group (0–4, 5–9 and 10–14) in Turkey. - Time series maps were created using Geographic Information Systems (GIS) to introduce the temporal changes in the morbidity rates of Hepatitis A. The spatial variation of Hepatitis A was measured using Moran's I at the global level and the local indicators of spatial associations (LISAs) Moran's I and Getis-Ord Gi *(d) in order to identify influential locations through clusters and hot spots detection of Hepatitis A cases as follows: 

Table 2. GIS techniques for spatial pattern and distribution (continue)

No.	Title and author	Details
5	The distribution, mixture, and diversity models of woody species in Spatial Pattern of Persian oak (Quercus brantii var. persica) forests by Modaberi et al. (2014)	- The aim was to examine spatial distribution pattern, mixture status, and diversity of forest wooden species in forests of Mid Zagros Zone (Zarabin Ilam, Shoorab, and Ghalehgol in Lorestan province) by means of Nearest Neighborhood Index (Clark & Evans). - This study used four indices: 1) Clark and Evans Index (CE), 2) Mixture Index (DMi), 3) Shannon Index (H'), 4) Distance to Neighbors Index (Di) and Nearest Neighbors (NN) Index. These indices was analyzed by GIS technique in ArcGIS program, named 'Spatial Statistic Tools' The study areas were explored spatial patterns (regular or uniform, random and clumped or cumulative) in the following order: 
6	Application of GIS techniques to analysis of spatial distribution patterns of loom-weights, spindle-whorls and tokens at Pistiros, ancient Thrace, within a domestic/urban context by Grzybalska (2010).	- This paper achieved the goal spatial mapping with GIS techniques, were applied to analyze distribution patterns of objects associated with the textile industry within a domestic context. - The spatial distribution was mapped by ArcGIS program with various spatial distribution patterns as follows: 

National Museum, 3) Phanomwan Castle, 4) Korat Fossil Museum, 5) Sirindhorn Learning Park, 6) Nakhonratchasima Regional Observatory for the Public, 7) Korat Water Park, 8) Arts of Korat Mirage Museum, 9) Nakhonratchasima Zoo, 10) Pa Salawan Temple, 11) Sala Loi Temple, and 12) Sala Thong Temple. In Mueang district, twelve tourist attractions are distributed in various sub-districts as shown in Figure 3:

1) There are six tourism places in Ni Muang sub-district.

2) There are four tourism places in Suranaree sub-district.

3) There is one tourism places in Ban Pho and Chaimongkol sub-district.

3.2 Data collection

3.2.1 Determining green logistics activities

Green logistics activities used data from the research project year 2016 named, 'Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province' (more details in introduction above). Eight green logistics activities studied in this study were green purchasing, green production, green transportation, green packaging, green inventory, green technology, green awareness, and green service as shown in Table 3.

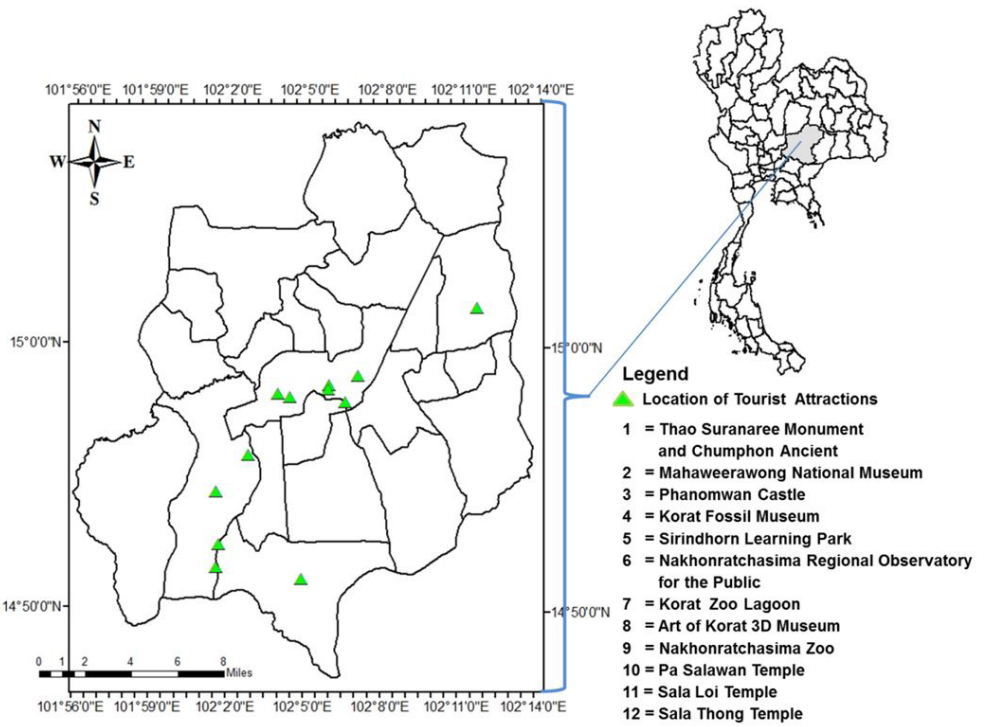


Figure 3. The twelve-tourist attraction in Muang Nakhonratchasima District, Thailand

Table 3. Details of green logistics activities used in this study (Jantakat & Chutiman, 2016)

No.	Green logistics activities	Details for considering green logistics activities
1	Green Purchasing	1.1 Choosing a reliable supplier of goods and services 1.2 Selection of suppliers who can produce products on time 1.3 Selecting an honest supplier of goods and services 1.4 Selection of suppliers that have an appropriate management system based on the following considerations: 1) delivery cycle arrangement, 2) having the power to negotiate the price of payment, and 3) optimizing information exchange management
2	Green Production	2.1 Inventing new production methods that reduce the use of raw materials 2.2 Inventing new production methods that reduce waste from the production process 2.3 Inventing new production methods that uses a low amount of energy to produce
3	Green Transportation	3.1 Using an appropriate transport routing system or called, 'Milk Run' 3.2 Choosing transportation routes together 3.3 Reducing the round trip of empty buses 3.4 Cost-effective vehicle selection aims to save energy and reduce Carbon dioxide (CO2) emissions
4	Green Packaging	4.1 Choosing the right packaging for the product
		4.2 Reusing packaging to be useful again
5	Green Inventory	5.1 Warehouse management approaches that reduce costs
		5.2 Implementing technology in the warehouse such as Electronic Data Interchange (EDI), using a forecast program, and Radio Frequency Identification (RFID)
6	Green Technology	Choosing the right technology to help reduce, prevent, correct and preserve the environment such as bio-energy etc.
7	Green Awareness	Creating awareness for all employees in the organization to be careful in working such as employees must drive at a speed that does not exceed the standard. and not driving while intoxicated etc.
8	Green Service	Providing customer-focused reverse logistics management using technology to facilitate the rapid exchange of information. and reducing the use of documents such as using barcode, electronic mail, informing information via online and call center etc.

3.2.2 Data surveying

This study used questionnaires from the research project named, 'Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province.' The survey used a purposive sampling-based sample size as Table 4 because the researcher required own decision based on consideration of characteristics of the selected group were in accordance with the research objectives, selecting a specific sample requires knowledge, expertise and experience in that subject of the researcher. With the COVID-19 situation, the questionnaires were distributed by email and then were returned back between April and June 2021.

3.3 Data analysis

This study analyzed spatial distribution patterns of green logistics activities in year 2021 and then compared with data in year 2016-based research titled, 'Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province' above. This analysis included steps as follows:

1) Preparing attribute data based on returned questionnaires year 2021 in form of spread sheets.

2) Joining tables from 1) into GIS-point layer of tourism places in ArcGIS program.

Table 4. Sample size used in the study

No.	Tourist attractions	Sample size	Responsible agency	Own stores or shops
1*	Thao Suranaree Monument and Chumphon Ancient Gate	9	1 representative from Office of Nakhonratchasima City Municipality	8
2*	Maha Weerawong National Museum	1	1 representative from the Fine Arts Department	0
3*	Phanomwan Castle	2	1 representative from the 10th Regional Office of Fine Arts, Nakhon Ratchasima	1
4*	Korat Fossil Museum	4	1 representative from Nakhon Ratchasima Rajabhat University	3
5**	Sirindhorn Learning Park	1	1 representative from Techno Thani Suranaree University of Technology	0
6**	Nakhonratchasima Regional Observatory for the Public	1	1 representative from National Astronomical Research Institute (Public Organization)	0
7**	Korat Water Park	8	1 representative from Sports Center of Thailand Region 3	7
8**	Arts of Korat Mirage Museum	1	1 representative from AKMM company	0
9**	Nakhonratchasima Zoo	19	1 representative from Zoo Organization of Thailand	18
10**	Pa Salawan Temple	1	1 representative from Office of Buddhism, Nakhon Ratchasima Province	0
11**	Sala Loi Temple	1	1 representative from Office of Buddhism, Nakhon Ratchasima Province	0
12**	Sala Thong Temple	1	1 representative from Office of Buddhism, Nakhon Ratchasima Province	0
Total	49	12	37	

Remark: * Govern agencies include Thao Suranaree Monument and Chumphon Ancient Gate, Maha Weerawong National Museum, Phanomwan Castle and Korat Fossil Museum.

** Private agencies include Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public, Korat Water Park, Arts of Korat Mirage Museum, Nakhonratchasima Zoo, Pa Salawan Temple, Sala Loi Temple and Sala Thong Temple.

3) Analyzing spatial distribution patterns of green logistics activities in year 2021 with High/Low clustering Getis-Ord General G in ArcGIS program (this technique can explain about spatial distribution patterns of objects as follows (Geog, 2020):

- Clustered occurs when objects exist in close proximity to one another.
- Dispersed: occurs when objects are spread out from one another.
- Random: occurs when objects exist in neither a clustered or dispersed pattern. This is what we also refer to as a "hypothetical" or "normative" pattern.

4) Comparing between spatial distribution patterns of green logistics activities in the year 2016 and year 2021.

4. Results and Discussion

4.1 Spatial Distribution Patterns of Green Logistics Activities in year 2021

Overall of 8-green logistics activity in 12-tourist attraction in Muang Nakhonratchasima district year 2021 is studied based on questionnaires online (more details in 3.2.2 Data surveying), is calculatedly scored and graded as Table 5. Overview of scoring and grading is in low level with a score of 1.89. However, green awareness is in high level in almost tourism places except Phanomwan Castle (low level).

The spatial distribution pattern of 8-green logistics activity in 12-tourism place of Muang Nakhonratchasima district is totally in random pattern, reveals scoring of green logistics activities exist in neither a clustered or dispersed pattern. This is what we also refer to as a "hypothetical" or "normative" pattern in such 12 tourist attractions, Muang Nakhonratchasima district as Figure 4.

4.2 Comparing of Spatial Distribution Patterns of Green Logistics Activities from 2016 to 2021

The spatial distribution pattern of 8-green logistics activity in tourism places of Muang Nakhonratchasima district in the year 2016 is compared with data in the year 2021. The data for year 2016 was taken from research named, 'Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province', funded by TSRI.

Table 5. Scoring and grading for green logistics activities of 12-tourist attraction in Muang Nakhonratchasima District year 2021

Tourist attraction	Green logistics activities								Score	Grade
	Green Purchasing	Green Production	Green Transportation	Green Packaging	Green Inventory	Green Technology	Green Awareness	Green Service		
1. Thao Suranaree Monument and Chumphon Ancient Gate	3.52	3.78	3.44	3.56	0.00	4.78	5.00	3.33	3.43	Middle
2. Maha Weerawong National Museum	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	1.25	Lowest
3. Phanomwan Castle	2.25	2.50	2.50	2.50	0.00	2.50	2.50	2.50	2.16	Low
4. Khorat Fossil Museum	3.31	3.67	3.19	3.00	0.00	5.00	5.00	3.50	3.33	Middle
5. Sirindhorn Learning Park	0.00	0.00	0.00	0.00	0.00	0.00	5.00	4.00	1.13	Lowest
6. Nakhonratchasima Regional Observatory for the Public	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	1.25	Lowest
7. Korat Water Park	3.96	3.79	3.88	3.56	0.00	4.75	5.00	3.38	3.54	High
8. Arts of Korat Mirage Museum	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	1.25	Lowest
9. Nakhonratchasima Zoo	3.72	3.79	3.84	4.08	0.00	4.05	4.11	4.16	3.47	Middle
10. Pa Salawan Temple	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.63	Lowest
11. Sala Loi Temple	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.63	Lowest
12. Sala Thong Temple	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.63	Lowest
Score	1.40	1.46	1.40	1.39		1.76	4.72	2.99	1.89	
Grade	Lowest	Lowest	Lowest	Lowest	-	Low	High	Middle	Low	

Remark: Scoring and grading included lowest between 0.01-1.49, low between 1.50-2.49, middle between 2.50-3.49, high between 3.50-5.00 and highest between 4.50-5.00

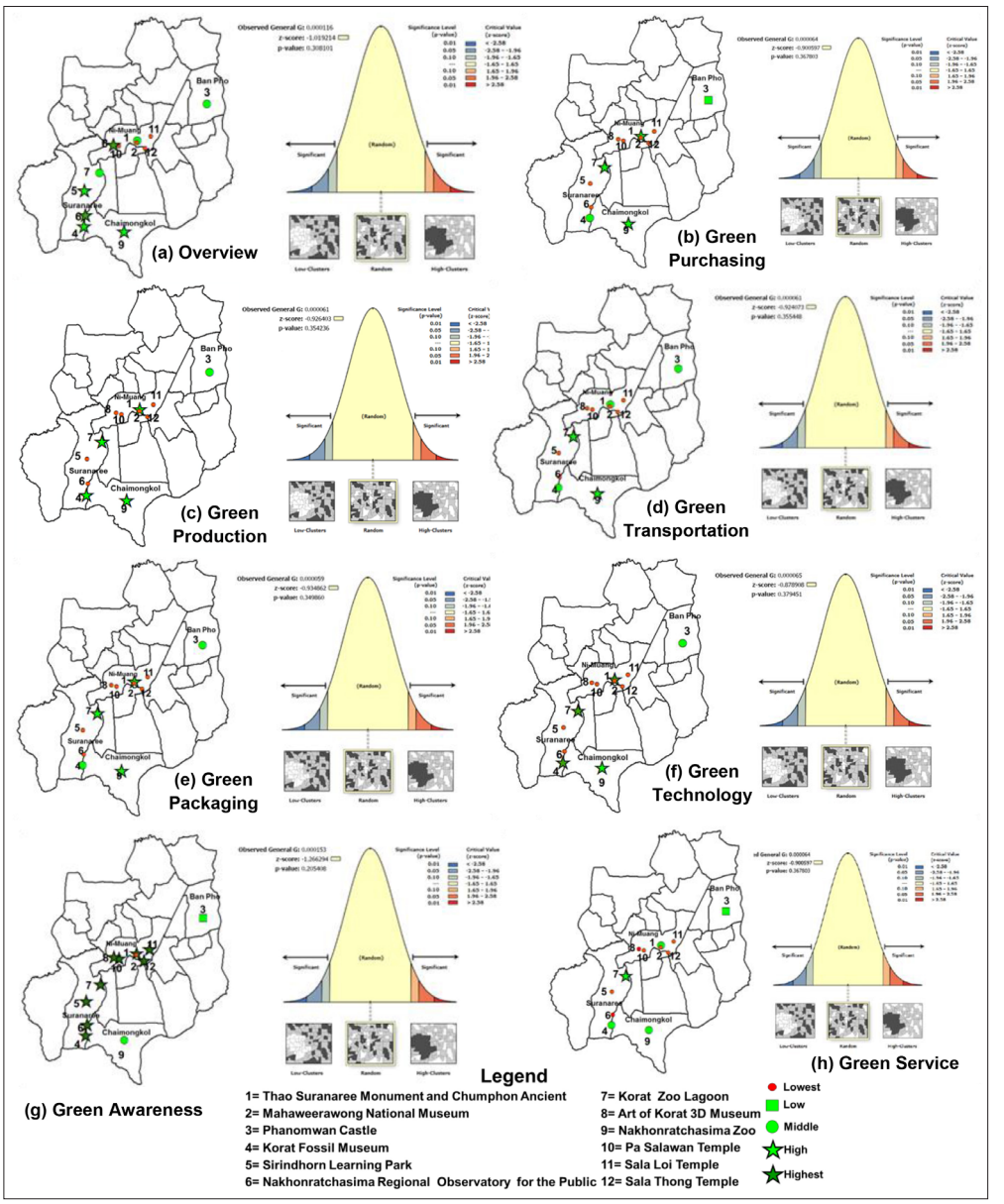


Figure 4. Spatial Distribution Patterns of Green Logistics Activities year 2021

Remark: Green Inventory was not replied in questionnaires by respondents

Both data, are totally in low level (scoring 1.57 for the year 2016 and 1.89 for the year 2021), are totally in the pattern of complete spatial randomness as Figure 5. These outputs show that scoring of green logistics activities exist in neither a clustered nor dispersed pattern. This is what we also refer to as a "hypothetical" or "normative" pattern in such 12 tourist attractions, Muang Nakhonratchasima district in. year 2016 and 2021.

Table 6 and Figure 6 shows changing of each green logistics activity in 12 tourism places. The results are found that green awareness has been found to change positively in 9 out of 12 tourist attractions (Thao Suranaree Monument and Chumphon Ancient Gate, Korat Fossil Museum, Sirindhorn Learning Park, Korat Water Park, Arts of Korat Mirage Museum, Nakhonratchasima Zoo, Pa Salawan Temple, Sala Loi Temple, and Sala Thong Temple) and negatively change in 2 out of 12 tourist attractions (Maha Weerawong National Museum and Phanomwan Castle).Similarly, green service has been positively change in 8 out of 12 tourist attractions (Thao Suranaree Monument and Chumphon Ancient Gate, Phanomwan Castle, Korat Fossil Museum, Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public, Korat Water Park, Arts of Korat Mirage Museum and Nakhonratchasima Zoo) and negatively change in 2 out of 12 tourist attractions (Sala Loi Temple and Sala Thong Temple). They are public and private organization that have realized to reverse logistics, using barcode, electric email, and information online for facing the current COVID-19 situation.

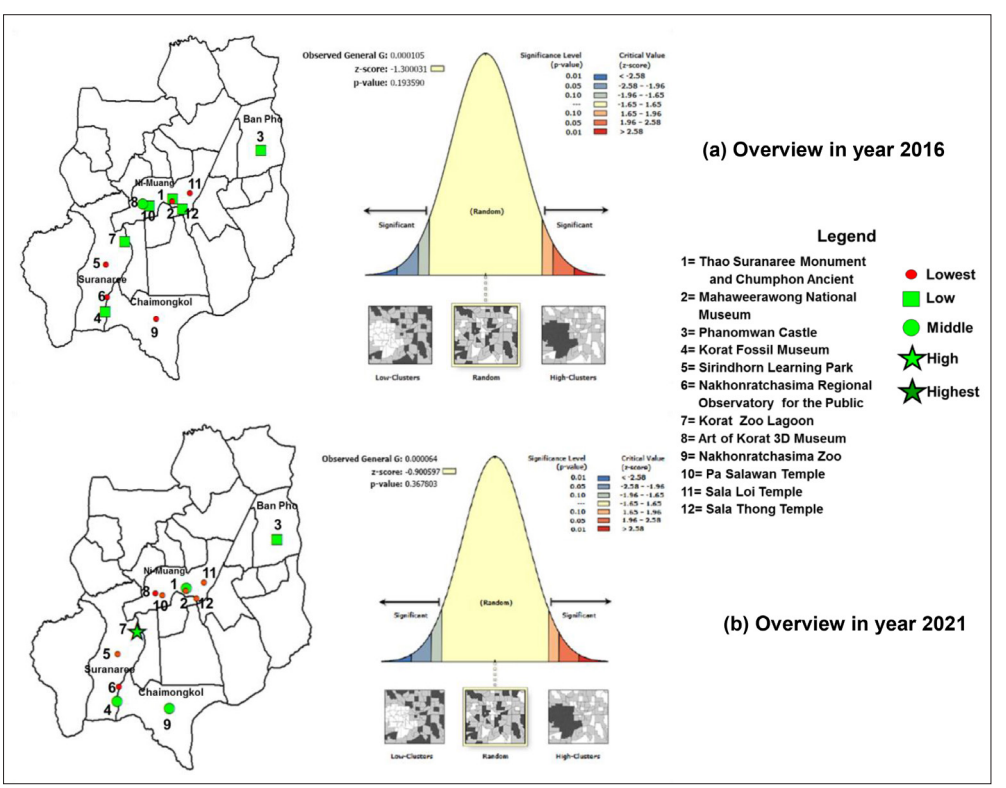


Figure 5. Overall comparison of spatial distribution patterns of green logistics activities from 2016 to 2021

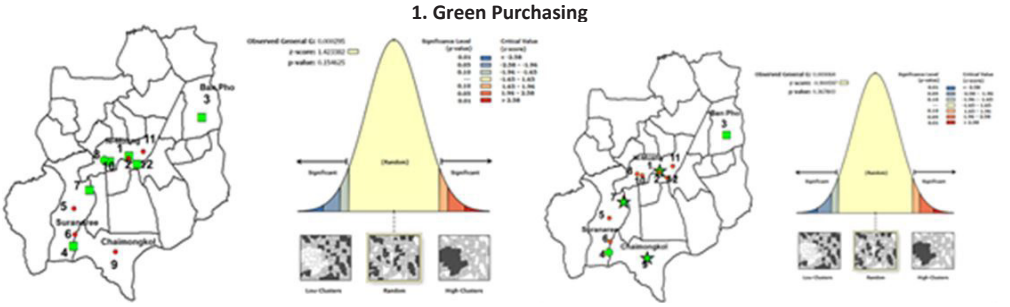
Remark: Data in year 2016 from the research project named, 'Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province', funded by TSRI

Table 6. Comparison of scoring and grading for green logistics activities of 12-tourist attraction in Muang Nakhonratchasima district from 2016 to 2021

Tourist attraction	Green logistics activities																Score		Grade	
	Green Purchasing		Green Production		Green Transport		Green Packaging		Green Inventory		Green Technology		Green Awareness		Green Service					
	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021
1. Thao Suranaree Monument and Chumphon Ancient Gate	4.00	3.52	1.00	3.78	4.00	3.44	2.00	3.56	2.00	0.00	2.00	4.78	2.00	5.00	1.00	3.33	2.25	3.43	Low	Middle
2. Maha Weerawong National Museum	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	5.00	5.00	2.00	5.00	1.63	1.25	Low	Lowest
3. Phanomwan Castle	2.00	2.25	2.00	2.50	1.00	2.50	2.00	2.50	1.00	0.00	3.00	2.50	3.00	2.50	2.00	2.50	2.00	2.16	Low	Low
4. Khorat Fossil Museum	1.00	3.31	1.00	3.67	0.00	3.19	1.00	3.00	1.00	0.00	2.00	5.00	2.00	5.00	2.00	3.50	1.25	3.33	Lowest	Middle
5. Sirindhorn Learning Park	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	5.00	0.00	4.00	0.13	1.13	Lowest	Lowest
6. Nakhonratchasima Regional Observatory for the Public	5.00	0.00	0.00	0.00	5.00	0.00	5.00	0.00	3.00	0.00	0.00	0.00	5.00	5.00	2.00	5.00	3.13	1.25	Middle	Lowest
7. Korat Water Park	4.00	3.96	2.00	3.79	3.00	3.88	2.00	3.56	2.00	0.00	1.00	4.75	1.00	5.00	1.00	3.38	2.00	3.54	Low	High
8. Arts of Korat Mirage Museum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0	5.00	0.00	1.25	-	Lowest
9. Nakhonratchasima Zoo	4.00	3.72	1.00	3.79	3.00	3.84	2.00	4.08	1.00	0.00	1.00	4.05	1.00	4.11	1.00	4.16	1.75	3.47	Low	Middle
10. Pa Salawan Temple	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	-	0.63	-	Lowest
11. Sala Loi Temple	4.00	0.00	1.00	0.00	2.00	0.00	5.00	0.00	3.00	0.00	1.00	0.00	2.00	5.00	4.00	0.00	2.75	0.63	Middle	Lowest
12. Sala Thong Temple	4.00	0.00	1.00	0.00	3.00	0.00	3.00	0.00	1.00	0.00	2.00	0.00	2.00	5.00	2.00	0.00	2.25	0.63	Low	Lowest
Score	2.75	1.40	0.75	1.46	1.75	1.40	1.83	1.39	1.17	0.00	1.17	1.76	1.73	4.72	1.42	2.99	1.59	1.89		
Grade	Middle	Lowest	Lowest	Lowest	Low	Lowest	Low	Lowest	Lowest	-	Lowest	Low	Low	High	Lowest	Middle	Low	Low		

Remark: - Scoring and grading included lowest between 0.01-1.49, low between 1.50-2.49, middle between 2.50-3.49, high between 3.50-5.00 and highest between 4.50-5.00

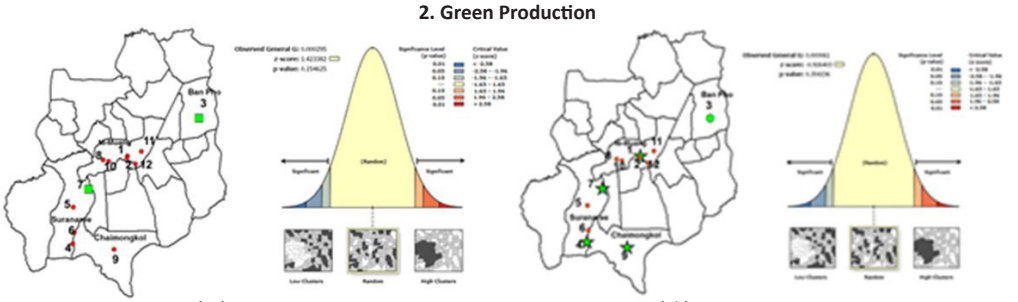
1. Green Purchasing



(1a) Year 2016 (1b) Year 2021

Changing (+ as higher grade, – as lower grade and * as no change): + 4 places (Thao Suranaree Monument and Chumphon Ancient Gate, Khorat Fossil Museum, Korat Water Park and Nakhonratchasima Zoo), - 4 places (Arts of Korat Mirage Museum, Pa Salawan Temple and Sala Thong Temple), and * 4 places (Maha Weerawong National Museum, Phanomwan Castle, Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public and Sala Loi Temple)

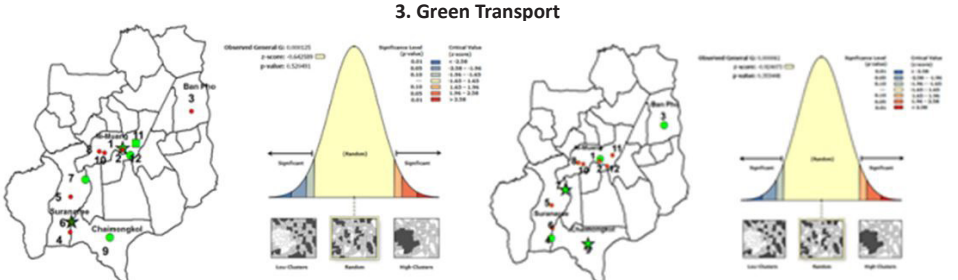
2. Green Production



(2a) Year 2016 (2b) Year 2021

Changing (+ as higher grade, – as lower grade and *as no change): + 5 places(Thao Suranaree Monument and Chumphon Ancient Gate, Phanomwan Castle, Korat Fossil Museum, Korat Water Park and Nakhonratchasima Zoo) and * 7 places (Maha Weerawong National Museum, Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public, Arts of Korat Mirage Museum, Pa Salawan Temple, Sala Loi Temple and Sala Thong Temple)

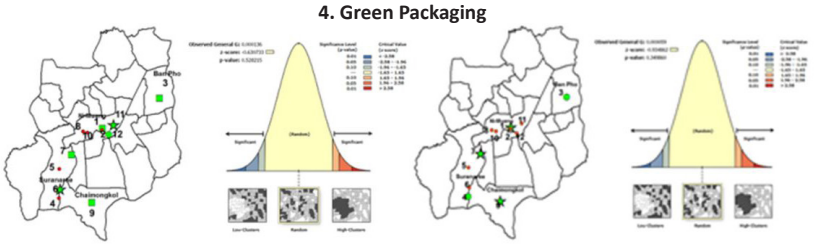
3. Green Transport



(3a) Year 2016 (3b) Year 2021

Changing (+ as higher grade, – as lower grade and * as no change): + 5 places (Thao Suranaree Monument and Chumphon Ancient Gate, Phanomwan Castle, Korat Fossil Museum, Korat Water Park and Nakhonratchasima Zoo), - 3 places (Nakhonratchasima Regional Observatory for the Public, Sala Loi Temple and Sala Thong Temple) and * 4 places (Maha Weerawong National Museum, Sirindhorn Learning Park, Arts of Korat Mirage Museum and Pa Salawan Temple)

4. Green Packaging

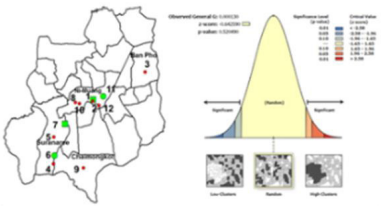


(4a) Year 2016 (4b) Year 2021

Changing (+ as higher grade, – as lower grade and * as no change): + 5 places (Thao Suranaree Monument and Chumphon Ancient Gate, Phanomwan Castle, Korat Fossil Museum, Korat Water Park and Nakhonratchasima Zoo), - 3 places (Nakhonratchasima Regional Observatory for the Public, Sala Loi Temple and Sala Thong Temple) and * 4 places (Maha Weerawong National Museum, Sirindhorn Learning Park, Arts of Korat Mirage Museum and Pa Salawan Temple)

Figure 6. Comparison of spatial distribution patterns of eight green logistics activities from 2016 to 2021

5. Green Inventory

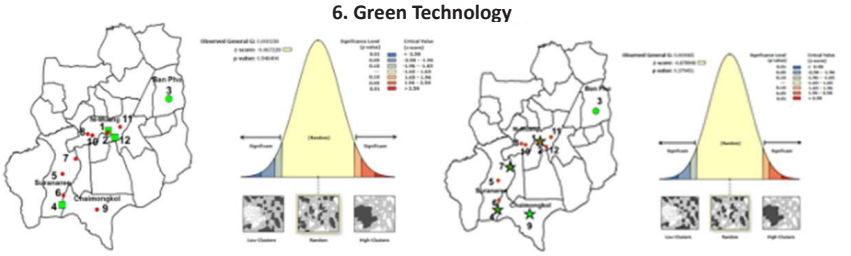


Not have data from questionnaires

(5a) Year 2016 (5b) Year 2021

Changing (+ as higher grade, – as lower grade and * as no change): * all 12 places

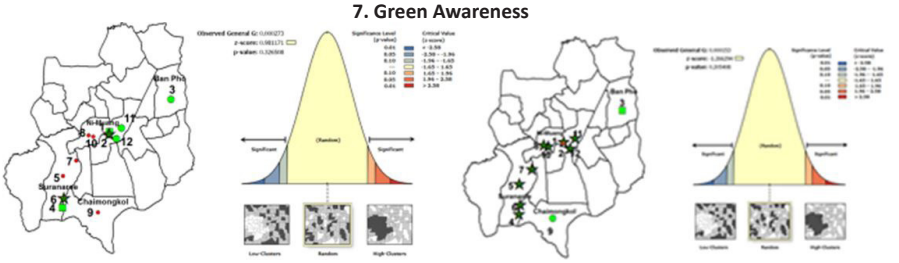
6. Green Technology



(6a) Year 2016 (6b) Year 2021

Changing (+ as higher grade, – as lower grade and * as no change): + 4 places (Thao Suranaree Monument and Chumphon Ancient Gate, Korat Fossil Museum, Korat Water Park and Nakhonratchasima Zoo), - 1 place (Sala Thong Temple) and * 7 places (Maha Weerawong National Museum, Phanomwan Castle, Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public, Arts of Korat Mirage Museum, Pa Salawan Temple and Sala Loi Temple)

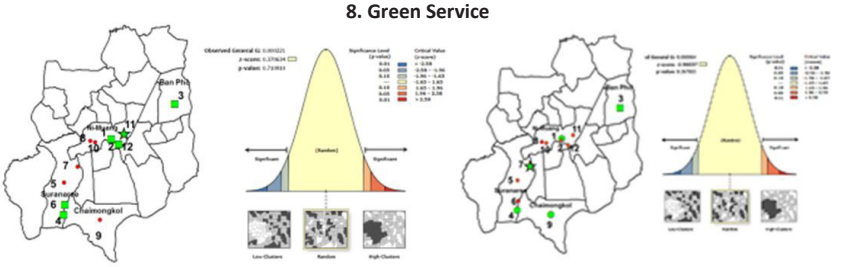
7. Green Awareness



(7a) Year 2016 (7b) Year 2021

Changing (+ as higher grade, – as lower grade and * as no change): + 9 places (Thao Suranaree Monument and Chumphon Ancient Gate, Korat Fossil Museum, Sirindhorn Learning Park, Korat Water Park, Arts of Korat Mirage Museum, Nakhonratchasima Zoo, Pa Salawan Temple, Sala Loi Temple and Sala Thong Temple), - 2 places (Maha Weerawong National Museum and Phanomwan Castle) and * 1 place (Nakhonratchasima Regional Observatory for the Public)

8. Green Service



(8a) Year 2016 (8b) Year 2021

Changing (+ as higher grade, – as lower grade and * as no change): + 8 places (Thao Suranaree Monument and Chumphon Ancient Gate, Phanomwan Castle, Korat Fossil Museum , Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public, Korat Water Park, Arts of Korat Mirage Museum and Nakhonratchasima Zoo), - 2 places (Sirindhorn Learning Park and Sala Thong Temple) and * 2 places (Maha Weerawong National Museum and Pa Salawan Temple)

Figure 6. Comparison of spatial distribution patterns of eight green logistics activities from 2016 to 2021 (continue)

5. Conclusions and next work

This study found that the average value of 8 green logistics activities in 12-tourist attraction in Muang Nakhonratchasima district year 2021 is in low level with average score of 1.89. These results should be reported and solved by office of TAT Nakhonratchasima, office of Nakhonratchasima City Municipality and other related agencies. However, green awareness is in high level in almost all tourism places except Phanomwan Castle (low level). In analysis of spatial distribution patterns-based clustering Getis-Ord General G in ArcGIS program, the 8 green logistics activities is totally in random pattern, reveals a normative pattern in all 12-tourist attraction of study area. Comparing of spatial distribution patterns of 8 green logistics activities from 2016 to 2021, both data are totally in low level (scoring 1.57 for the year 2016 and 1.89 for the year 2021) and are totally in pattern of complete spatial randomness. These outputs are obtained that refer to as a normative pattern in such 12 tourist attractions of Muang Nakhonratchasima district in both year 2016 and 2021. For each green logistics activity in 12 tourism places, there is so interesting that is green awareness and green service. These 2 green logistics activities that are green awareness and green service are shown by the most positive change. Green awareness is about 9 of 12 tourist attractions (Thao Suranaree Monument and Chumphon Ancient Gate, Korat Fossil Museum, Sirindhorn Learning Park, Korat Water Park, Arts of Korat Mirage Museum, Nakhonratchasima Zoo, Pa Salawan Temple, Sala Loi Temple, and Sala Thong Temple). Green service is about 8 of 12 tourist attractions (Thao Suranaree Monument and Chumphon Ancient Gate, Phanomwan Castle, Korat Fossil Museum, Sirindhorn Learning Park, Nakhonratchasima Regional Observatory for the Public, Korat Water Park, Arts of Korat Mirage Museum and Nakhonratchasima Zoo). This is public and private organization that has realized to reverse logistics, using barcode, electric email, and information online for facing the current COVID-19 situation.

Next work, the researchers will study as: (1) relationship between operator's tasks and customer demand and how green logistics will be able to leverage the successfulness of green logistics for tourist attraction in future, (2) the relationship between distance and green logistics parameter and (3) comparison of green logistics activities between urban area and rural area to solve some tourist attractions seem agglomerate in urban area which might affects to the successfulness of green logistics between urban area and rural area. Other urban features such as the availability of mode choice or public transit issues may affect in this case as well.

6. Acknowledgement

The authors thank to TSRI for funding fundamental research in year 2016. The funded research named, 'Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province.' This paper used data from research above for comparing with spatial distribution patterns of Green Logistics Activities at tourism places to current COVID-19 situation: case of Muang Nakhonratchasima district, Thailand. Furthermore, the authors thank to Faculty of Sciences and Liberal Arts, RMUTI to support courtesy of the place and facilities for this study. Finally, thank for office of TAT Nakhonratchasima, 12 tourist attractions above and their restaurant operators and grocery stores, to respond their questionnaires via email.

References

Addington, R. N., Aplet, G. H., Battaglia, M. A., Briggs, J. S., Brown, P. M., Cheng, A. S., Dickinson, Y., Feinstein, J. A., Pelz, K. A., Regan, C. M., Thinnes, J., Truex, R., Fornwalt, P. J., Gannon, B., Julian, C. W., Underhill, J. L. & Wolk, B. (2018). *Principles and practices for the restoration of ponderosa pine and dry mixed-conifer forests of the Colorado Front Range*. Retrieved April 18, 2021, from https://www.fs.usda.gov/treesearch/pubs/55638

AEC Tourism Connectivity. (2016). *Thailand pushes the strength of the country to penetrate the ASEAN trade and investment market*. Retrieved March 9, 2021, from http://th.aectourismthai.com/content2/4017

Balaman, S. Y. (2018). *Chapter 7 - Modeling and Optimization Approaches in Design and Management of Biomass-Based Production Chains*. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780128142783000078.pdf

Bishop, M. P., Young, B. W., Huo, D. and Chi, Z. (2020). *Spatial Analysis and Modeling in Geomorphology*. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780124095489124297.pdf

Bradley, K. (2021). *Green Logistics*. Retrieved April 9, 2021, from https://dlca.logcluster.org/display/LOG/Green+Logistics

Caliper. (2021). *GIS Software.* Retrieved June 8, 2021, from https://www.caliper.com/maptitude/gis_software/default.htm

Charlton, M. (2009). *Spatial Pattern.* Retrieved from https://www.sciencedirect.com/topics/earth-and-planetary-sciences/nearest-neighbor-analysis.pdf

Corvec, N. L., Sporli, K. B., Rowland, J. & Lindsay, J. (2013). Spatial distribution and alignments of volcanic centers: Clues to the formation of monogenetic volcanic fields. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0012825213001037.pdf

DHL. (2020). *Green Logistics: Good for the environment, good for business*. Retrieved May 6, 2021, from https://www.dhl.com/th-en/home/logistics-solutions/green-logistics.html

Dogru, A. O., David, R. M., Ulugtekin, N., Goksel, C., Seker, D. Z. & Sozen S. (2017). GIS based spatial pattern analysis: Children with Hepatitis A in Turkey. *Environmental Research*, 156, 349-357. https://doi.org/10.1016/j.envres.2017.04.001

Geog, (2020). *Point Pattern Analysis.* Retrieved May 10, 2021, from https://storymaps.arcgis.com/stories/2d7ebcc8ae5c4df3b8ad56a3e9a82317

Grzybalska, M. (2010). Application of GIS techniques to analysis of spatial distribution patterns of loom-weights, spindle-whorls and tokens at Pistiros, ancient Thrace, within a domestic/urban context. *Virtual Archaeology Review*, 1(1), 103-109.

Hu, Y. & Liu, K. (2017). *Chapter 3 - Tour inspection technology of transmission lines*. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780128126448000035.pdf

Interlake Mecalux. (2019). *Green logistics: definitions, challenges and solutions*. Retrieved May 10, 2021, from https://www.interlakemecalux.com/blog/green-logistics

Isitwa Inc. (2017). *GIS is a Powerful Business Tool for Logistics and Transportation*. Retrieved May 19, 2021, from https://www.isitwa.com/gis-logistics/

Jacobsen, T. (2020). *The road towards green logistics*. Retrieved July 9, 2021, from https://www.mixmove.io/blog/how-do-we-achieve-green-logistics

Jantakat, Y. & Chutiman, N. (2016). *Geoinformatics Technology for Spatial Pattern and Distribution of Green Logistics' Activities in Tourism Place of Muang District, Nakhon Ratchasima Province*. Nakhon Ratchsima, Thailand: Rajamangala University of Technology Isan.

Jerram, D. A., Dobson, K. J., Morgan, D. J., Pankhurst, M. J. (2018). *Chapter 8 - The Petrogenesis of Magmatic Systems: Using Igneous Textures to Understand Magmatic Processes*. Retrieved from https://www.sciencedirect.com/science/article/pii/B978012809749600008X.pdf

Kamsingnork, K. (2014). *Open concept for green economy*. Retrieved from http://www.tei.or.th/publications/2014-download/2014-TBCSD-Greenbusiness-y8-2.pdf

Li, H., Li, H., Ding, Z., Hu, Z., Chen, F., Wang, K., Peng, Z. & Shen, H. (2020). *Spatial statistical analysis of Coronavirus Disease 2019 (Covid-19) in China*. Retrieved April 12, 2021, from https://geospatialhealth.net/index.php/gh/article/view/867/888#content/figure_reference_6

Ludwig, J. A. & Reynolds, J. F. (1988). *Statistical Ecology: A Primer on Methods and Computing*. Retrieved from https://www2.ib.unicamp.br/profs/thomas/NE002_2011/maio12/LR%201988%20StatEcol%20sel1.pdf

Melyantono, S. E., Susetya, H., Widayani, P. Tenaya, I. W. M. & Hartawan, H. W. (2021). *The rabies distribution pattern on dogs using average nearest neighbor analysis approach in the Karangasem District, Bali, Indonesia, in 2019*. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8076469/pdf/Vetworld-14-614.pdf

Ministry of Transport. (2018). *Monitoring and Evaluation Report Operations of the Ministry of Transport According to the Transport and Traffic Development Master Plan 2011–2020 Fiscal Year 2017 (October 2016 – September 2017)*. Retrieved from https://complain.mot.go.th/prproject/files_upload/otp/report_otp_tracking2561.pdf

Ministry of Tourism and Sports. (2020). *Strategy for promoting green tourism*. Retrieved from https://chainat.mots.go.th/download/article/article_20200605154529.pdf

Ministry of Tourism and Sports. (2016). *ASEAN Tourism Strategic Plan*. Retrieved June 28, 2021 from https://www.mots.go.th/ewt_dl_link.php?nid=10854

Modaberi, A., Soosani, J., Vajari, K. A., Khosravi, S., Farhadi, P. & Kianfar, M. (2014). The distribution, mixture, and diversity models of woody species in Spatial Pattern of Persian oak (Quercus brantii var. persica) forests. *Advances in Environmental Biology*, 8(11), 911-918.

Nowak, P., Cutforth, L. B., Cabot, P. E. & Kahn, B. M. (2001). *Chapter 19 - Nitrogen Management by Producers: A Multiple Scale Perspective*. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780444504869500212.pdf

Office of the National Economic and Social Development Council. (2021). *Master Plan under the National Strategy: Tourism*. Retrieved from http://nscr.nesdb.go.th/wp-content/uploads/2021/01/06_NS_05.pdf

Office of Tourism Authority of Thailand (TAT) Nakhonratchasima. (2021). *Nakhon Ratchasima Travel Guide*. Nakhonratchasima, Thailand: DD Media Plus Company Limited.

Peters, D. P. C., Goslee, S. C., Collins, S. L., Gosz, J. R. (2013). *Landscape Diversity*. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780123847195000848.pdf

Pian, S. & Menier, D. (2018). *Chapter 6 - Spatial and Statistical Analyses of Clifftop Retreat in the Gulf of Morbihan and Quiberon Peninsula, France: Implications on Cliff Evolution and Coastal Zone Management*. Retrieved from https://www.sciencedirect.com/science/article/pii/B978012814350600006 9.pdf

Rodrigue, J.-P., Slack, B. & Comtois, C. (2020). *Green Logistics*. Retrieved March 29, 2021, from https://transportgeography.org/contents/applications/green-logistics/

Pacheco, G. D. (2006). *Discrete probability models to assess spatial distribution patterns in natural populations and an algorithm for likelihood ratio goodness of fit test*. Retrieved from http://www.scielo.org.bo/pdf/ran/v3n3/v3n3_a07.pdf

Subsanguanboon, W.. (2019). *Sustainable Supply Chain Management in Thailand 4.0.* Retrieved April 12, 2021, from https://dol.dip.go.th/en/category/2019-02-08-08-57-30/2019-03-15-10-58-56

Walker, S. E. (2011). *Density and Dispersion*. Retrieved April 12, 2021, from https://www.nature.com/scitable/knowledge/library/density-and-dispersion-19688035/

Welty, C. (2014). *Chapter 22 - The Regenerative Community Régénérer: A Haitian Model and Process Toward a Sustainable, Self-Renewing Economy*. Retrieved from https://www.sciencedirect.com/science/article/pii/B9780123979148000229.pdf