

How to cite this article: Changhuad, T., Arreeras, T., Sittivangkul, K., & Utainarumol, S. (2026). Analyzing Tourist Activity Patterns Using Association Rule Mining: A Case Study of Chiang Rai Night Market, *Journal of Logistics and Supply Chain Operations*, 12(2), 100-118. <https://doi.org/10.53848/jlsc.v12i2.298370>

Received:	February	13, 2026
Revised:	April	21, 2026
Accepted:	August	28, 2026

Analyzing Tourist Activity Patterns Using Association Rule Mining: A Case Study of Chiang Rai Night Market

Thitima Changhuad¹, Tosporn Arreeras^{2*}, Krit Sittivangkul³ and Supornchai Utainarumol⁴

Abstract

This research aims to explore patterns of tourist activity participation and analyze the relationships between tourist activities at Chiang Rai night market in order to support effective urban tourism management. A descriptive quantitative research design was employed. Data were collected from 405 tourists visiting the Chiang Rai Night Market using a structured questionnaire covering demographic characteristics, travel behavior, and activity participation. Descriptive statistical analysis, including frequency distribution and percentages, was used to examine tourist characteristics and overall participation. In addition, activity relationship patterns were analyzed using association rule mining with the FP-Growth algorithm, utilizing minimum thresholds of 0.60 for support value and 0.95 for confidence value, implemented through RapidMiner. The results showed that tourist activities were highly interconnected, creating integrated experiences. Tourists who participate in sightseeing and cultural learning activities show a strong tendency to engage in food consumption activities. Moreover, food consumption appears to be the central activity in most activity patterns at the market. The most frequent pattern involves dining combined with watching local music performances, which subsequently leads to sightseeing experiences within the night market environment. The practical implications suggest that the spatial planning of night markets should position food-related activities as the core attraction, while integrating cultural performances and experiential activities along major circulation areas, and allocating infrastructure in alignment with identified activity clusters to enhance tourist experiences and support sustainable urban tourism management, contributing new evidence on activity-level behavioral patterns in informal tourism settings where such data-driven analysis remains limited.

Keywords: Association Rule Mining (ARM), Tourist behavior patterns, FP-Growth algorithm, Night market spatial planning

Type of Article: Research Article

* Corresponding author

¹ International Logistics and Supply Chain Management, School of Management, Mae Fah Luang University, E-mail: 6751209259@lamduan.mfu.ac.th,

²⁻³ Urban Mobility Lab., School of Management, Mae Fah Luang University, E-mail: tosporn.arr@mfu.ac.th, krit.sit@mfu.ac.th,

⁴ Department of Civil Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Email: supornchai.u@eng.kmutnb.ac.th

การวิเคราะห์รูปแบบพฤติกรรมนักท่องเที่ยวด้วยเทคนิคภูมิคุ้มกัน: กรณีศึกษาตลาดกลางคืนเชียงราย

จิตติมา แซ่ฮวด¹, ทศพร อาริราษฎร์^{2*}, กฤษ สิริวิชวงศ์กุล³ และ สุพรชัย อุทัยนฤมล⁴

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อสำรวจรูปแบบการเข้าร่วมกิจกรรมของนักท่องเที่ยวและวิเคราะห์ความสัมพันธ์ระหว่างกิจกรรมต่างๆ ณ ตลาดกลางคืนเชียงราย เพื่อสนับสนุนการจัดการการท่องเที่ยวในเมืองอย่างมีประสิทธิภาพ การวิจัยใช้รูปแบบการวิจัยเชิงปริมาณแบบพรรณนา โดยเก็บรวบรวมข้อมูลจากนักท่องเที่ยวจำนวน 405 คน ที่มาเยือนตลาดกลางคืนเชียงรายด้วยแบบสอบถามที่มีโครงสร้าง ครอบคลุมข้อมูลลักษณะทางประชากรศาสตร์ พฤติกรรมการเดินทาง และการเข้าร่วมกิจกรรม วิเคราะห์ข้อมูลเบื้องต้นด้วยสถิติเชิงพรรณนา ได้แก่ การแจกแจงความถี่และค่าร้อยละ เพื่ออธิบายลักษณะของนักท่องเที่ยวและการเข้าร่วมกิจกรรมโดยรวม นอกจากนี้ ยังวิเคราะห์รูปแบบความสัมพันธ์ระหว่างกิจกรรมด้วยเทคนิคการค้นหากฎโดยใช้อัลกอริทึม FP-Growth ผ่านโปรแกรม RapidMiner โดยกำหนดค่าเกณฑ์สนับสนุนขั้นต่ำเท่ากับ 0.60 และค่าเกณฑ์ความเชื่อมั่นขั้นต่ำเท่ากับ 0.95 ผลการวิจัยพบว่ากิจกรรมของนักท่องเที่ยวมีความเชื่อมโยงกันสูงก่อให้เกิดประสบการณ์แบบบูรณาการ นักท่องเที่ยวที่เข้าร่วมกิจกรรมชมทัศนียภาพและเรียนรู้ทางวัฒนธรรมมีแนวโน้มสูงที่จะเข้าร่วมกิจกรรมการรับประทานอาหาร นอกจากนี้ การรับประทานอาหารปรากฏเป็นกิจกรรมศูนย์กลางในรูปแบบกิจกรรมส่วนใหญ่ของตลาด โดยรูปแบบที่พบบ่อยที่สุดคือการรับประทานอาหารร่วมกับการชมการแสดงดนตรีพื้นเมือง ซึ่งนำไปสู่การชมทัศนียภาพภายในบริเวณตลาดกลางคืน ข้อเสนอแนะเชิงประยุกต์ชี้ว่าการพัฒนาพื้นที่ตลาดกลางคืนควรจัดผังพื้นที่โดยยึดกิจกรรมการรับประทานอาหารเป็นแกนหลัก พร้อมบูรณาการกิจกรรมทางวัฒนธรรมและการแสดงในพื้นที่สัณฐานหลัก เพื่อยกระดับประสบการณ์ของนักท่องเที่ยวและสนับสนุนการจัดการการท่องเที่ยวในเมืองอย่างยั่งยืน ทั้งนี้ งานวิจัยนี้ยังเป็นการนำเสนอหลักฐานเชิงประจักษ์ใหม่เกี่ยวกับรูปแบบพฤติกรรมในระดับกิจกรรมในบริบทการท่องเที่ยวแบบไม่เป็นทางการ ซึ่งการวิเคราะห์เชิงข้อมูลในลักษณะดังกล่าวยังมีการศึกษาอย่างจำกัด

Keywords: ภูมิคุ้มกัน, รูปแบบพฤติกรรมนักท่องเที่ยว, FP-Growth, การวางแผนพื้นที่ตลาดกลางคืน
ประเภทบทความ: บทความวิจัย

* ผู้รับผิดชอบงานหลัก

¹ การจัดการโลจิสติกส์และโซ่อุปทานระหว่างประเทศ สำนักวิชาการจัดการ มหาวิทยาลัยแม่ฟ้าหลวง, อีเมล: 6751209259@lamduan.mfu.ac.th

^{2,3} ห้องปฏิบัติการการคมนาคมในเมือง สำนักวิชาการจัดการ มหาวิทยาลัยแม่ฟ้าหลวง, อีเมล: tosporn.arr@mfu.ac.th, krit.sit@mfu.ac.th

⁴ ภาควิชาวิศวกรรมโยธา คณะวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี, อีเมล: supornchai.u@eng.kmutnb.ac.th

ผ่านการรับรองคุณภาพจากศูนย์ดัชนีการอ้างอิงวารสารไทย (TCI.) อยู่ในกลุ่ม 2 สาขามนุษยศาสตร์และสังคมศาสตร์

1. Introduction

International tourism has experienced a strong post-pandemic recovery. According to the United Nations World Tourism Organization (UN Tourism, 2025), global international tourist arrivals reached approximately 1.5 billion by the end of 2025, nearly matching pre-pandemic levels. Thailand is a prime tourist destination in Southeast Asia, welcoming approximately 33.97 million international visitors in 2025 (Statista, 2025), with tourism contributing substantially to national economic recovery. Within this national context, northern provinces including Chiang Rai have emerged as increasingly significant tourism zones, attracting visitors seeking cultural heritage, natural landscapes, and authentic local experiences.

Chiang Rai, the northernmost province of Thailand, has developed a distinctive tourism identity rooted in its multicultural heritage and proximity to the Golden Triangle. At the center of its urban tourism landscape is the Chiang Rai Night Market, located near the city's Clock Tower, covers approximately 4,000–5,000 square meters and features a multi-zone layout, including an open-air vendor area, a food court, a cultural performance stage, and surrounding craft stalls. The market attracts approximately 2,000–4,000 visitors per evening during peak periods, particularly on weekends and public holidays. Its distinctive characteristic lies in the integration of cultural performances, local cuisine, and artisan products, enabling tourists

to engage in multiple activities within a single spatial setting.

Within this context, night markets have evolved beyond traditional retail spaces into essential nodes of urban tourism systems. They function simultaneously as economic platforms supporting SMEs and as cultural spaces where tourists engage in diverse activities, including dining, cultural performances, souvenir shopping, and social interaction. As a result, understanding tourist behavior within night market environments has become critical for urban tourism management, particularly with respect to spatial planning, visitor flow management, and service allocation.

Despite growing scholarly interest in night market tourism, several key research gaps remain. First, prior studies have largely focused on tourist demographics, motivations, and satisfaction (Rueda-López et al., 2026) or spatial configurations of market environments, with limited attention to activity-level participation patterns, particularly how activities are combined and experienced concurrently. Second, conventional analytical approaches, such as descriptive statistics and regression models, treat activities as independent variables, which does not adequately capture the interconnected nature of tourist experiences (Huang et al., 2023). Third, although data-driven approaches have gained importance, their application in informal, SME-driven settings such as night markets and their translation into actionable

insights for spatial and logistics management remains limited (Zhang, 2024).

To address these gaps, Association Rule Mining (ARM) provides an appropriate analytical framework for identifying co-occurrence patterns within behavioral data, ARM enables the analysis of interdependent activities without assuming variable independence, making it particularly suitable for examining integrated tourist experiences. The FP-Growth algorithm is employed due to its computational efficiency in extracting frequent patterns without generating candidate itemsets, outperforming traditional approaches such as Apriori in datasets with multiple co-occurring activities (Wicaksono et al., 2020). Although widely applied in retail analytics, its use in tourism, especially at the activity level in informal settings, remains limited (Yu et al., 2022).

Therefore, this study aims to analyze tourist activity participation patterns and examine the relationships among activities at the Chiang Rai Night Market using ARM with the FP-Growth algorithm. By identifying and quantifying co-occurrence patterns, the study

provides empirical insights into how tourists experience night markets as integrated systems of activities.

This study contributes in two key ways. Theoretically, it extends the application of ARM to activity-level behavioral analysis in informal tourism contexts, revealing structured experience bundles. Practically, it bridges tourism analytics and urban management by translating these patterns into actionable insights for spatial zoning, visitor flow optimization, and resource allocation. Figure 1 shows an example of a Chiang Rai night market, highlighting its key economic hubs and recommended tourist attractions.

2. Research Objectives

1. To explore activity patterns of the Chiang Rai night market visitors using association rule mining (ARM).
2. To analyze the relationship between activities that tourists engage in together in the Chiang Rai night market area.
3. To provide policy implications for effective night market and tourism logistics management.



Figure 1 Spatial characteristics of Chiang Rai night market as an integrated tourism and economic hub. (Source: Authors)

3. Conceptual framework

This research applies ARM techniques along with tourism logistics management to Chiang Rai night markets for analyzing tourist behavior. First, it provides a literature review toward developing a conceptual framework and research tools validated for reliability and then proceeds to collect data from a sample size of 405 people. After processing, the extracted data is then analyzed through algorithms for the identification of behavioral relationships. To confirm the association rules, support, confidence, and lift values are used to verify the importance and reliability of those rules. The results were integrated into strategic logistics recommendations, such as route planning, parking lots, and facility design, which aimed to enable the enhancement of tourist distribution and sustainable destination management, as detailed in Figure 2.

4. Literature review

4.1 Pattern Mining in Tourism

Pattern mining is a significant method of research that emphasizes identifying hidden patterns, frequency, relationships, and structures

in a set of specific data. Pattern mining is a technique that can be considered very useful for the tourism industry to understand tourists' behavior, preferences, and decision processes, which can hardly be grasped through statistical data (Park et al., 2020). Using pattern mining in the tourism industry is considered a trend, as the tourism industry is looking for solutions to understand human behavior regarding tourism and leisure through data. Pattern mining was traditionally applied to mine sequential pattern data to understand the routes and tourist destinations. The study by Agrawal and Srikant (2022) provided the basis for pattern discovery in sequential data, which was used in the tourism sector to analyze the patterns taken by tourists. The use of trajectory location data, such as mobile phone data, was used to identify the spatial structures, key tourist spots, and travel routes (Yin et al., 2022). However, a critical limitation in prior work is that most studies examine destination-level or route-level patterns rather than activity-level participation within a single venue, a gap this study addresses by applying ARM at the intra-venue activity level.

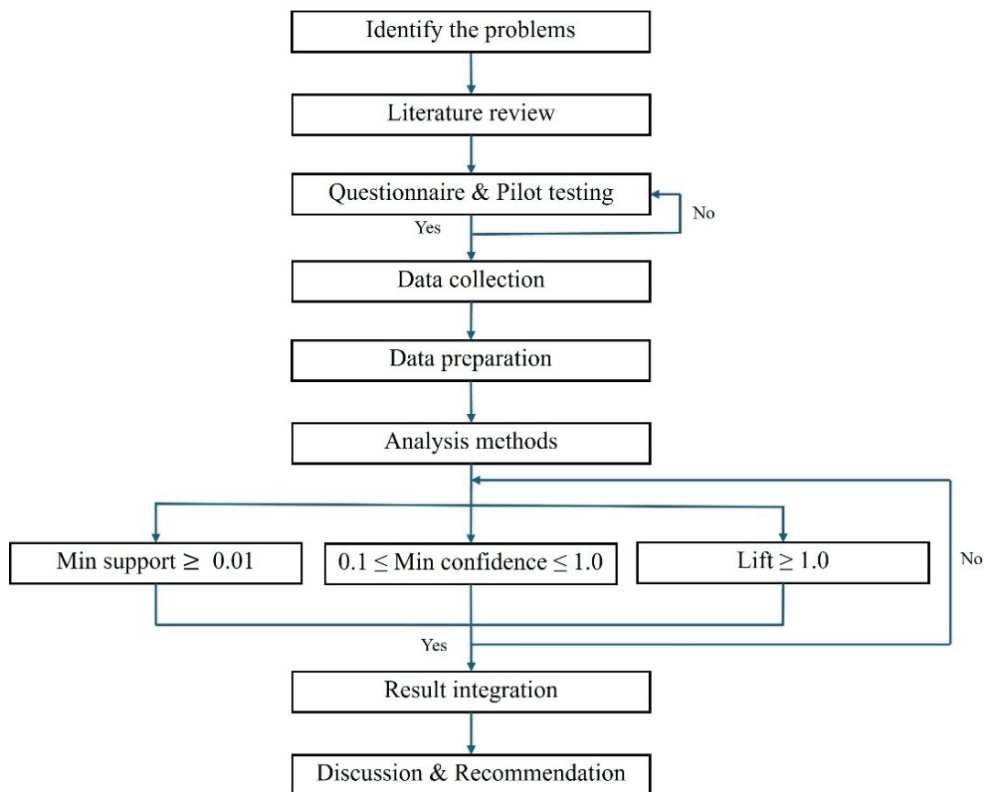


Figure 2 Conceptual framework.

4.2 Night Markets as Tourism Destinations

Night markets have become a vital part of urban tourism infrastructure, integrating economic, cultural, and social dimensions. Li et al. (2021) described a market as an evening pedestrian-only space characterized by food, handicrafts, and social activities. It attracts different types of tourists, both local and international, who wish to engage in a local experience. In addition, the economic aspect of the market directly distributes income among SMEs, mainly benefiting grassroots development (Liang et al., 2021). Logistics management integration into tourism planning has become critical for sustainable development.

Zhu and Zhu (2023) demonstrated how modern logistics and tourism activities are interconnected. The fields are related by means of food, accommodation, transport, purchase, and entertainment. Therefore, they ought to be planned in an integrative manner. In this respect, literature on the integration of urban logistics and tourism is limited, particularly in the context of night markets. Bentalha (2023) mentioned that tourism supply chain management, in this case, is vital in that logistics involve the flow of materials and products from demand planning and facility distribution in pedestrian spaces.

Nevertheless, despite the economic and cultural advantages provided by the high volume of tourist activities, there is the problem of managing the crowds, waste disposal, and noise pollution (Carmona, 2019). Although previous literature on the subject focused on the participation of consumers and spatial arrangement (Jeong & Ban, 2020), little emphasis is given to the examination of combinations and relations of activities. This is particularly noted in data processing to show the real nature of activity participation in spatial management for the development of sustainable tourism. This gap highlights the need for a data-driven, combinatorial approach such as ARM to systematically examine how activities co-occur and reinforce each other, which this study contributes to the existing body of knowledge.

4.3 Association Rule Mining Applications

Machine learning developments have helped tourism researchers overcome limitations in intention-based analysis and provide data-driven behavioral discovery investigation approaches. In this series of developments, ARM has appeared as an unsupervised model that can discover data concerning "co-occurring relationships"; that is, relationships between transactional data, as described as $X \rightarrow Y$. In order to determine rule significance, support, and confidence, lift metrics are used to generate activity relationships. This investigation adopted the FP growth algorithm on the basis of its computational advantages and its ability to minimize database

scans as opposed to more conventional algorithms. In addition, its efficacy has recently been confirmed for dense transactional data sets. ARM has significantly appeared as a technique that can be applied in various industries, including health, as demonstrated in support of diagnosis (Syah et al., 2023), transportation for understanding travel patterns (Kumar & Toshniwal, 2016), and tourism studies, among others. In tourism, these transactional data are applied as visiting experiences, and "items" are regarded as tourism destinations or activity bundles, while mined rules reflect tourist behavior patterns. (Arreeras et al., 2019) used ARM technology and analyzed Wi-Fi data to discover hotspots of co-visited attractions in Hokkaido that are used for coordinating transportation. However, to date, there is limited research that examines the activity-level behaviors in informal settings concerning tourism. Moreover, there are still limitations in the integration of behavioral insights from ARM technology concerning tourism logistics and space management, which create limitations in its contribution to sustainable development in tourism. This research aims to address these gaps through applications and implications for spatial management and sustainable development. FP-Growth was specifically selected over alternative algorithms such as Apriori and Eclat due to its computational efficiency, constructing a compact FP-tree that requires only two database scans and its confirmed superiority for dense transactional

datasets such as the activity participation data used in this study (Tank, 2014).

5. Methodology

5.1 Research method

The research employed a quantitative research methodology that incorporates data mining with the identification of behavioral patterns concerning participation in different tourist activities at the Chiang Rai Night Market. The research focused on identifying co-occurrence patterns of activities rather than causal relationships, making it suitable for data mining techniques such as ARM with the FP growth algorithm.

5.2 Population and sample

The research population for this study was visitors to the Chiang Rai Night Market. Since there are no official records of the exact number of tourists visiting the market, the sample size was determined using the population formula for Chiang Rai province, which includes not only tourists but also locals (5,364,627 populations), estimated using the Taro Yamane formula. At a 95% confidence level and a 5% margin of error, this yielded approximately 400 participants. Data was collected from 405 participants using a structured questionnaire.

5.3 Research instruments

A structured questionnaire was developed to obtain three data categories aligned with analytical requirements, conducted exclusively on-site. The first section, demographic information, gathered

data on gender, age, marital status, educational level, monthly income, region of origin, and vehicle ownership. The second section of this structured questionnaire is traveling behavior and aims at obtaining information related to the composition of the visiting party, information concerning the visit, transportation used, length of stay, spending, information source, distance of the visited place from the accommodation, and probability of return visitation. It also includes activity participation at the night market, in which the respondents indicated the activities in which they had participated that were designed into binary format (1 = participated, 0 = not participated) to facilitate the analysis. The structured questionnaire was tested among 20 respondents, and the reliability of the instrument was assessed using Cronbach's alpha, which yielded a value of 0.812, indicating acceptable internal consistency.

5.4 Data collection

Data was collected through on-site questionnaires distributed at Chiang Rai night market, available in both Thai and English languages. Data was collected every Saturday the market was open, from December 2025 to January 2026. Due to time constraints, data was collected only during that period, and no seasonal comparisons were made. Responses were recorded in binary format, as shown in Table 1. Each questionnaire requires 10-15 minutes to be completed. Respondents were informed of research purposes and objectives,

with questionnaires immediately verified for completeness to prevent missing data. The collection process ensured adequate sample representation across visitor segments. However, this study may be subject to certain limitations. The use of convenience sampling

may introduce selection bias, as participants were self-selected based on their willingness to respond. In addition, the field survey approach may not fully capture variations in tourist behavior across different seasons or special events.

Table 1 Participation in Chiang Rai night market activities.

Activities	Measurement	
	Yes	No
Dining	Yes	No
Agricultural Products	Yes	No
Local Music Performances	Yes	No
Cultural Learning	Yes	No
Sightseeing	Yes	No
Business Networking	Yes	No
Walking Exercise	Yes	No
Artworks	Yes	No
Retro Dance	Yes	No
Make Merit	Yes	No
Massage Services	Yes	No

Note: Yes: 1 = participated, No: 0 = not participated

5.5 Data analysis

This research employed a quantitative approach to analyze visitor activity patterns at Chiang Rai night market. The methodology consisted of two main analytical techniques: descriptive analysis to characterize the sample population and ARM to identify activity co-occurrence patterns.

1. Descriptive Analysis

Descriptive statistics characterized demographics and general behavioral characteristics of night market visitors.

Descriptive data includes key demographic information such as gender, age, marital status, education, occupation, monthly income, region, and vehicle ownership. The descriptive findings statistics, including frequency and percentage, were used to summarize the characteristics of the respondents and their activity participation.

2. Association Rule Mining (ARM)

The application of ARM as a significant instrument in uncovering related activities among individuals attending the night market

was very important. The significance of this technique is based on its ability to unearth relationships between activities by revealing those activities that are carried out simultaneously more than by mere chance. The FP-Growth algorithm was selected due to its computational efficiency and ability to handle large and dense datasets without generating candidate itemsets, making it more suitable than alternative algorithms such as Apriori or Eclat by using RapidMiner software was used.

To attain applicable rules aligned with ARM use, three specifications require consideration: support, confidence, and lift (Tank, 2014).

Support indicates item set co-occurrence frequency. High support values represent repetition frequency, meaning frequent itemset detection. Support is calculated as shown in Equation (1). This study's minimum support threshold is defined as 0.60.

$$\text{Support}(X) = \frac{\text{Number of transactions } X}{\text{Total number of transactions}} \quad (1)$$

Confidence value represents conditional validity or probability of item set occurrence (Yaman et al., 2020). Its value relates to transaction sets: something containing X also contains Y. Relational rules with high

confidence values are considered reliable, expressed in Equation (2). Rules are created from item sets meeting confidence and lift thresholds. This study's minimum confidence threshold is identified as 0.95.

$$\text{Confidence}(X \rightarrow Y) = \frac{\text{Number of transactions include both } X \text{ and } Y}{\text{Total number of transactions } X} \quad (2)$$

Lift value measures relationship strength between activities, indicating greater correlation than expected if activities were independent. Lift values exceeding 1.0 indicate positive correlation, where activities

occur together more frequently than random chance would predict (Sowan et al., 2025). Higher Lift values indicate stronger relationships, given in Equation (3).

$$\text{Lift}(X \rightarrow Y) = \frac{\text{Confidence}(X \rightarrow Y)}{\text{Support}(Y)} \quad (3)$$

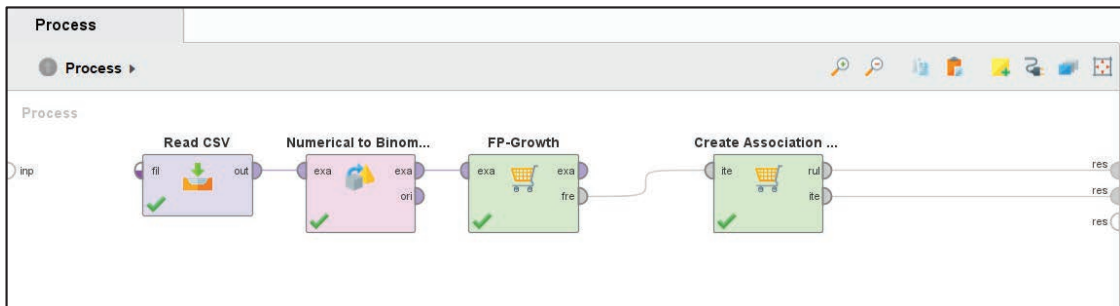


Figure 3 Association rule mining workflow using FP-Growth algorithm in RapidMiner.

These relatively high thresholds were selected to ensure that only strong and reliable patterns were retained, thereby reducing noise and focusing on dominant behavioral structures among tourists. Wang et al. (2025) studied commonly adopt lower thresholds, which may generate a large number of less meaningful rules. In contrast, this study prioritizes robustness and interpretability by focusing on frequent and highly confident patterns. It allows for a deeper view of behavioral patterns among night market visitors by integrating the descriptive analysis with rule relationship discovery, as shown in Figure 3. Above, the descriptive statistics have been used to understand market visitors and their general characteristics. Then, ARM techniques are applied to establish how market visitors interact with one another, rules that do not meet the minimum criteria

mentioned above are eliminated.

6. Results

The numerical analysis is of two components: descriptive visitor characteristics and results from the ARM. The findings reveal considerable diversity among night market visitors and demonstrate strong interconnections among tourist activities.

6.1 Descriptive analysis of tourist activities

Table 2 indicates the descriptive results, the implication of which is the diversity of the visitors. Female visitors were the majority in the sample. Married visitors were a majority in the category of visitors who were not alone. The majority of the visitors at the night market came with their families, and this implies the social nature of the night market for purposes of leisure.

Table 2 The results of descriptive observational data. (N=405)

Categories		Frequency	Percent
Gender	Male	118	29.14
	Female	195	48.15
	Other	92	22.72
	Total	405	100
Marital Status	Single	69	17.04
	Married	304	75.06
	Other	32	7.90
	Total	405	100
Traveling to night market with	Alone	74	18.27
	Family	242	59.75
	Friends	72	17.78
	Organization	17	4.20
	Total	405	100

6.2 Association rule mining results

ARM analysis using the FP-Growth algorithm identified significant patterns in visitor activities at Chiang Rai night market. 10 rules for relationships were established with support values ≥ 0.6 and confidence values

≥ 0.95 , revealing strong relationships between different tourist activities. The results are presented in Table 3, sorted in descending order by confidence values to highlight the most reliable activity associations.

Table 3. Results of association rules for tourist activities at Chiang Rai night market.

Rule	Premises	Consequence	Support	Confidence	Lift
1	Sightseeing, Cultural Learning	Dining	0.746	0.987	1.049
2	Sightseeing, Local Music Performance, Cultural Learning	Dining	0.716	0.986	1.049
3	Dining, Local Music Performance, Walking Exercise	Sightseeing	0.620	0.984	1.069
4	Local Music Performance, Cultural Learning	Dining	0.728	0.983	1.045

Table 3. Results of association rules for tourist activities at Chiang Rai night market. (Cont.)

Rule	Premises	Consequence	Support	Confidence	Lift
5	Dining, Local Music Performance, Cultural Learning	Sightseeing	0.716	0.983	1.067
6	Local Music Performance, Walking Exercise	Sightseeing	0.637	0.981	1.065
7	Sightseeing, Agricultural Product	Dining	0.612	0.980	1.042
8	Local Music Performance, Cultural Learning	Sightseeing	0.726	0.980	1.064
9	Local Music Performance, Agricultural Product	Dining	0.600	0.980	1.042
10	Dining, Local Music Performance	Sightseeing	0.817	0.976	1.060

The analysis produced three key findings. First, the highest-confidence rule (Rule 1 confidence = 0.987) indicated that tourists engaging in sightseeing and cultural learning have an extremely high probability of also engaging in dining activities. Second, dining featured prominently as the consequent activity in seven of the ten rules, confirming dining as the dominant subsequent activity in the night market environment. Third, the most frequently occurring activity combination (Rule 10; support = 0.817) demonstrated that tourists participating in both dining and local music performances had a very high probability of engaging in sightseeing. All lift values exceeded 1.0, indicating positive correlations among activities, with the highest lift value (1.069) observed for Rule 3 involving dining, local music performances, and walking exercise.

Table 3 shows that there are two activities that stand out as the most frequent

patterns: dining and sightseeing. For example, the network diagrams in Figure 4 illustrates dining as a central node strongly connected with {sightseeing, cultural learning → dining} (Rule 1), this rule demonstrates that dining serves as both a primary and complementary activity within an integrated tourism experience. Each node represents a tourist activity observed at the Chiang Rai Night Market. The circle size corresponds to the support value of the association rule, where larger circles indicate higher co-occurrence frequency. The number inside each circle represents the rule number as listed in Table 3, with the first value indicating support and the second value indicating confidence. Arrows indicate the direction of the association rule, from antecedent activity (premise) to outcome activity (consequent). The label format within each circle denotes (support, confidence) as reported in Table 3.

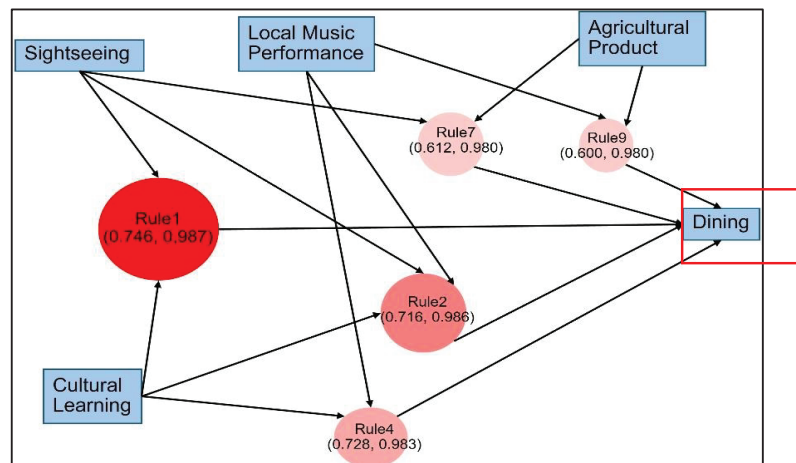


Figure 4 Network structure of tourist activities associated with dining at Chiang Rai night market.

Another example is shown in Figure 5. pattern where experiential consumption and sightseeing as a central node {dining, local music performance → sightseeing} (Rule 10), reflecting a highly interconnected activity

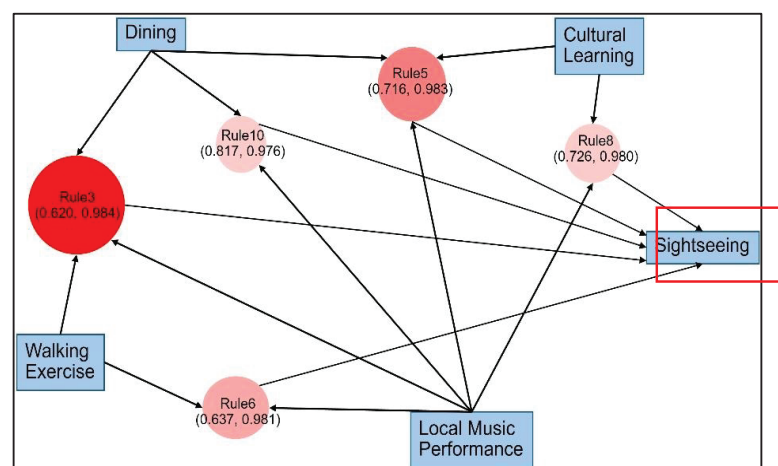


Figure 5 Network structure of tourist activities associated with sightseeing at Chiang Rai night market.

6.3 Behavioral interpretation of activity patterns

The identified association rules were interpreted from a behavioral perspective in

order to offer deeper insights. The findings show that eating is a key component of the night market experience. Dining is a part of a larger series of experiences that include

entertainment, sightseeing, and cultural education rather than being a stand-alone activity.

There are several possible explanations why tourist activities tend to cluster around dining. First, food represents both a basic need and a key attraction, making it a natural focal point for visitors. Second, dining areas frequently serve as spatial and social hubs where visitors congregate, relax, and socialize, which raises the possibility that they will participate in nearby activities. Third, tourists are encouraged to combine dining with cultural and entertainment activities because its food and cultural performances enhance the dining experience. Furthermore, the market's layout makes it easier to move between the dining areas and the surrounding areas, which supports these patterns of activity.

Theories of tourism behavior can help us better understand these findings. According to Pine and Gilmore (2013) and Oh et al. (2007), tourism activities are organized as integrated experiences where consumption is closely associated with the creation of emotional, cultural, and social value. In this situation, eating is an essential part of the whole experience rather than just a practical activity. According to Li (2004) and Testa and Sipe (2012), consumption-based tourism highlights that traveler behavior is motivated by experiential consumption, which combines food, culture, and social interaction into integrated experience bundles. Therefore,

the observed co-occurrence patterns reflect a broader behavioral structure in which tourists engage in interconnected activities to construct meaningful and immersive experiences, rather than participating in isolated actions.

7. Discussion and conclusions

This study extends the understanding of tourist behavior in night market contexts by employing association rule mining (ARM) to identify specific co-occurrence patterns of activities. The results support earlier studies on pattern mining in tourism by confirming that visitor behavior is not a private event but rather takes place in integrated activity bundles (Park et al., 2020). While previous research highlights the multifunctional role of night markets (R. Li et al., 2021), this study further shows how activities are behaviorally interconnected rather than just co-located. By connecting these findings with existing literature, the strong association between sightseeing, cultural learning, and dining supports the idea of structured and repeatable tourist behavior patterns.

Dining is central to the night market experience, is deeply embedded in the night market experience, and fosters social interaction alongside other activities such as sightseeing. This strong association with cultural learning indicates that tourists value authentic experiences more than mere consumption. Therefore, this synergy reinforces the meaning of participation, making

dining a key link driving broader engagement within the tourism framework. The theoretical implications of this study are significant, as it contributes by supporting a shift from isolated activity analysis toward interconnected behavior systems and demonstrating the value of data-driven approaches like ARM in uncovering latent patterns. The study also made a significant methodological contribution by connecting visitor behavior with spatial and logistics planning frameworks (Zhu & Zhu, 2023).

8. Recommendation

8.1 Recommendations for implementing

1. Dining-centric spatial configuration based on dominant participation patterns: From the descriptive analysis, it is evident that dining and sightseeing are the most participated activities. In addition, based on the association rule mining analysis, dining is found to be the most central activity with the highest support and confidence values. Accordingly, dining facilities should be spatially distributed throughout the night market and integrated with main tourist routes to accommodate the high number of participants and facilitate efficient visitor flow.

2. Strategic Co-location of Cultural Activities with High Traffic: The results of the ARM show strong correlations between the activities of dining, cultural learning, music performances, and sightseeing. Furthermore, the descriptive results show significant levels of engagement with these activities. This

implies that cultural performances and cultural learning activities should be strategically located close to the dining areas and areas of high traffic.

3. Infrastructure allocation should align with activity clustering patterns: The identified activity clusters, particularly those related to dining, tourism, and cultural performances, are likely to attract large numbers of tourists. Therefore, market management should allocate supporting infrastructure, including seating areas, waste management facilities, and service facilities, based on these clustering patterns.

4. Policy recommendations for sustainable management: Night market authorities should implement a zoning system, designating food zones as central thoroughfares with adjacent cultural performance areas. This aims to increase visitor flow, reduce congestion, and enhance the overall tourism experience. Investment in infrastructure such as seating, waste management, and lighting is also recommended.

8.2 Future research direction

1. Study the patterns of tourist activity at various times of the day and in various seasons to account for dynamic patterns.

2. Compare activity patterns in various night markets across different regions in Thailand, which would reveal similarities as well as unique features regarding each place.

3. Explore the impact of identified activity patterns on tourist satisfaction, spending behavior, and intention to revisit,

and establish causal relationships into the analysis to better understand the economic implications of activity patterns.

4. Conduct comparative research on various correlation algorithms other than FP-Growth to determine their relative strength for tourist pattern analysis.

5. Tourist clustering using integrated analysis methods. Future studies may combine descriptive variables with clustering and correlation techniques to study variations in activity participation patterns among different tourist groups.

เอกสารอ้างอิง

- Agrawal, R., & Srikant, R. (2022). Mining sequential patterns. *Proceedings of the Eleventh International Conference on Data Engineering*, 3–14. <https://doi.org/10.1109/ICDE.1995.380415>
- Arreeras, T., Arimura, M., Asada, T., & Arreeras, S. (2019). Association Rule Mining Tourist-Attractive Destinations for the Sustainable Development of a Large Tourism Area in Hokkaido Using Wi-Fi Tracking Data. *Sustainability*, 11(14), 3967. <https://doi.org/10.3390/su11143967>
- Bentalha, B. (2023). Sustainable supply chain management in tourism. In N. D. Aggarwal & R. K. Bharti (Eds.), *Implementing sustainable development goals in the service sector* (pp. 53–66). IGI Global. <https://doi.org/10.4018/979-8-3693-2065-5.ch004>
- Carmona, M. (2019). Principles for public space design, planning to do better. *URBAN DESIGN International*, 24(1), 47–59. <https://doi.org/10.1057/s41289-018-0070-3>
- Huang, R., Xie, C., Lai, F., Li, X., Wu, G., & Phau, I. (2023). Analysis of the Characteristics and Causes of Night Tourism Accidents in China Based on SNA and QAP Methods. *International Journal of Environmental Research and Public Health*, 20(3), 2584. <https://doi.org/10.3390/ijerph20032584>
- Jeong, S. K., & Ban, Y. U. (2020). Spatial Configurations for The Revitalization of a Traditional Market: The Case of Yukgeori Market in Cheongju, South Korea. *Sustainability*, 12(7), 2937. <https://doi.org/10.3390/su12072937>
- Kumar, S., & Toshniwal, D. (2016). A data mining approach to characterize road accident locations. *Journal of Modern Transportation*, 24(1), 62–72. <https://doi.org/10.1007/s40534-016-0095-5>
- Li, R., Wang, X., & Wang, Y. (2021). Night Market Cultural Transformation and Upgrading. *Journal of Service Science and Management*, 14(04), 412–428. <https://doi.org/10.4236/jssm.2021.144026>

- Li, W. (2004). Environmental management indicators for ecotourism in China's nature reserves: A case study in Tianmushan Nature Reserve. *Tourism Management*, 25(5), 559–564. <https://doi.org/10.1016/j.tourman.2003.06.001>
- Liang, C.-C., Yu, A. P.-I., & Le, T. H. (2021). Customers focus and impulse buying at night markets. *Journal of Retailing and Consumer Services*, 60, 102434. <https://doi.org/10.1016/j.jretconser.2020.102434>
- Oh, H., Fiore, A. M., & Jeoung, M. (2007). Measuring Experience Economy Concepts: Tourism Applications. *Journal of Travel Research*, 46(2), 119–132. <https://doi.org/10.1177/0047287507304039>
- Park, S., Xu, Y., Jiang, L., Chen, Z., & Huang, S. (2020). Spatial structures of tourism destinations: A trajectory data mining approach leveraging mobile big data. *Annals of Tourism Research*, 84, 102973. <https://doi.org/10.1016/j.annals.2020.102973>
- Pine, B. J., & Gilmore, J. H. (2013). The experience economy: past, present and future. In *Handbook on the Experience Economy*. Edward Elgar Publishing. <https://doi.org/10.4337/9781781004227.00007>
- Rueda-López, R., Castaño-Prieto, L., Álvarez-Robles, C., & Aguilar-Rivero, M. (2026). Relationships between tourists' motivations, satisfaction, perceived value and loyalty in a second-tier city: the case of León (Spain). *Cities*, 170, 106650. <https://doi.org/10.1016/j.cities.2025.106650>
- Sowan, B., Zhang, L., Matar, N., Zraqou, J., Omar, F., & Alnatsheh, A. (2025). A novel lift adjustment methodology for improving association rule interpretation. *Decision Analytics Journal*, 15, 100582. <https://doi.org/10.1016/j.dajour.2025.100582>
- Syah, R. D., Madenda, S., Suhatri, R. J., & Harmanto, S. (2023). Digital Image Encryption using Composition of RaMSH-1 Map Transposition and Logistic Map Keystream Substitution. *International Journal of Advanced Computer Science and Applications*, 14(3). <https://doi.org/10.14569/IJACSA.2023.0140365>
- Tank, D. M. (2014). Improved Apriori Algorithm for Mining Association Rules. *International Journal of Information Technology and Computer Science*, 6(7), 15–23. <https://doi.org/10.5815/ijitcs.2014.07.03>
- Testa, M. R., & Sipe, L. (2012). Service-leadership competencies for hospitality and tourism management. *International Journal of Hospitality Management*, 31(3), 648–658. <https://doi.org/10.1016/j.ijhm.2011.08.009>
- Statista Research Department. (2025). *Number of international tourist arrivals in Thailand from 2015 to 2025 (in millions)*. Statista. <https://www.statista.com/statistics/994693/thailand-number-international-tourist-arrivals/>

- UN Tourism. (2025). World Tourism Barometer. *UNWTO World Tourism Barometer*.
- Wang, J., Jiang, X., He, Y., Guan, B., & Deng, C. (2025). Exploration of association rule mining between lost-linking features and modes of loan customers using the FP-growth algorithm for risk warning strategies. *PLOS One*, 20(9), e0332623. <https://doi.org/10.1371/journal.pone.0332623>
- Wicaksono, D., JAMBAK, M. I., & SAPUTRA, D. M. (2020). The Comparison of Apriori Algorithm with Preprocessing and FP-Growth Algorithm for Finding Frequent Data Pattern in Association Rule. *Proceedings of the Sriwijaya International Conference on Information Technology and Its Applications (SICONIAN 2019)*. <https://doi.org/10.2991/aisr.k.200424.047>
- Yaman, S., Fagerholm, F., Munezero, M., Männistö, T., & Mikkonen, T. (2020). Patterns of user involvement in experiment-driven software development. *Information and Software Technology*, 120, 106244. <https://doi.org/10.1016/j.infsof.2019.106244>
- Yin, C., Wang, X., Shao, C., & Ma, J. (2022). Exploring the Relationship between Built Environment and Commuting Mode Choice: Longitudinal Evidence from China. *International Journal of Environmental Research and Public Health*, 19(21), 14149. <https://doi.org/10.3390/ijerph192114149>
- Yu, T., Rita, P., Moro, S., & Oliveira, C. (2022). Insights from sentiment analysis to leverage local tourism business in restaurants. *International Journal of Culture, Tourism and Hospitality Research*, 16(1), 321–336. <https://doi.org/10.1108/IJCTHR-02-2021-0037>
- Zhang, P. (2024). Innovative Development Mode of Tourism and Culture Industry in the Era of Smart Tourism. *Applied Mathematics and Nonlinear Sciences*, 9(1). <https://doi.org/10.2478/amns-2024-2141>
- Zhu, J., & Zhu, Z. (2023). The space-time evolution and driving mechanism of coordinated development of modern logistics industry and tourism industry. *Journal of Cleaner Production*, 423, 138620. <https://doi.org/10.1016/j.jclepro.2023.138620>