Article

Path analysis of social network factors influencing sustainable eco-city development in the northeast of Thailand

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Abstract: In Urban development, diversity respect is needed to prioritize and balance the urban development design for sustainable eco-city development. As a result, this research aimed to investigate the causal factor pathways of social network factors influencing sustainable eco-city development in the northeastern region of Thailand through a quantitative research approach. With the aim to survey insightful information, the analysis unit was conducted at the individual level with three hundred and eighty-three (383) samplings in Khon Kaen and Udon Thani provinces, including univariate analysis and multivariate analysis, using path analysis and multiple linear regression. The study results indicated that two pathways of social network factors influencing sustainable eco-city development were indirect influence factors. The indirect influence factor consists of information exchange, benefits exchange in the network, and members' role in the social network. Additionally, the study revealed that the pathway has influences through social network types and the economic and social dimensions of sustainable cities ($R^2 = 0.330$). Therefore, this study concluded that sustainable eco-city development should be implemented through community networks and economic and social network development for environmental development through social network types.

Keywords: social network; eco-city; northeastern region; Thailand

1. Introduction

Replicating the previous study, an urban city is a city that respects diversity, and everyone can access benefits, not just any group in the community (Phongsawat, 2019). Since the old-style urban development in the past mainly emphasized a section development and, people in the city could determine the direction of their urban development. Therefore, urban development in the present may need to support people in the city to determine the direction of their urban development (Laothamathat, 2017). The study of Pieterse (2009) stated that the past urban development focused on creating modernity, creating industries, and using technology for development to become a high-income country with a high economic scale to grow into an urban area (Turok and Mcgranahan, 2013). Even with the rapid urban and economic development advantages, there still have been some glitches in the ecosystem and environment in urban areas, causing ecological imbalances and leading to inequality and unstable investment. In this study, the rapid development has caused three main problems (Ekaiam, 2021).

1) Economic problems: when considering the economic development of cities according to the concept of the central place theory, which emphasizes the development of urban areas as economic centers for convenience (Irwin et al., 2009). Similarly, in Western urban development, according to the classical economic concept

that determined cities as the center of employment and attract people to live in the city. These may result in concentration only in urban areas (Pack et al., 2002). However, nowadays, urban cities are expanding to peripheral areas, while the city center area tends to stagnate and enter into economic regression. As a result, the income tax collection in the city area decreased, and more was needed for urban development. The city has no engagement in economic activities that connect, which may result in an imbalance of economics and instability in urban development (Goldstein and Moses, 1973).

2) Social problems: the social problems in urban areas are caused by the urbanization phenomenon due to the increase of population migration into cities, resulting in rural populations moving into cities. This phenomenon has both positive and negative impacts on well-being and employment (Zhang, 2016), especially in developing countries that are affected by rapid urbanization. This phenomenon was not affected only by the immigration riot but also affected the ecological vulnerability of cities (Kritsuthathachiva, 2013).

3) Environmental problems: the urban areas usually come with the extensive needs of people in the cities, for example, the energy demand and the demand for food, which leads to a mass production industry as well as small and large infrastructure development in cities. All of these have affected the surrounding environment and caused the urban environment to be dramatically damaged, such as air pollution, noise pollution, contaminated water quality, garbage and waste problems, crowded communities, flooding problems, and so on (National Geographic, 2021).

The problems entailed the eco-city concept in the late 19th century for solving the problems, which began to play a role in sustainable urban development. In 2011, an eco-city development concept was surveyed in 178 countries worldwide, whether initiated or in the process of launch (Joss et al., 2012). The eco-city is a concept that mentions changing cities to balance economics, society, and the environment for the well-being of the city at present and in the future (Register, 1987). This concept aimed to change the environment in the city to create a balance of waste and increase the amount of oxygen in the city to be suitable for the residents, reduce the impact of unplanned land usage, and create a network of cities in the areas (Global Environment Centre Foundation, 2005).

However, eco-city development is still under debate, and there needs to be a concrete consensus about eco-city development. Thus, the eco-city concept would adopt an actor as theoretical knowledge from urban ecology and sustainable urban development as a prototype model (Chamondusit, 2015). Since the concept had recently developed, it might not be well-known among city administrators or policymakers. It might cause misunderstanding and principle awareness in the ecological city development. Resulted in the eco-city indicators just partial cover for determining eco-city policy (Saad et al., 2017).

Another challenge in this study discovered that the eco-city development is still separated and scattered, resulting in ecological city development in each country or city not being as effective as it should be and not being able to proceed for effective organization. For example, the development of public transportation systems in urban areas is not linked to the residential area (United Nations, 2013). Furthermore, there

was a vital gap in urban development in the past; the infrastructure in the city mainly emphasized governmental management instead of community interaction.

The notion of as Lefebvre (1968), who postulated human rights issues in urban development in 'The Right to the City', stated that everyone in the city, whether the elderly, the disabled, women, housing conditions, and social and cultural conditions, all have the right to determine the direction of the development of that city. Similarly, Harvey (2008) mentioned that urban development needs to authorize and participate the authentic citizen by allowing the city to determine its direction of development, not only for specific planners or administrators. Indeed, the authority for urban development has to understand social relations and the thoughts of people in the city. This is the way to consider that the city has social capital, which is one of the social networks that drive eco-city development (Kanchanaphan, 2015).

Thus, it is significantly reflected that the social network is a driving force in urban development in all three dimensions: economic, social, and environmental dimensions proportionately. The social networks have driven the city forward into eco-city development. However, all sectors still need some help to obtain full authority in working due to a number of limitations. In addition, the eco-city development also needs the stakeholder's network to plan this development together with the local business groups, industrial groups, local administrative organizations, urban experts, academics, and civil society organizations since it is not able to achieve by one organization (Stren et al., 1991). Therefore, it is necessary to investigate the causal relationship path of social networks in eco-city development to create an understanding of balanced urban development in terms of economics, society, and the environment, as well as strengthen the eco-city development definition term to be more concrete and more clearly in the context of Thailand. Researchers will achieve their study goals by doing the following: To investigate the causal pathways of social network factors influencing sustainable eco-city development in the Northeastern region of Thailand.

2. Literature review

2.1. Social network concept

The fundamental concept of social networks originated from the Exchange Theory, which emphasizes the relationships within the network and the structure independent of both behavior and society by considering the relationships and interactions that occur in the network (Wasserman and Faust, 1994). Parallelly, this concept also emphasizes the connections between states and countries, which are the relationships embedded in the key factor conditions hidden in the social network (Freeman, 2004). In the 1970s, sociologists began to examine social network analysis, not only in the general social system but also inspect the social networks in urban areas and social movements, and initiated instruments to analyze social networks in the 1990s (Granovetter, 2007).

Constructing a social network refers to constructing relationships with people in the community or sharing experiences in dealing with problems and helping each other in the network in formal and informal ways. After that, the bonded relationships in the network would entail the member conducting activities together in the network,

exchanging benefits with each other, and receiving benefits together in the network, including providing information and giving advice in the network (Nirathorn, 2000; Pongpit, 2005; Suwanatchariya, 2006; Vanhnahong and Chamaratana, 2018).

Social network construction and social network categorization resulted in the analysis of social networks, i.e., 1) the members role in social networks, 2) the basis of benefit exchange, 3) the direction of the flow of relationships, and 4) the frequency and duration of relationships in developing city into sustainable eco-city (Boissevain, 1979; Boonmak, 2011; Chamaratana, 2017; Freeman, 2004; Wasserman and Faust, 1994). Additionally, the social network type, i.e., 1) networks with common issues, such as the diverse group who has encountered problems related to urban development with various conditions in occupation, age, or even experiences, to collaborate and solve problems together. These relationship networks can be divided into two types—horizontal networks and vertical networks. The horizontal network has equal relationships and vertical networks have unequal relationships within the network that interact with each other in urban development (Nirathorn, 2000; Pongphit, 2005).

Therefore, the concept of social networks aids in understanding the phenomenon of collaboration among diverse groups, encompassing both formal and informal networks. It also provides insight into the development model of eco-cities that emphasizes network-based approaches.

2.2. Eco-city concept

The fundamental concept of eco-city is influenced by the concept of garden city in 1898 in England by Sir Ebenezer Howard, who explicated that the environment of the countryside and the city related to the environment usage by the people (Caves, 2004). In 1987, Richard Register, an influential thinker on eco-city, proposed the eco-city concept on city construction and urban development planning in California. As a result, the city was surrounded by a suitable and friendly environment for the residents, which was equally balanced (Register, 1987).

The eco-city analysis principle can be divided into two principles. The first is the principle of physical analysis, which starts with considering the location, buildings, and transportation to be environmentally friendly and gorgeous in the city. Next is 3R model—Reduce, Recycle, and Reuse, which will have a sequence of essential steps for the eco-city that can be developed (Deesuan, 2014). In addition, it also considers the equality that occurs in the development of eco-city, in which people can access the benefits equally (Dominski, 1992). When considering the physical aspect, creating a gorgeous city may require designing roads, buildings, and transportation to be environmentally friendly (Register, 1987). However, when considering the principles of eco-city analysis, the principles of eco-city can be divided into three main aspects: economic, social, and environmental.

The components of eco-city indicators were divided into three components according to the theory: 1) Economic component, considering income, expenditure, employment, GDP per capita, GDP of the city, investment in real estate, investment in urban areas, construction of safe and secure housing, and economic stability of the city. 2) Social component, considering population density, literacy, education access, quality of education, health care access, livability community, social justice, member's

participation, environmentally friendly activity, good neighbors, welfare access, continuation of traditions and culture, the in-charged members have a good knowledge and ability, good governance, well-defined development plans and policies, and urban development mechanisms. 3) Environmental component, considering low carbon emissions, waste and garbage management, drain water discharge, drain water treatment, greenhouse gas emission reduction, green spaces, wetlands, cycling areas, increased pedestrian access, public transport access, water availability, renewable energy use (hydro, wind, solar), green buildings and city size (Caprotti and Gong, 2017; Cugurullo, 2015; Flynn et al., 2016; Grey, 2019; Lijuan et al., 2011; Saad et al., 2017; Wang et al., 2015).

Consequently, the concept of eco-city focuses on developing urban areas that maintain a balance between economic, social, and environmental dimensions. This approach aims to ensure that city residents can live fulfilling lives with equitable access to urban resources, while also fostering the creation of environmentally friendly cities (**Figure 1**).
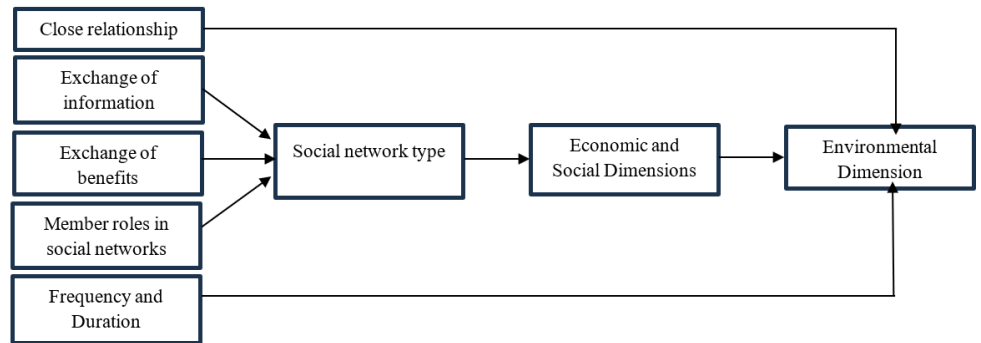

Figure 1. The conceptual framework.

3. Materials and methods

3.1. Research design

This study collected data at the individual level as a research unit of analysis from the participants in Khon Kaen and Udon Thani provinces.

This article employed the cluster sampling method by gathering all the major cities in the northeastern region, dividing the groups into major cities, and selecting two cities, Khon, Kaen, and Udon Thani. Thus, the population in this study consisted of participants in Khon Kaen, which has a total population of 119,240 people, while Udon Thani has a total population of 130,531. After that, the researcher combined the population of both cities to get a total population of 249,771.

The sample size in this study was calculated using the equation of Krejcie and Morgan with a 95 percent confidence level with a total population of 249,771 people from Khon Kaen Municipality and Udon Thani Municipality (Krejcie and Morgan, 1970; Neuman, 1994; Wachararat, 2009). The number of samples used for data collection can be calculated using the following equation:

$$n = \frac{x^2 \mathrm{N}p(1-p)}{e^2(N-1) + \mathrm{x}^2 p(1-p)}$$

where: n = The Selected samples,

p = The Probability of Occurrence = 0.5,

N = The Total population,

X^2 = Chi-square value = 3.841,

e = Maximum Permissible Error = 0.05/0.01.

Substitute into the equation.

$$n = \frac{3.841(249{,}771)(0.5)(1 - 0.5)}{0.05(0.05)(249{,}771 - 1) + 3.841(0.5)(1 - 0.5)}$$

where: n = 239,842.602/625.385,

n = 383.51.

Therefore, the researcher determined the sample size to be 383.

In sampling design, the researcher employed accidental sampling because data collection in urban areas has time constraints for interviews. Thus, accidental sampling was employed in order to obtain a sample group that is representative of the research population as best as possible.

The study was conducted at Khon Kaen Municipality and Udon Thani Municipality, which were pushed by drive forces to the rapid urban development by the eco-city development concept (**Figure 2**).
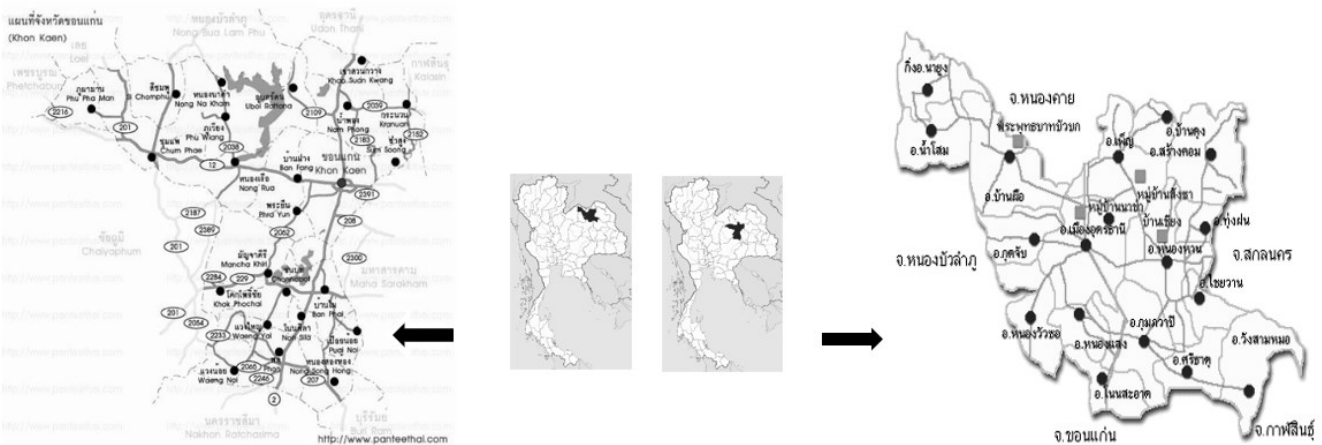

Figure 2. The study areas in Khon Kaen city and Udon Thani city.

The study was conducted in the communities as were: 1) Khon Kaen Municipality, consisted of Thepharak Community V, Lak Muang community, Mittraphap community, Lao Nadi Community XII, Ba Kham community, Sri Than community I, Non Nong Wat community I, Non Nong Wat community IV, 2) Udon Thani Municipality consisted of Khlong Charoen I community, Khlong Charoen II community, Thor 6th Nonniwet community, Nong Tao Lek community, Pho Thong community, Srichomchuen II community, Phothiwara Ram community, and Phothisom Phon community **(Table 1)**.

Table 1. Number of sample groups categorized by community area.

No	Khon Kaen		Udon Thani	
	Community	**Amount**	**Community**	**Amount**
1	Theparak V	23	Khlong Charoen I	27
2	Lak Muang	33	Khlong Charoen II	21
3	Mittraphap	39	Thor 6th Nonniwet	27
4	Lao Nadi XII	24	Phosom Phon	26
5	Kham	22	Nong Tao Lek	28
6	Srithan I	8	Pho Thong	28
7	Non Nong Wat I	12	Srichomchuen II	22
8	Non Nong Wat IV	22	Phothiwara Ram	21
	Total	183	Total	200

3.2. Variables and variable measurement levels

Variables and variable measurement levels. The social network variables consisted of close relationships, shared experiences, activities in the network, exchanging information, exchanging benefits in the network, roles of members in the social network, basics of benefit exchange, directions of relationship flow, frequency and duration of relationships. These variables were measured as an interval scale according to the rating scale, five levels, i.e., the least, little, moderate, very, and the most, with the length numbers from 1 to 5, respectively.

The social network variable consisted of social networks which shared common issues with relationship structures, which were measured as an interval scale according to the rating scale, five levels, i.e., the least, little, moderate, very, and the most, with the length numbers from 1 to 5 respectively.

The eco-city in economic dimension and social dimensions consisted of twenty-six (26) indicators, which were measured as an interval scale according to the rating scale, five levels, i.e., the least, little, moderate, very, and the most, with the length numbers from 1 to 5 respectively.

The eco-city environmental variable consisted of sixteen (15), measured as an interval scale according to the rating scale, five levels, i.e., the least, little, moderate, very, and the most, with the length numbers from 1 to 5, respectively.

The research instrument in this study was the Interview Schedule, which is divided into five main parts, consisted of Part 1. General information of the interview respondents, i.e., gender, age, main occupation, number of household members, monthly income. Part 2, the Process of constructing the social networks and types of social networks, consisted of close relationships, shared experiences, activities in the network, exchanging information, and exchanging benefits. The social network type consisted of networks that shared common issues with relationship structures. Next is Part 3: Social network analysis consisted of members' roles in the social network, basics of benefit exchange, directions relationship flow, frequency and duration of relationships. Lastly, Part 4: Eco-city components and indicators include economic, social, and environmental aspects with Part 5: Additional suggestions.

The interview Schedule was reviewed by three experts to assess its validity, utilizing the Index of Item Objective Congruence (IOC). Subsequently, a field data collection was conducted to pre-test the interview in Nakhon Ratchasima, Thailand, a location that is not part of the research target group, covering 30% of the total target population. The collected data were then used to measure the reliability of the interview, ensuring the consistency of the information. The reliability assessment yielded a Cronbach's alpha score of 0.977.

3.3. Data analysis

The data analysis employed a univariate level in this study. The researcher analyzed the characteristics of the sample group using descriptive statistics, such as frequency, percentage, mean, standard deviation, maximum value, and minimum value, analyzed in the SPSS program. Next, in the multivariate analysis, the researcher employed Path analysis with the principles of Multiple linear Regression analysis by starting with Correlation analysis to screen all variables obtained from reviewing concepts and theories involved in the research in order to prevent Multicollinearity in a relationship between variables at the level of 0.70–0.80 (Berry and Feldman,1985). Then, analyze the influence of the path analysis with additional conditions as were: 1) The model shows the influence of all related variables affecting all dependent variables, or in other words, the whole model was closed, 2) The prior ordering of variables is according to the theory specified or explained. The independent variables have occurred before the dependent variables, 3) The variable measurement was reliable and highly accurate, with no deviation in measurement, 4) The error of each variable was independent, and after that, constructing a route model using the SPSS program as a data analysis program to achieve a sustainable eco-city development model.

4. Results and discussion

4.1. General information

For general information on the respondents in the study, the results indicated that Udon Thani was counted at 52.2 percent, and Khon Kaen was counted at 47.8 percent of the respondents. Regarding gender, it was found that 72.1 percent were female and 27.9 percent were male. For age, the average age was 53.9 years, with the youngest being 18 years old and the oldest being 96. Regarding occupation, it was found that other (elderly, unemployed) was the most, counted for 31.1 percent, followed by occupation, private business owner/trader, and independent occupations counted for the same percentage of 21.1 percent, and daily contract occupations counted for 11.7 percent. In the household members, it was found that the average household members were 4 people, the least was 1 person, and the largest number was 11 people. In terms of monthly income, it was found that the average income was 22,232.1. Thai baht per month, whereas the highest income is 80,000 baht monthly.

4.2. Social network factors

Social network factors are divided into three main aspects with 11 variables. In the process of constructing social networks, it was found that the exchange of benefits in the network obtained the highest mean with 4.39, followed by exchanging information, creating relationship activities in the network, having joint experiences, and close relationships, with the averages means as were 4.19, 3.55, 3.52, and 3.32, respectively.

In the types of social networks, it was found that social networks share common issues and obtained the highest mean of 3.88, followed by social networks in the type of relationship structure, which obtained an average mean of 3.61.

In the relationships within the social network, it was found that the basis for the exchange of benefits obtained the highest mean of 3.86, followed by the role of members in the social network, the direction of the relationship flow, and the frequency and duration of relationships, with the averages means as were 3.41, 3.01, and 2.99, respectively (**Table 2**).

Table 2. The value of mean, standard deviation, and sequence of social networks.

Social Network Construction	Mean	SD.	Rank
X1 Close relationship	3.32	0.64	5
X2 Shared experience	3.52	1.02	4
X3 The activities in the network	3.55	0.72	3
X4 Exchange of information	4.19	0.68	2
X5 Exchange of benefits in the network	4.39	0.67	1
Social network type	Mean	SD.	Rank
X6 Social networks share common issues.	3.88	0.55	1
X7 Social networks in relationship structures	3.61	0.57	2
Relationships within social networks	Mean	SD.	Rank
X8 Member roles in social networks	3.41	0.54	2
X9 Basics of Beneficial Exchange	3.86	0.77	1
X10 Relationship Flow Direction	3.01	0.73	3
X11 Frequency and Duration of relationships	2.99	0.66	4

4.3. The eco-city in economic dimension

The indicators for the eco-city in economic dimensions consisted of 9 indicators, which revealed that the construction of housing is safe and stable obtained the highest average of 3.48, followed by investment in urban areas obtained 3.33, the city's gross product (GPP) obtained 3.27, real estate investment obtained 3.07, the city's economic stability obtained 3.04, employment obtained 2.94, gross product per capita (GDP) obtained 2.92, income of people in the city obtained 2.83. The expenditure of people in the city was 2.69 (**Table 3**).

Table 3. The value of mean, standard deviation, and sequence of the eco-city indicator in economic dimension.

Economic dimension	Mean	SD.	Rank
y1.1 Economic stability of the city	3.04	0.92	5
y1.2 Income of people in the city	2.83	0.92	8
y1.3 Expenses of people in the city	2.69	0.88	9
y1.4 Employment	2.94	1.04	6
y1.5 Gross product per capita (GDP)	2.92	1.00	7
y1.6 Gross city product (GPP)	3.27	0.98	3
y1.7 Real estate investment	3.07	1.02	4
y1.8 Investment in urban areas	3.33	0.98	2
y1.9 Building safe and secure housing.	3.48	1.01	1
Total	3.06	0.69	

4.4. The eco-city in social dimension

Table 4. The value of mean, standard deviation, and sequence of the eco-city indicator in social dimension.

Social dimension	Mean	SD.	Rank
y2.1 Population density	3.30	0.93	14
y2.2 Literacy	3.60	0.91	12
y2.3 Student access to education	3.78	0.92	9
y2.4 Improving the quality of education	3.55	1.07	13
y2.5 Access to the health system	4.06	0.90	1
y2.6 Nice community	3.90	0.88	5
y2.7 Justice in society	3.78	0.93	9
y2.8 People's participation	3.91	0.92	4
y2.9 Activities to promote environmental friendliness	3.79	1.01	8
y2.10 Good neighbor	3.85	0.79	6
y2.11 Good community leader	4.05	0.93	2
y2.12 People have access to welfare.	3.64	1.06	11
y2.13 Continuing cultural traditions	3.97	0.97	3
y2.14 Personnel have knowledge and abilities.	3.85	0.85	6
y2.15 Good governance	3.80	0.84	7
y2.16 Well-defined development plan and policy.	3.78	0.85	9
y2.17 Urban development mechanisms	3.70	0.86	10
Total	3.78	0.64	

The indicators for the eco-city in social dimensions, consisted of 17 indicators, which revealed that 1) Access to the health system obtained the highest average of 4.06, followed by 2) Good community leaders obtained 4.05, 3) Continuing cultural traditions obtained 3.97, 4) People's participation obtained 3.91, 5) Nice community obtained 3.90, 6) Good neighbors obtained 3.85 and Personnel have knowledge and ability obtained 3.85, 7) Good supervision obtained 3.80, 8) Activities to promote

environmental friendliness obtained 3.79, 9) Student access to education and Justice in society and Well-defined development plan and policy obtained 3.78, 10) Urban development mechanisms obtained 3.70, 11) People have access to welfare obtained 3.64, 12) literacy obtained 3.60, 13) Improving the quality of education obtained 3.55, and 14) Population density obtained 3.30 (**Table 4**).

4.5. The eco-city in environmental dimension

The indicators for the eco-city in social dimensions consisted of 15 indicators, which revealed that 1) Comprehensive public transportation obtained 3.85, followed by 2) Garbage and waste management obtained 3.80, 3) size of the city obtained 3.58, 4) Green space obtained 3.29, 5) Pedestrian walkways obtained 3.15, 6) Sufficient water quantity obtained 3.14, 7) Technology and Science obtained 3.11, 8) Green buildings obtained 3.02, 9) Wastewater discharge obtained 2.96, 10) Wetlands and cycling areas obtained 2.92, 11) Wastewater treatment obtained 2.87, 12) Renewable energy usage (water , wind , solar) obtained 2.79, 13) Low carbon emissions obtained 2.56 and reduce greenhouse gas emissions obtained 2.53 (**Table 5**).

Table 5. The value of mean, standard deviation, and sequence of the eco-city indicator in environmental dimension.

Environmental dimension	Mean	SD.	Rank
y3.1 Low carbon emissions	2.56	1.12	13
y3.2 Garbage and waste management	3.80	1.06	2
y3.3 Wastewater discharge volume	2.96	1.27	9
y3.4 Wastewater treatment	2.87	1.27	11
y3.5 Reduce greenhouse gas emissions	2.53	1.19	14
y3.6 Green area	3.29	1.23	4
y3.7 Wetlands	2.92	1.34	10
y3.8 Cycling area	2.92	1.28	10
y3.9 Pedestrian walkways	3.15	1.21	5
y3.10 Universal public transportation	3.85	0.79	1
y3.11 Adequate amount of water	3.14	1.31	6
y3.12 Using renewable energy (water, wind, solar)	2.79	1.25	12
y3.13 Green building	3.02	1.20	8
y3.14 Technology and Science	3.11	1.13	7
y3.15 Size of city	3.58	1.01	3
Total	3.10	0.86	

4.6. Analysis of correlation coefficients in variables

The analysis of the correlation coefficient between 11 independent variables and 3 dependent variables to examine the problem of the relationship in all variables with Multi-collinearity Diagnosis at the level of 0.70–0.80, consisted of (X1) close relationship, (X2) shared experience, (X3) activities in the network, (X4) information exchange, (X5) exchange of benefits in the network, (X6) role of members in the social network, (X7) basis of exchange of benefits, (X8) direction of relationship flow, (X9)

frequency and duration of relationship, (X10) type of social network, (Y1) economic and social dimensions, (Y2) environmental dimensions. When analyzing the correlation coefficient all variables, it was found that the highest internal correlation coefficient was 0.574, resulted in there were no Multi-collinearity condition. Therefore, it can be concluded that the variables used for analysis are appropriate and can analyze the causal path of factors affecting the sustainable development of eco-cities in the Northeast (**Table 6**).

Table 6. The analysis of correlation coefficients in variables.

Variable	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	Y1	Y2
X1	1											
X2	0.089	1										
X3	0.071	−0.088	1									
X4	0.027	−0.016	0.282**	1								
X5	0.141**	0.008	0.131*	0.281**	1							
X6	−0.024	−0.037	0.113*	0.031	0.178**	1						
X7	0.209**	0.017	0.146**	0.252**	0.393**	0.113*	1					
X8	−0.039	0.023	0.116*	0.089	−0.047	−0.044	0.046	1				
X9	0.034	0.057	−0.001	−0.135**	−0.046	0.031	0.001	0.105*	1			
X10	0.08	0.041	0.135**	0.263**	0.321**	0.200**	0.237**	0.041	−0.078	1		
Y1	0.001	0.161**	0.098	0.085	0.167**	0.085	0.08	0.052	0.127*	0.124*	1	
Y2	−0.097	0.110*	−0.082	−0.053	−0.121*	−0.036	−0.083	−0.008	0.086	−0.071	0.574**	1

* Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

4.7. The causal path analysis of factors influencing sustainable eco-city development in the northeast of Thailand

For the analysis of causal paths of factors that influence the sustainable development of eco-city in the Northeast and indirect influences through types of social networks and eco-city in economic and social dimensions. The results of the causal path analysis of factors influencing social network types found that (X4) Information exchange was a positive correlation path with social network type and obtained statistical significance at the 0.05 level with standard path coefficient (Beta = 0.158). The (X5) Exchange of benefits in the network was a positive correlation path with social network type and obtained statistical significance at the 0.05 level with standard path coefficient (Beta = 0.206). The (X6) Social network member role was a positive relationship with social network type at the 0.05 level and obtained statistical significance at the 0.05 level with a standard path coefficient (Beta = 0.151) (**Table 7**).

Table 7. The causal path analysis of factors influencing social network types.

Social network variables	social network types.		
	b	Beta	Sig
X1 Close relationship	0.020	0.029	0.550
X2 Shared experience	0.021	0.049	0.305
X3 Activities in the network	0.018	0.031	0.536
X4 Exchange of information	0.100	0.158	0.003*
X5 Exchange of benefits in the network	0.133	0.206	0.001*
X6 Member roles in social networks	0.120	0.151	0.002*
X7 Basics of Beneficial Exchange	0.048	0.086	0.106
X8 Direction of relationship flow	0.025	0.042	0.380
X9 Frequency and Duration of relationships	−0.039	−0.060	0.211

For the causal path analysis results of the factors influencing the environmental dimension of eco-city, it was found that (X1) Close relationship was a negative relationship path with the environmental dimension of eco-city with statistical significance at the 0.05 level with a standardized path coefficient (Beta = −0.090). The (X9) Frequency and time of relationship was a positive relationship path with the environmental dimension of eco-city with statistical significance at the 0.05 level with a standardized path coefficient (Beta = 0.082), and The (Y1) Economic and Social dimension of eco-city was a positive relationship path with the Environmental dimension of eco-city with statistical significance at the 0.05 level with a standardized path coefficient (Beta = 0.574). When considering the intervening variable the (X10) Type of social network, it has an influenced on the (Y1) Economic and social dimension of eco-city and has a positive relationship path with the environmental dimension of the eco-city with statistical significance at the 0.05 level with a standardized path coefficient (Beta = 0.124) (**Table 8**).

Table 8. The causal path analysis of factors influencing the eco-city in environmental dimension.

Social network variables	the eco−city in environmental dimension		
	b	Beta	Sig
X1 Close relationship	−0.122	−0.090	0.031*
X2 Shared experience	0.093	0.111	0.357
X3 Activities in the network	−0.059	−0.050	0.846
X4 Exchange of information	0.014	0.011	0.109
X5 Exchange of benefits in the network	−0.117	−0.092	0.802
X6 Member roles in social networks	−0.021	−0.013	0.685
X7 Basics of Beneficial Exchange	−0.026	−0.023	0.670
X8 Direction of relationship flow	−0.026	−0.022	0.112
X9 Frequency and Duration of relationships	0.107	0.082	0.031*
X10 Social network type	0.167	0.124	0.015*
Dependent variable	the eco-city in environmental dimension		
Y1 Eco−city, economic and social dimensions	0.848	0.574	0.001*

[$R = 0574$, $R^2 = 0.330$, $F = 187.54$, Sig of $F = 0.000$].

For the causal path analysis of the factors influencing the sustainable development of eco-city in the Northeast and indirectly through the types of social networks and eco-city in the economic and social dimensions, the study results were as follows.

The 1st causal path, direct influence, consisted of close relationships, and the frequency and timing of relationships which reflected through the variation of sustainable development of eco-city in the Northeast.

The 2nd causal path, indirect influence, consisted of information exchange, exchange of benefits in the network, and the roles of members in the social network, with the influence path through the types of social networks and through eco-city in the economic and social dimensions, which reflected through the variation of sustainable development of eco-city in the Northeast by 33 percent ($R^2 = 0.330$) (**Table 9**).

Table 9. The causal path analysis of factors influencing sustainable eco-city development in the northeastern region.

Variables	Direct Effect; DE	Indirect Effect; IE	Total Effect; TE
X1 Close relationship	0.090		0.090
X4 Exchange of information		$(0.158 \times 0.124 \times 0.574) = 0.011$	0.011
X5 Exchange of benefits in the network		$(0.206 \times 0.124 \times 0.574) = 0.014$	0.014
X6 Member roles in social networks		$(0.151 \times 0.124 \times 0.574) = 0.010$	0.010
X9 Frequency and duration of relationships	0.082		0.082
X10 Social network type		$(0.124 \times 0.574) = 0.071$	0.071
Y1 Eco−city, economic and social dimensions	0.574		0.574

This research clearly indicates that indicators for the eco-city, such as "access to the health system" in the social dimension and "comprehensive public transportation" in the environmental dimension. These indicators are essential as they reflect the community's priorities and the effectiveness of eco-city initiatives. And the analysis shows that the economic and social dimensions of the eco-city have the strongest positive influence on the environmental dimension. Also, indirect factors such as information exchange and social network type contribute to sustainable eco−city development, which highlights the importance of social networks in driving sustainable outcomes.

5. Discussion

In aspect of social network, the results revealed that the roles of members in social networks, information exchange, and benefits exchange in networks were some of the factors that influence the sustainable development of eco-city in the Northeast of Thailand, which is consistent with Harvey (2008) study, who provide the aspect of the urban development requires full and authentic participation and an understanding of social relationships in the form of networks, allowing people to have the right to fully determine the city to what they desire, not just the planners or city administrators. In addition, this study is consistent with Kanchanaphan (2015) study, which viewed that if a city has social capital, which is a social network, it would create a network of the city and help to develop an eco-city. Nonetheless, this study also found some

differences from Granovetter's (1973) study, which studied social networks in the issue of The Strength of Weak Ties, which explained that an over-powerful social network would prevent other network members from accessing and exchanging important information. However, if the social network is not too strong, information may be exchanged and accessed, such as people who know each other from social gatherings as a point. Therefore, constructing a social network does not necessarily need only an exchange of benefits.

In the aspect of eco-city development in economic and social dimensions, the results indicated that to develop an eco-city sustainably, it tends to begin from the construction of social networks and pass on to the development of the city in economic and social dimensions. These two dimensions must develop first, and then, after the economy and society in the city have improved, further development in environmental aspects will follow. However, this conclusion differed from Register (1987), who proposed the development of an eco-city using the principles of a good governance city, a city of beauty, and a city of equality by developing the city to achieve balance in economic, social, and environmental dimensions.

6. Suggestions

The research results indicate that 1) Information exchange, network benefits exchange, and members' roles in social networks influenced the sustainable development of eco-city in the Northeast. Therefore, local administrative organizations and governments, such as the Office of Social Development and Human Security and the Community Development Office, may need priority to support the construction of community networks to strengthen the networks for further ecological development.

The results indicate that 2) Sustainable eco-city development must begin with the economic development of people in the city first for the good quality of life of the people in the city. These would entail the development of the environment in the city area and a sustainable eco-city. Therefore, local administrative organizations, the Provincial Chamber of Commerce, and the Provincial Industry may need support investment by the government and private sectors in the city to create economic activities that generate income and employment in all sectors to have increased income monetary stability in the city.

The research findings indicate that 3) Each country can adopt an approach that integrates economic and social development with the establishment of networks. Therefore, eco−city development policies should prioritize economic and social development as the initial focus by building and strengthening social networks as a foundation to support the city's economic and social progress. Subsequently, environmental development should follow. This approach aligns with the diverse cultural and economic contexts found across Asia.

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