THE REVIEW OF CIRCULAR ECONOMY ANALYSIS TECHNIQUES: A CASE OF THE URBAN TOURISM SECTOR

Thidarat KRIDAKORN NA AYUTTHAYA[1*], Napat JAKRAWATANA[1]
and Vongkot OWATSAKUL[2]
1 Faculty of Engineering, Chiang Mai University, Thailand; thidarat_krid@cmu.ac.th (Correspondence Author)
2 Chiang Mai City Municipality Office, Thailand

ARTICLE HISTORY
Received: 29 September 2023 **Revised:** 11 October 2023 **Published:** 27 October 2023

ABSTRACT
The problems of tourism industrial metabolism (consumption and production) can generate massive impacts on the environment and human health, explicitly emerging urban tourism. The goal of the circular economy is to reduce the issues associated with environmental management and monitoring by improving resource efficiency, extending product lifespan, and closing the loop. However, these systematics for decision-making procedures and policy must adequately analyse data resources and analysis. This article presents a systematic review of novel techniques for circular economy analysis to overcome those barriers, especially in the urban tourism sector: information technology, data mining, and data analysis. These resources support decision-making systems for managing resources and waste in the tourism city toward a circular economy. This result helps provide appropriate information to city managers and the private sector operating various businesses. It will develop a framework that can be applied more widely to tourism and different sectors in other emerging markets.
Keywords: Circular Economy, Material Flow Analysis, Systematic Review, Tourism Sector, Urban Metabolism

CITATION INFORMATION: Kridakorn Na Ayutthaya, T., Jakrawatana, N., & Owatsakul, V. (2023). The Review of Circular Economy Analysis Techniques: A Case of the Urban Tourism Sector. *Procedia of Multidisciplinary Research, 1(10),* 26.

INTRODUCTION

The problems of rapid urban metabolism (production and consumption) can generate massive impacts on the environment and human health. The more virgin raw material is required to produce more products and provide services. However, raw materials are finite; some will run out in the next decade. Moreover, after consumption, materials are discarded as waste, causing disposal and other environmental problems. The current system is linear. We take resources, make products, and dispose of them when finished. The recycling rate is higher in many developed countries. However, the material cycle back to production is still tiny compared to virgin raw materials entering production. Infrastructure and the built environment are still being built up in emerging economies. To fully close the loop, our technical capabilities must be enhanced. Additionally, many recycling procedures are still needed to improve material quality and quantity (Wit, Hoogzaad, Ramkumar, Friedl, & Douma, 2018).

The recent resource management concept, Circular Economy (CE), has arisen and applied mainly in the European Union (EU). According to the European Union (2014), "a circular economy involves a substantial shift of production chains, and consumption patterns are anticipated to keep resources cycling in the economy for longer. This idea will lessen waste generated during the recycling process and, whenever possible, prevent downcycling.

The primary metric for determining CE status is the proportion of recycled materials in the annual total of materials input into the global economy. According to the Circularity Gap Report (Wit et al., 2018), the global economy was only 9.1% circular in 2015, creating a significant circularity gap. This alarming statistic shows that closing this circular gap is an urgent global issue (Wit et al., 2018). Solutions for the circular economy have the potential to significantly contribute to the drive to lessen the adverse effects on the climate, as 67% of global greenhouse gas emissions are related to material management (Wit et al., 2018). The circular economy can also support meeting global SGDs, especially SDG 12, sustainable consumption, and production, decreasing waste and wasteful primary resource extraction (Wit et al., 2018).

The necessity for a uniform framework for measuring is a significant obstacle to integrating the circular economy into business strategy and public policy. Limitations for quantifying local material flows, and stocks and data quality variations exist. Data on material extraction and production or commercialization can be found only from national or regional statistics. However, the data could be more minimal at the city or local scale. Nevertheless, these material flow systems are becoming a reality with advances in data science, storage capabilities, and machine learning (Macpherson, 2017). However, the framework for exploring and extracting the big data from various available sources to be used in the material flow model and circularity analysis needs to be more developed in the previous work.

Meanwhile, one of the Thai economy's fastest-growing areas is tourism, attracting 38.2 million tourists in 2018 and THB 2.01 trillion in revenue. However, this boom places unsustainable stress on local resources such as water, energy, food, local infrastructures, and the environment, including solid waste and wastewater generation. For example, in Chiang Mai province, where the current business mindset is Take-Make-Consume-Dispose, the local industry needs more exposure to alternative and innovative business models, such as the CE.

In order to ensure the sustainability of local resources and incomes, there is a need to improve and adapt the operation of the tourism and service industries. This issue focuses on waste minimization and increasing resource circularity. In the seasonality of tourism flow, tourists are resource consumers and waste producers. CE audit tools will be developed to comprehend the current urban metabolism, how cities affected by tourism use their resources, and how touristic activities are connected to waste management and resource conservation. Additionally, due to their geographic and climatic characteristics, tourist cities must adapt to unique waste prevention and resource circulation issues.

Thus, there is a need for an integrated framework to review and analyze the consequences of urban growth and eventually forecast the impacts of sustainable policies on CE strategies. Such a framework will equip policymakers with evidence-based recommendations to reduce the amount of municipal waste production and increase the circularity rate to be a role model as a circular tourist city.

However, good management must start from the measurement, appropriate and concrete data, and reflect the current conditions and results. Even though many government policies and strategies support CE in Thailand, we are in the first step of the approach and need a precise understanding of the CE concept and approach. Thailand still needs data and appropriate analyzing and CE managing techniques that suit the Thai context. Most people still understand that CE is the same as waste management, 3R (reduce, reuse, and recycle). The material input or consumption in the city and the share of cycled materials have to be known as the leading circularity metric indicator. However, as mentioned before, the quantification of local material flows and stocks at the city or local scale, the data is minimal, especially in developing countries like Thailand. Moreover, the statistics data alone does not reveal the behavior of the consumers, especially tourists.

They must be used to create information systems to integrate with material flow techniques to assist decision-making regarding CE strategy and action plan. A scenario of CE improvement measures in a rethink of business model and redesign of product and packaging, sharing economy, bio-based material packaging, refill container, material, waste cascading, and waste exchanging platform can also be simulated and evaluated. The evaluation index includes the circularity metric, economic index, and greenhouse gas reduction potential. However, one of the critical processes to achieve the goal of the CE model framework for the urban tourism sector a systematic review of the evidence to support the modeling process is needed. This research presents a systematic literature review on circular economy strategic tools for urban tourism. A key deliverable will be to provide a clear understanding of the indicator structure of the CE model that can be applied more widely to tourism SMEs and different sectors in other collaboration.

MATERIAL AND METHODS

This systematic review consists of three main parts. Section 2.1 elucidates the methodology employed for data collecting and analysis in order to get a thorough sample of CE activities implemented within tourism urban areas. Section 2.2 outlines the methodology employed for conducting the the CE model framework for the urban tourism sector. And finally Section 2.3 defines case study of CE model for urban tourism sector.

Collection Resource uses and waste generate inventory

The number of businesses, workers, and tourists was used to determine resource consumption and waste creation in the tourism industry. Many studies separately focus on the energy resource use or waste generation models. A literature review summarized resource use and waste generation in the tourism business in Table 1 (Chiang Mai Municipality, 2018; Paulina Bohdanowicz 2018; Saito, 2013; Trung & Kumar, 2005).

Table 1 Resource use and waste generation in the tourism business (Authors, 2019)

Resource Use	Waste generate	
Utility Material	Paper	Print paper, newspaper and magazine).
	Cardboard	Paperboard, containerboard, cardstock
	Garden waste	Leaf, grass, flower
	Kitchen and food waste	Leftover food, vegetable
	Tissues	Tissue and toilet paper
	PET	PET bottles
Facilities, Furniture and Equipment	Nylon	All kinds of nylon bags
	Metal	All kinds of metal (iron, aluminum, copper, lead)
	Plastic	All kinds of plastics do not contain toxic substances
	Glass	All kinds do not contain toxic substances
	Rubber	All kinds of nylon bags
	Textile	Tablecloths, clothes
	Wood	Wooden furniture, branches
	Nappy	Sanitary napkins, diapers,
	Ceramic	Ceramic, minerals, light bulbs
	Chemicals	Soap, cosmetic residues
Electricity Equipment	Hazardous waste	Paint, varnishes, oils, pesticides, insecticides, fertilizer
Water	Wastewater / Greywater	
Electricity	Heat and Light pollution	
Food and Supply	Food loss and waste	
Gasoline, petroleum gas	Exhaust gas	

A business in the tourism sector involves output across various branches. Tourist-specific goods and services may be produced specifically for tourists, or they may be goods and services designed to fulfill the requirements of tourists and locals. The tourism industry consists of 6 main businesses, as follows;

1) Tourism, according to the Tourism and Guide Business Act 2008(The Constitution of the Kingdom of Thailand, 2008) , business travel is about bringing tourists to travel or travel for another purpose by providing one or many services or facilities such as accommodation, food, tour guides, or other services as prescribed in the Ministerial Regulations. The tourism business will focus on business tourism has operated as a business with a return on operations. The tour company may arrange various services. To travel or arrange to travel by oneself or an intermediary or service representative between tourists and various related establishments.

2) Accommodation, according to the Hotel Business Act B.E. 2547 (2004) (The Constitution of the Kingdom of Thailand, 2004), a hotel is a place of lodging created for commercial purposes to house guests temporarily in exchange for payment of any kind. Other types of this business include many lodging businesses, hotels, motels, guesthouses, resorts, apartments, mansions, condominiums, campsites, department stores, department stores, wooden vacation homes, bungalows, and rafts. The accommodation must be clean, comfortable, safe, and have a suitable price for each type of accommodation. There are 9 types of accommodation are 1) Hotel 2) Motel 3) Guest house 4) Home Stay 5) Bungalows 6) Condominiums or apartments 7) Hostels or dormitories 8) Vacation homes and 9) Campgrounds or caravan parks.

3) Food and beverages are a business that must supply meals to visitors while they are on the road. Visitors must eat when traveling, so it is vital to have a food business to provide—services for food and beverage businesses. Tourists in tourist attractions the food business means providing food and beverage services. For tourists, it could be a restaurant or a restaurant while traveling. Tourists can eat food and drinks in full swing. In addition, the food business is also an attraction for tourists to taste delicious and exotic food, in which only Thai food is considered a type of tourism product that can attract foreign tourists.

4) Selling goods and souvenirs are local products, especially handicrafts, which are people's products. In addition, the shopping area or shopping area is another part that helps attract the

attention of tourists if that place is a source or a market for indigenous people Because it is colorful and lively in the community way. Tourists always need to use consumer products during their travels. Whether personal items or equipment needed to travel. Most tourists can buy from retail shops in tourist attractions that already provide services to local people for souvenir shops. It is a type of store designed expressly to cater to tourists. It is usually found in popular tourist sites and stocks souvenirs that are useful to travelers and specific to that location.

5) Transportation under the Thailand's Land Traffic Act B.E. 2565 (2022AD) (The Constitution of the Kingdom of Thailand, 2022) means transporting or moving people or things with transportation equipment. When people or goods are moved, such as when taking the bus or train, transportation, a word that does not exist, takes place. For the above-mentioned, tourism is travel, and now, because of convenient transportation, transportation is an indispensable factor. It has been a significant human development activity for the last hundred thousand years. Humans traveled worldwide until the era of tourism became an everyday activity for the masses; transportation activities were never stopped, both in vehicles and the way of transportation and commercial transportation services mainly involve the transfer of passengers and goods from one location to another. Passenger transportation, which can be broken down into four categories—land, water, air, and tube—is directly influenced by tourism. However, when we think of transportation in the context of travel, we typically think of transportation via cars, trains, sea, and air.

6) Recreation and entertainment businesses mean the business related to activities and services to meet the needs or the purpose of traveling for tourists will profit from the service participating in activities or watching sporting events, competitions and playing sports, competitions and playing sports using the health center restoring health from natural sites, adventure sports activities including meetings, training, seminars about sports. The private sector usually runs business or recreation areas in tourism, but the government created quite a few to allow people to relax.

Process of CE Quantitative Research Review

The systematic literature review focuses on "circular economy" "material flow analysis" "input-output" "municipal solid waste" "life cycle assessment" "carbon footprint", "urban metabolism" and "tourism city" as a keyword. The researchers are published in 2018-2023 which were retrieved from Web of Science, Google Scholar and Science Direct. This sections reviews 35,300 results. The search engines sorts all useful and poor of articles. Hence, the researchers review and screened only the articles a core aspect as "circular economy". Finally, ultimately, a total of 118 publications were deemed suitable for analysis.

Case Study Circular Econmy Models

This study refrains from adopting a restrictive framework or definition of CE in order to prevent the findings from being constrained by practitioner and to facilitate the identification of patterns and areas of research that require further exploration. An inductive methodology was employed to ascertain and construct a typology of methods for corporate entrepreneurship (CE) by examining tourism urban metabolism. Inductive research holds significant value in the exploration of novel study areas, as it enables researchers to maintain a receptive stance towards developing themes and concepts derived from the CE framework for tourism sector.

RESULTS

Mass Flow Analysis and Urban Metabolism

Economic activity, population, material stock, energy, and the production and consumption of materials are concentrated in urban areas. The four basic categories of material found in a given area are biomass, metals, minerals, and fossil fuels. These material flows illustrate potential effects on ecosystems at many scales, including local, regional, and global (Smaranda, 2013).

The development of time series in material flow analysis (MFA) enables the examination of trends in the economic system's material consumption and the assessment of a system's material consumption over a specific period, typically one year. As shown in Figure 1, MFA focuses more specifically on the inputs of materials into a system (private household, business, region, or city), the stocks and flows within the system, and the system's outputs (export, wastes) to other systems.

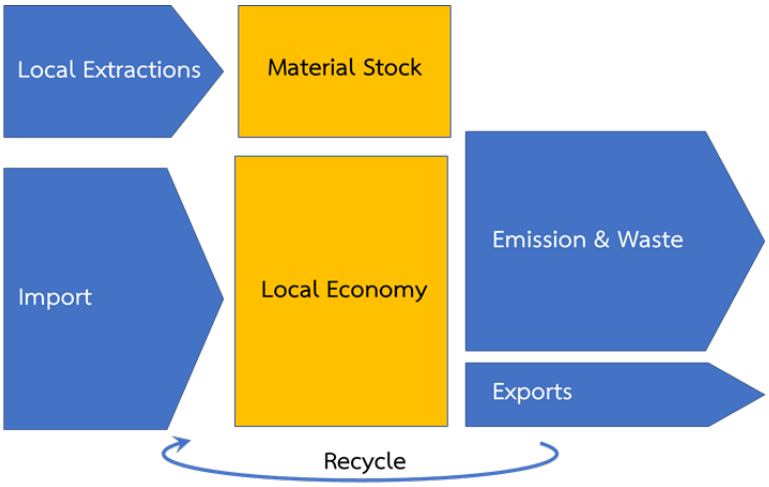

Figure 1 Mass flow analysis scheme (Smaranda, 2013)

The mass flow analysis scheme, shown in Figure 2, is a system that accepts some inputs, such as imports and local extractions, caches the necessary material for internal use, and exports various products together with emissions and waste. The objective is to comprehend the functioning of the local economy within the system using the inputs and outputs that are currently known.

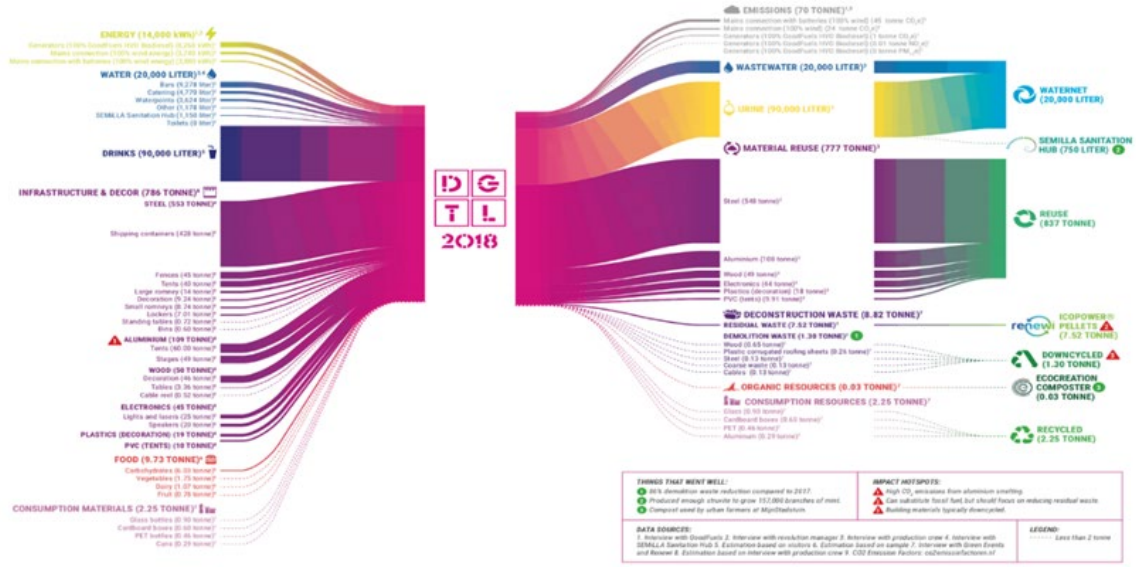

Figure 2 Events of mass flow analysis diagram (Teubner, 2018)

Data Mining for Material Flow Analysis

To turn unstructured data into pertinent information, businesses use data mining. By using software to detect patterns in vast amounts of data, businesses may learn more about their customers to develop more effective marketing strategies, increase sales, and save costs. Data mining requires efficient data gathering, warehousing, and computer processing. Machine

learning models are created through data mining techniques and power various applications, such as search engine technology and website recommendation systems (Twin, 2019). Data mining is examining and analyzing vast chunks of data to discover significant patterns and trends. Numerous applications exist, including database marketing, credit risk management, fraud detection, spam email screening, and user sentiment analysis (Twin, 2019).

There are five steps in the data mining process. Data is first gathered by organizations and loaded into data warehouses. The data is then kept and managed on internal servers or the cloud. Business analysts, management teams, and information technology professionals can access and select how to organize the data. Finally, the end-user understandably presents the data, such as a graph or table, as illustrated in Figure 3—next, the user's results and the application program sort the data.

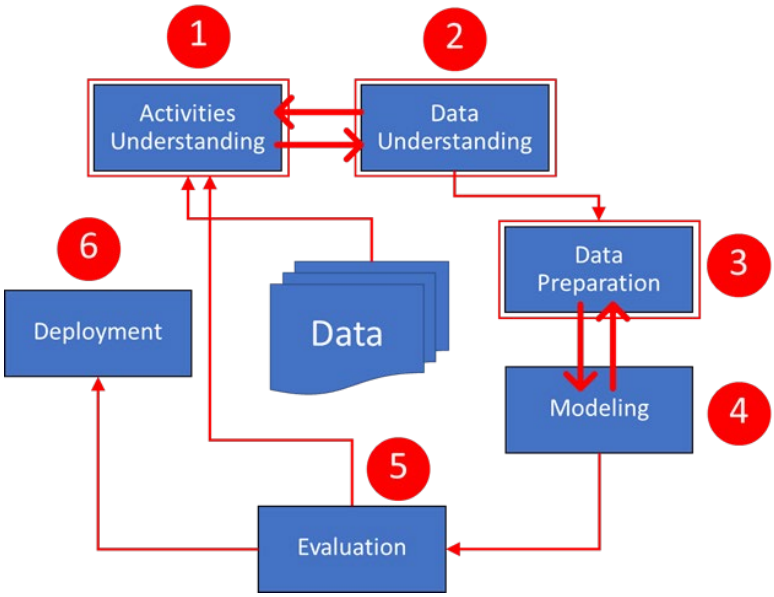

Figure 3 Data mining diagram (Patcharawongsakda, 2016)

Numerous worldwide MFA studies have been conducted. A few studies still concentrate on the regional or local level, and developing a standardized approach comparable to that EUROSTAT offers at the national level is still necessary. Although the studies that are currently accessible highlight the significance of material fluxes for regional and urban metabolism, they also exhibit a wide range of methodologies that can be categorized using the MFA methodology. The requirement for statistical data is the fundamental barrier to attempting to estimate the material movement of a city or region. It urges the use of various methods for analyzing urban material flows. Studies concentrate on tracing a particular substance, like lead, copper, or phosphorus or selecting and examining only the most fundamental goods and materials. The literature offers a variety of analytical approaches, such as extrapolating data from the nation or region and making estimates based on sales, population, or labor force (Smaranda, 2013).

All of these methods result in studies that typically fail to explain the relationship between the types of materials and the types of drivers within a city or an area, and they still need to undergo more testing.

Machine Learning and Data Analysis

A mathematical equation that uses data to represent a problem, frequently a business problem —is called a machine learning algorithm (or model). The objective is to move from data to insight. An online retailer, for instance, might use a machine-learning algorithm to forecast sales for the following quarter based on historical sales and other relevant information. Like this, a manufacturer of wind turbines might visually inspect critical equipment and process the

video data using algorithms trained to identify dangerous defects. The ten methods described offer an overview — and a foundation on machine learning knowledge and skill (Castañón, 2019), for example, techniques of Regression, Classification, Clustering, Dimensionality Reduction, Ensemble Methods, Neural Nets and Deep Learning, Transfer Learning, Reinforcement Learning, Natural Language Processing, and Word Embeddings.
However, Castañón (2019) and Li, Wang, Tian, & Zhang (2018) conclude that the artificial neural network (ANN) is one of the most powerful for MFA analysis, including in the urban metabolism objective. The brief detail of ANN is presented in Figure 4 below.

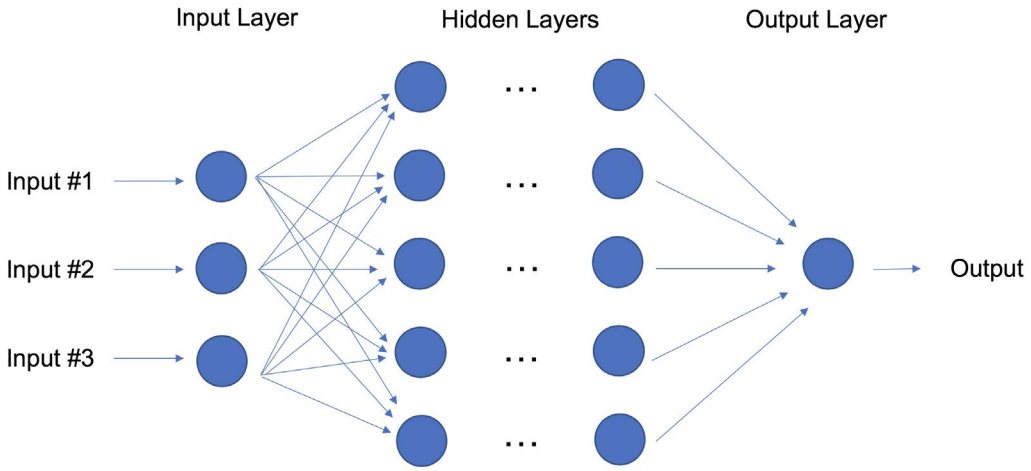

Figure 4 Neural Network with Set of Hidden Layers (Castañón, 2019)

Because deep learning approaches self-tune numerous parameters within massive networks, they require much data and computing power to function well. The necessity for powerful computers outfitted with graphical processing units (GPUs) by deep-learning practitioners becomes immediately apparent. Deep learning approaches have benefited text, audio, video, and vision. Figure 5 illustrates how the functional data mining and analytics architecture enables a usage-oriented production and consumption model for tourism.

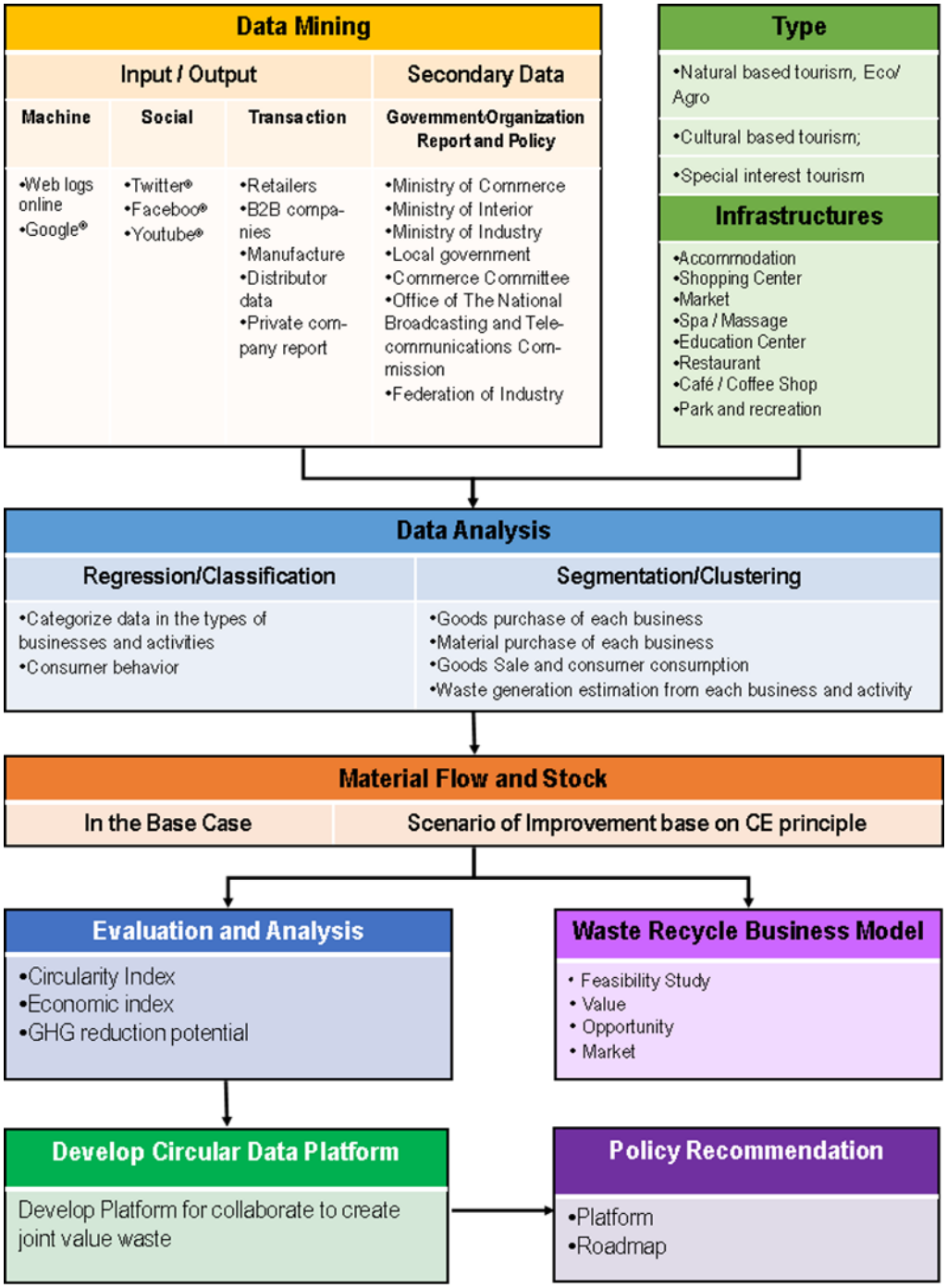

Figure 5 Framework functional data mining and analytics enable usage-oriented tourism production and consumption model.

Circular Economy and Case Study

Cities are working to meet sustainability standards even as their populations are expanding. According to UN-HABITAT (2011), metropolitan areas produce 70% of the world's greenhouse gas emissions, while the exact percentage depends on how cities are classified. Due to the prediction that 66% of the world's population will reside in cities by the year 2050, decision-makers are taking action in this area (The United Nations, 2015), and the circular economy (CE) is one of the concepts that is gaining traction. This idea has developed through the fusion of business and natural science fields (Korhonen, Honkasalo, & Seppälä, 2018). The core strategy behind CE is the creation of systems that move beyond simple "take-make-

dispose" economic models and toward closed material and energy cycles that preserve the value of resources in the economy. In order to reach a regenerative CE, eco-innovation is a crucial transforming process. A large European action plan and national laws, like the Circular Economy Promotion Law of the People's Republic of China, have CE as their central focus. The CE diagram is as follows in Figure 1.

A relatively new way of doing business, the circular economy seeks to "close the loop" and eliminate waste from the system. It entails changing the antiquated, wasteful, and environmentally damaging linear operating model of "take, make, dispose of" to a more accountable, comprehensive, and plentiful resource management approach. The existing system mines resources uses them to make products, and then discards these priceless materials at the end of usage, typically through landfill or incineration, which results in a significant loss of resource value. Conversely, the circular economy closes this resource loop by offering a method of operation that completely avoids waste, avoids landfills and incineration, and prolongs the useful life of resources by reusing and regenerating new goods.

This circular economy approach can facilitate the decrease of resource depletion. For instance, a "circular" phone would be manufactured of high-quality materials certified for use and could be securely recycled into another phone or other acceptable items. It would also be intended for disassembly at the end of usage. Reusing resources comprises their recovery by the original producer for use in new products, which enables producers to reduce costs significantly. Material value is maintained, and the activity significantly lessens unfavorable ecological effects.

As with any new notion or concept, it is possible to misread its meaning or fail to understand how it relates to present practices. The circular economy idea can also be interpreted as responsible recycling, effective waste management, or waste reduction. These actions enhance the outcomes of the circular economy and should be included in any definition. The circular economy is a regenerative system that slows down, closes, and narrows energy and material loops to reduce resource input, waste, emissions, and energy leakage. It can be done using durable design, maintenance, repair, reuse, re-manufacturing, refurbishing, recycling, and upcycling. It compares the "take, make, dispose" production model with a linear economy. Each circular economy project will have specific guidelines, standards, and evaluation criteria. Applying the fundamental criteria to these projects ensures a transparent circular economy culture is ingrained with quantifiable outputs and outcomes. By implementing the circular economy concepts and employing "Cradle to Cradle" as practical guidance, the company can better contribute to the 17 Sustainable Growth areas identified by the United Nations Development Program (UNDP) for successful sustainable development. These are essential to any sound, successful CSR strategy.

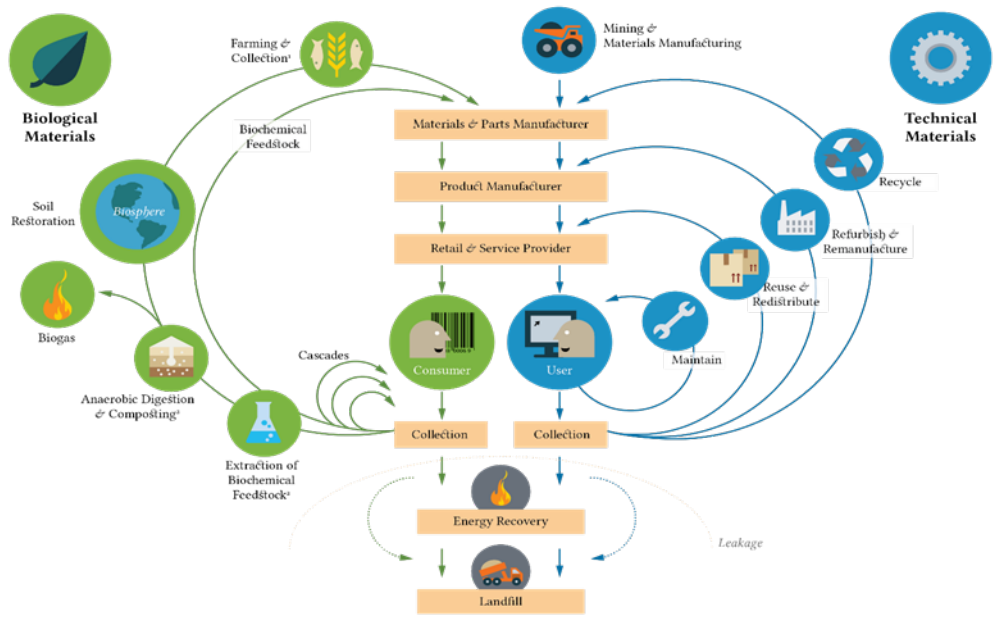

Figure 6 Circular economy scheme (Rowen, 2018)

Cities and communities are encouraging innovative ways to achieve circularity at the urban scale. Recent research has identified the primary CE projects supported in growing case studies worldwide to understand better how cities may become more circular. Some authors also examine urban circularity using metrics like resource usage or garbage recycling rates (Petit-Boix & Leipold, 2018). In the developing of a circular economy is a top priority for the municipality of Amsterdam, which is considered the pioneer of sustainability policy. The research findings guide the municipality as it considers possible actions toward more circularity. The roadmap links to and expands upon the numerous investigations of material movement and urban metabolism. Source separation of organic waste in all 430,000 houses in Amsterdam is one of the chosen steps that form the basis of this hypothetical future circular city of Amsterdam. The ability to collect organic waste separately enables the organic waste stream to be directed toward brand-new applications, including the manufacture of biogas, building blocks for the chemical industry, and bioplastics. Additionally, the organic waste streams from the food processing industry in the port region offer higher processing opportunities, leading to the creation of additional value. On top of the 10,000 agricultural and food processing employees, this scenario is predicted to add 1,200 jobs to Amsterdam over time. Some jobs will be created due to the necessary upgrades to the waste infrastructure, including underground container construction, separate waste stream pickup services, and more complex waste flow processing. Indirect job growth in industries like engineering and logistics and direct employment implications in the agriculture and food sectors may exist. Numerous short- and long-term initiatives are presented in the roadmap and action agenda to process better organic residual streams that can help change the chain and realize the impacts (Kruk et al., 2017)

The effects above are based on four techniques that can make it possible to recycle organic residual streams at a higher value, as shown in Figure 7 and Figure 8.

1) The bio-refinery's Central hub is a hub for valorizing organic residual streams from municipal, industrial, and business waste.

2) Waste separation and return logistics shrewd waste separation and return logistics to effectively deploy Amsterdam as a logistics center and boost the value of residual flows.

3) Organic flow cascading using organic residual streams in the most intelligent way feasible.

4) Recovering nutrients to complete the nutrition cycle and recover vital nutrients.

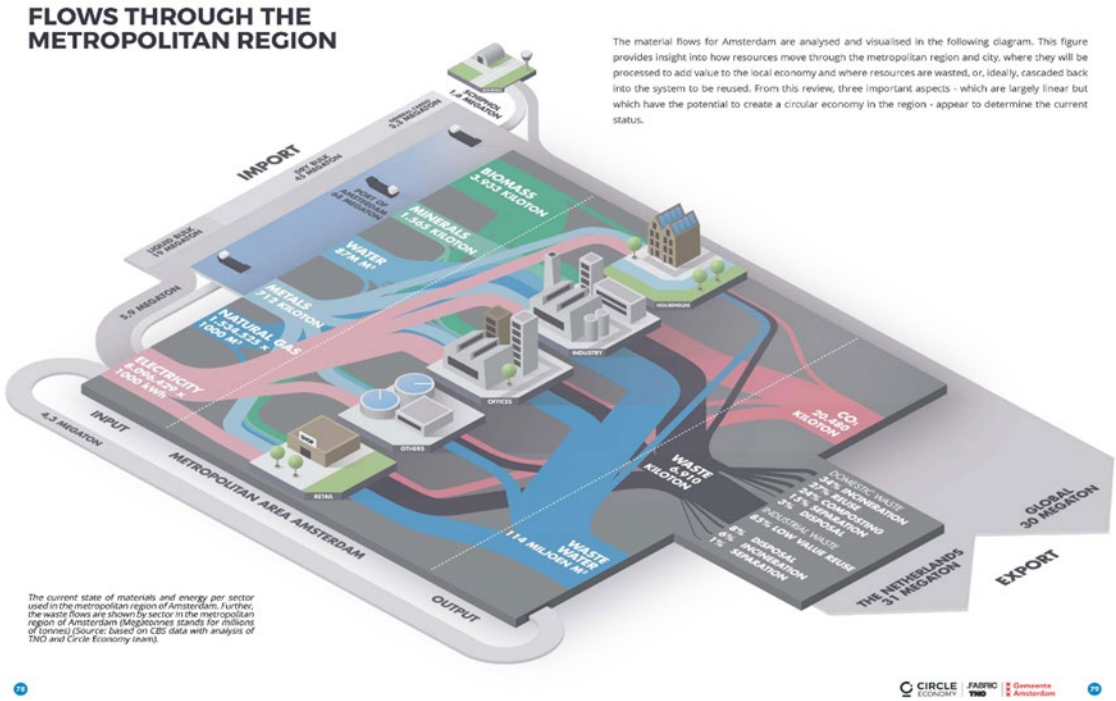

Figure 7 The current state of materials and energy per sector used in the metropolitan region of Amsterdam (Kruk et al., 2017)

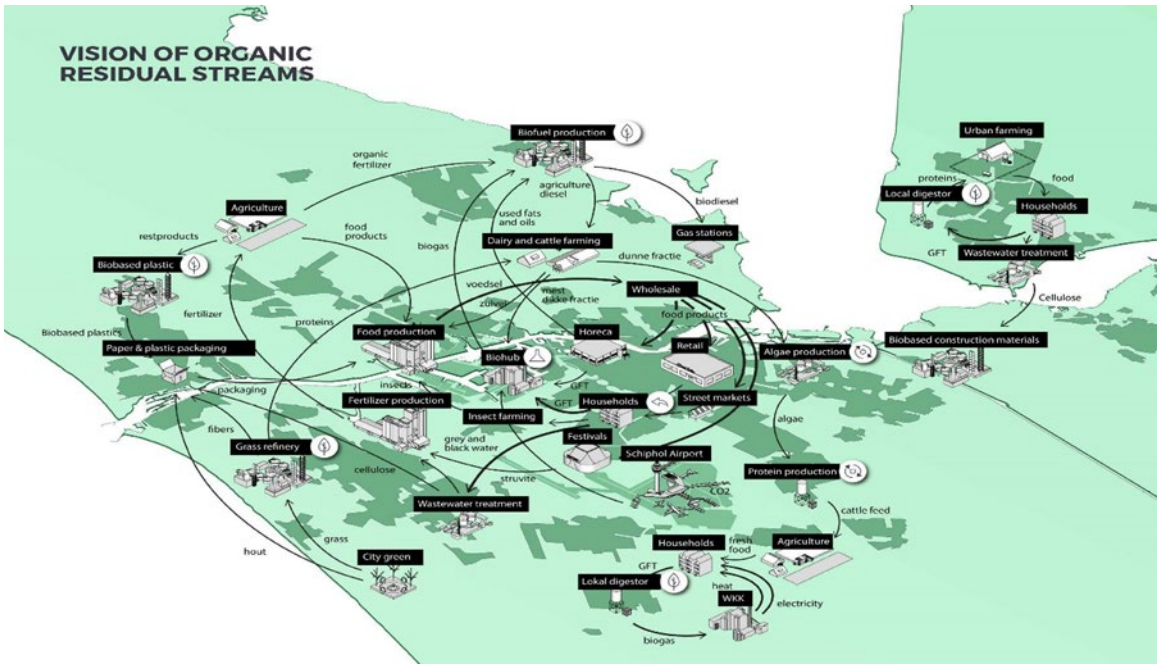

Figure 8 The vision of organic residue streams (Kruk et al., 2017)

In the context of gathering substantial quantities of data, the utilization of computational tools becomes imperative for facilitating the computation of outcomes. This article shows the systematic evaluation of cutting-edge methods for studying the circular economy in the urban tourism industry concludes. A five-phase structure serves as the foundation for the Sustainable Circular Index (SCI), which is proposed. This index can assist managers in determining their level of sustainability and circularity and put measures into place that enhance how well their businesses perform in these two areas. This index is a management tool and a crucial

benchmarking tool for manufacturing organizations to evaluate their sustainable and circular behavior (Azevedo, Godina, & Matias, 2017). The study structure for the conclusion is shown in Figure 9: Phase 1 is the selection of sustainability and circularity indicators; Phase is the weighting of indicators; Phase 3 is normalization; Phase 4 is the aggregation method for Index development; and Phase 5 is the index construction.

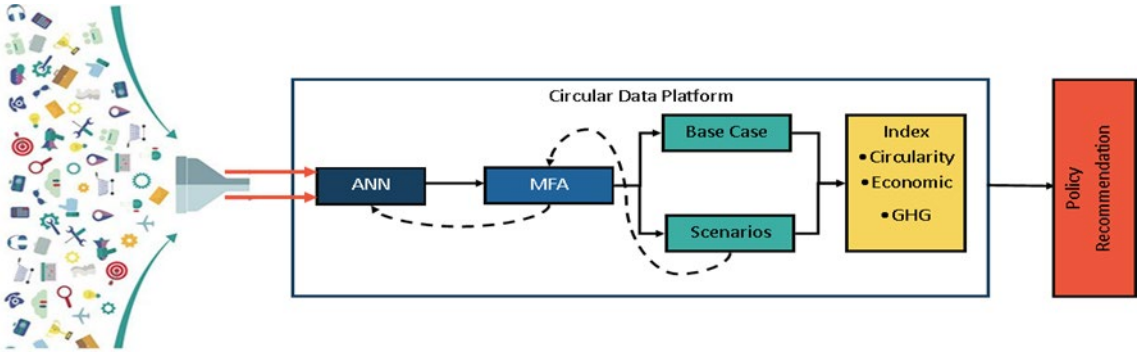

Figure 9 Framework functional IoT, Big Data, CE framework

DISCUSSION

The study examines the application of circular economy analysis techniques within the context of the urban tourism sector. It proposes a framework that can be extended to other sectors in emerging markets, focusing on aspects such as resource use efficiency and the extent of resource recirculation (Chiang Mai Municipality, 2018; Teubner, 2018; Kruk et al., 2017; Smaranda, 2013). The framework utilizes existing indicators to assess the quantity of resource flows and process to transform the resources (Kruk et al., 2017). The reviews examines the application of circular economy analysis approaches within the context of the urban tourism sector. The framework proposed in this research holds potential for broader implementation in the tourism industry as well as other industries within emerging markets. The findings indicate that the circularity evaluation index serves as the outcome of the decision-making process for various scenarios, with particular emphasis on factors such as greenhouse gas reduction potential and circularity rate. . However, in order to accomplish the objective of the CE model framework for the urban tourist sector, it is essential to conduct a comprehensive evaluation of the available information to provide support for the modeling process. This study provides a comprehensive analysis of the existing literature pertaining to strategic tools for implementing circular economy principles in the context of urban tourism. One of the primary objectives is to offer a comprehensive comprehension of the indicator framework utilized in the CE model, which may be effectively implemented in a broader context encompassing tourism SMEs and diverse industries within collaborative endeavors.

CONCLUSION

From the reviews focused work will be filled out with the CE empirical application, which aims to deploy mass flow analysis and urban metabolism. There are retrieved the design and analysis of the scenarios from base case improvement according to the circular economy approach. There are developed a platform for collaboration to create joint value waste—the circular economy approach to improve waste management of tourism's produce and consume model and at the end create a guideline for the waste recycling business model, and the summary and recommend the waste management by display platform and guideline. Furthermore, the next research could usage focused on IoT, big data analytics platform with 2 parts of the production and consumption of food and beverage tourism. The data mining

collected through input/output data with the proper analytic to optimize the usage phase and mass flow of food and beverage, waste, secondary materials, packaging, stock, circularity index, economic index, and GHG reducing potential.

REFERENCES

Azevedo, S. G., Godina, R., & Matias, J. C. D. O. (2017). *Proposal of a Sustainable Circular Index for Manufacturing Companies*. Resources.

Castañón, J. (2019). *10 Machine Learning Methods that Every Data Scientist Should Know*. Retrieved from https://towardsdatascience.com/10-machine-learning-methods-that-every-data-scientist-should-know-3cc96e0eeee9.

Chiang Mai Municipality. (2018). *The Chiang Mai Municipality : Policy on Sustainable Urban Waste Management*. Retrieved from http://www.jgsee.kmutt.ac.th/v2/uploads/images/files/7_%20CMM-WtE.pdf.

Kruk, K., Wit, M. D., Ramkumar, S., Winter, J. D., Güvendik, M., & Hof, K. V. T. (2017). *Cicular Amsterdam*.

Li, Y., Wang, X., Tian, X., & Zhang, Y. (2018). Understanding the mechanism of urban material metabolism with ecological network analysis: An experimental study of Wuxi, China. *Ecological Modelling, 367*, 58-67.

Macpherson, L. (2017). *Amsterdam's Environmental Saviour: The Circular Economy*. Towards Data Science. Retrieved from https://towardsdatascience.com/amsterdams-environmental-saviour-the-circular-economy-c83200222e61.

Patcharawongsakda, E. (2016). *Introduction to Data Mining and Big Data Analytics*. Retrieved from http://dataminingtrend.com/2014/.

Paulina Bohdanowicz, I. M. (2018). Determinants and benchmarking of resource consumption in hotels—Case study of Hilton International and Scandic in Europe. *Energy and Buildings, 39*, 82-95.

Rowen, B. (2018). *The circular economy concept, explained*. Retrieved from https://www.governmenteuropa.eu/circular-economy-concept-explained/90557/.

Saito, O. (2013). Resource Use and Waste Generation by the Tourism Industry on the Big Island of Hawaii. *Journal of Industrial Ecology*. Retrieved from https://kohalacenter.org/archive/pdf/Research_BI_ResourceUseWasteGenerationTourism.pdf.

Smaranda, B. (2013). *Data Mining for Material Flow Analysis: Application in the Territorial Breakdown of French Regions*. Master, Universitat Polit`ecnica de Catalunya, Retrieved from https://hal.inria.fr/hal-00932203/document.

Teubner, W. (2018). *Urban Transformation to a Circular Economy In*. Freiburg and Basel Local Renewables.

Hotel Act, B.E. 2547 (2004). (2004).

Tourism Business and Guide Act, B.E. 2551 (2008). (2008).

Thailand's Land Traffic Act, B.E. 2565 (2022AD). (2022).

Trung, D. N., & Kumar, S. (2005). Resource use and waste management in Vietnam hotel industry. *Journal of Cleaner Production, 13*, 109±116.

Twin, A. (2019). *Data Mining*. Retrieved from https://www.investopedia.com/terms/d/datamining.asp

Wit, M. D., Hoogzaad, J., Ramkumar, S., Friedl, H., & Douma, A. (2018). *The Circularity Gap Report*. In.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.