Mono - Economy and Urban Vulnerability:
A Case Study of Pak Phanang Municipality in Nakhon Si Thammarat Province

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ABSTRACT

This paper examines the relationship between mono-economic growth and urban sensitivity. The selected case study is the Pak Phanang Municipality of Nakhon Si Thammarat Province, which has a mono-economy of bird's-nest businesses as its main economic base. The research methodology was divided into three parts. Part 1 includes the study of changing urban morphology caused by the growth of the mono-economy and the evaluation of urban decline from decentralization according to the theory of spatial centrality. Part 2 studies the distribution patterns of spatial and social sensitivity, using quantitative research and an indicator-based approach from the Social Vulnerability Index. Part 3 determines the relationship between economic, social, and spatial sensitivities together with the concentration of the mono-economy by applying an overlay technique. The study indicated that the growth of the mono-economy from bird's nest businesses in the city center caused urban decline due to two significant factors: (1) Changing urban morphology — the city was not able to attract employment and various economic activities, which accelerated the migration of the population; (2) Changes in the socio-economic structure of the city center — as seen in the socio-economic sensitivity index — it was found that the city center had a high concentration of bird's nest businesses which was greater than other urban areas. Therefore, the results determine that the growth of the mono-economy was the root cause of urban decline and an increased urban sensitivity. One potential suggestion is to strengthen the economic base of the city and create a variety of urban conditions to solve the root problems and help decrease urban vulnerability.

Keywords: mono-economy, socio-economic sensitivity, urban decline, urban vulnerability, social vulnerability index

INTRODUCTION

Urbanization is a moving process with complex dynamics that is progressing at all levels, places, and times. The complexity of urban systems evolves through several different processes depending on the dynamic interactions in the city between humans, ecology, economy, and society that may result in the growth or decline of the city. Therefore, urban planning must be able to handle the dynamics of urban change. The city that is unable to adapt itself to changed dynamics will cause a socio-economic imbalance, leading to the loss of urban variety and urban decline.

The key factor for maintaining socio-economic balance is the diversity of urban conditions consisting of the following components: an appropriate urban morphology that is essential for a modern lifestyle, focusing on concentrations of activities and people, as well as the centers that attract resources, knowledge, and innovation. A variety of urban conditions creates an urban lifestyle and contains a significant density of economic activities, people, society, and culture. Therefore, diversity is a gauge to measure urbanism (Wirth, 1938) consistent with Jane Jacobs who supports the concept of creating a diversity of urbanization as stated in "Diversity is natural to big cities." Diversity is a combination of usable buildings, social activities and time spent on local roads. Consequently, the city needs a large enough population to support the diversity that key to urban quality (Jacobs, 1961).

Nowadays, the concept of urban resilience focuses on interactions of urban systems such as environments, economic activities, people, and usable buildings and infrastructure. The city is recognized as a complex ecological system and its diversity is an important characteristic that helps it to cope and adapt to negative situations. Therefore, urban diversity is considered to be a key factor in strengthening urban resilience and increasing a city's ability to adapt and respond to changes. (Tyler & Moench, 2012)

As stated by Ernstson et al., the city with a diverse population encourages self-organizing behavior at a very high level which has typically resulted in new innovation, encouraged urban resilience and increased adaptability to negative situations (Ernstson et al., 2010).

The key concept of creating urban diversity is the economic base theory. Employment in the basic sector is a main economic activity that provides external income to the city; in other words, it generates income from exportation due to external demand that creates employment in the non-basic sector (Chan, 2001). The economic base is easily influenced by changes in physical and socio-economic structure leading to an urban dynamic that is able to attract people and concentrate economic activity and employment in both the basic and non-basic sectors. It creates urban diversity that enhances social networks, promotes the development of innovation, and adapts to negative situations (Martin-Breen & Anderies, 2011).

On the contrary, the economic base of the city that focuses only on external demand and ignores internal demand will not be able to provide employment in either the basic or non-basic sectors (as stated in this study as "Mono Economy"). It destroys a city's ability to attract economic activity and employment opportunities, which causes the migration of the working-age population and leads to urban decline. Urban decline, for cities that tend to lose long-term residents, causes a surplus of infrastructure resulting in rising urban costs while decreasing the efficient use of resources. This negative dynamic is known as urban shrinkage (Beauregard, 1993). Urban decline results in an accumulation of negative externalities such as a loss of culture and social capital, a loss of infrastructural value, a weak economic structure, unemployment, a migration of skilled working–age populations, unoccupied properties, increased poverty, an increase in the number of dependent elderly people and children, a reduction in tax revenue (with increasing social security costs), and an unwillingness to invest. It creates a regression that leads to a loss of urban lifestyle (Laursen, 2008). Furthermore, urban decline causes significant structural changes, both spatially and socio-economically, that can influence a city's ability to cope, absorb distractions, organize itself, and adapt to negative situations that indicate urban vulnerability (Eraydin, 2013).

As stated previously, it leads to the idea that "The growth of the mono-economy will not create employment in either the basic or non-basic sector. It is the root cause of urban decline resulting from physical and socio-economic imbalance, and it

causes an accumulation of negative impacts that will increase urban sensitivity to external exposures." The primary research question is "How does the growth of the mono-economy relate to urban vulnerability?"

From this research question, the selected case study is the Pak Phanang municipality of Nakhon Si Thammarat province. The Pak Phanang municipality has seen urban decline from the growth of bird's nest businesses, which are currently considered to be an urban economic base, and it is characterized as a mono-economy. According to an assessment of the income of entrepreneurs and the amount of building area for nesting birds in Pak Phanang city (not less than 300,000 square meters), the bird's nest business has become the basic sector of the city. The growth of the bird's nest businesses results from its uniqueness. Since a bird's nest is a natural and incomparable product, there is no available substitute. This results in higher-priced bird's nests. For that reason, the growth of bird's nest businesses is not dependent on the local economy and focuses on producing for exportation. Therefore, the bird's nest businesses, which compose the basic sector of the city, have generated local economic activities and employment, also known as the non-basic sector.

The growth of bird's nest businesses in Pak Phanang city has caused a decline in the population especially since the growth of the industry in 1997. Census data from the National Statistical Office of Thailand reveals that the population has migrated rather than immigrated. Furthermore, the working-age population has decreased while the elderly dependent population has increased. This clearly indicates the decline of Pak Phanang city. This study establishes Pak Phanang city as a "typical case" because of its clear boundaries.

The purpose of this study is to answer the theoretical question about urban sensitivity that results from the growth of the mono-economy, the increased understanding and awareness of the importance of the city in controlling and adapting itself to the mono-economic base, and the causes of the socio-economic imbalance in the internal systems of the city. Urban sensitivity is considered the root cause of an accumulation of negative impacts, leading to urban vulnerability and a risk of negative side effects. Furthermore, the result of this study will be able to continue the theoretical knowledge of urban planning and lead to the determination of policy and planning to create a city with an appropriate economic base that encourages positive dynamics, reduces urban vulnerability, and strengthens long-term urban resilience.

LITERATURE REVIEW

1. The Vulnerability Theory

1.1 The Progression of Vulnerability

Blaikie, Cannon, Davis, & Wisner (2004) explain the progression of vulnerability and classified it into three levels as follows:

- **Level 1: The root causes** of vulnerability are embedded in ideologies that determine the level of access to power and resources, revealing social issues such as economic inequality, social stratification, and the distribution of environmental justice etc.; The marginalized groups in society are being more affected by disaster than other social groups.

- **Level 2: Dynamic pressures** are the factors that have a major influence in determining the socio-economic sensitivity of a population, including income, gender roles, political power, ability to access to resources, education levels, household structure, employment, etc. The dynamic pressure represents a "structural constraint." As time goes by, the structural constraints may lead to unsafe conditions.

- **Level 3 Unsafe conditions** visualize the external hazard exposure; for instance, settlement in environments with substandard infrastructure. In addition, unsafe conditions are the result of discrimination of certain groups, resulting in disparities of resource distribution to address hazard exposure caused by disasters, which is a spatial inequality that leads to increased urban vulnerability.

The definition of "vulnerability" varies according to the specific purpose and context of the study (Fekete & Brach, 2010). The specific context can be classified into different types of impacts, both internal and external, such as natural disasters, social conflicts, and economic change. Furthermore, it relates to spatial and time contexts known as "place-based approaches" (Cutter, 1996). In addition, Birkmann and Birkmann (2006) describe the characteristics of vulnerability, which are based on spatial and time contexts and depend on the size of the analysis, such as person, households, and cities, or on specific types of vulnerability (i.e. physical, economic, social, and institutional vulnerability). Also, vulnerability is dynamic and it constantly changes due to internal and external pressures. (Birkmann & Birkmann, 2006)

1.2 The Definition and Structure of Vulnerability

There are different definitions of vulnerability in every field with no universal consensus. According to the study of theoretical development of vulnerability in each field, we can provide a general understanding of the vulnerability concept that can be define as follows:

- **Risk-Hazard**: Vulnerability is identified as the opportunities for loss or other negative effects from the interaction between hazard exposure and the sensitivity of a population. It affects risks and opportunities of physical impact and social economics. For that reason, Risk-hazard considers vulnerability to be a product of risk hazard at a certain time. Disasters are important for analysis purposes by focusing on the spatial distribution of risk, the physical components that are present, and the most sensitive groups of people in areas that are exposed to hazards. (Eakin & Luers, 2006)

- **Social-Ecological Systems**: Vulnerability is determined by the level of sensitivity of social-ecological systems as well as their adaptive capacity. It is an important component that is embedded in the social-ecological systems. Therefore, in term of social-ecological systems, vulnerability is not always considered to be a negative characteristic. If a system is able to enhance its adaptive ability, it will establish learning processes from those vulnerable situations. This creates innovation that helps the system increase its coping ability, resolve unexpected situations, recover, reorganize, and maintain itself without losing its original identity. This includes being able to move to a new system when the existing system becomes unstable (Folke, 2006).

- **Political Economy**: Sensitivity has root causes in several areas which are economic, social, political, and institutional imbalances. These influence the determination of socio-economic sensitivity of a population and indicate inequality, rights, and accessibility to capital while facing a hazard. Moreover, sensitivity indicates the level of hazard exposure for distinct social groups. (Blaikie et al., 2004)

Vulnerability can also be defined in an educational context as follows:

Cutter (1996) states that the susceptibility of large societies together with political, economic, and institutional capabilities has affected social opportunities and the sensitivity to loss or hazard that creates interaction between society, politics, and the biophysical environment. (Cutter, 1996)

- Alexander (2002) states that the sensitivity of people and their characteristics indicate the potential for loss from hazards in a certain time and place. (Alexander, 2002)

- Adger (2006) indicates that the status of systems with internal sensitivity and more exposure to hazards is determined by an inability to adapt themselves to change or unexpected situations. (Adger, 2006)

- Fekete (2009) argues that sensitivity or incompetence affect hazard exposure. Combining vulnerability with hazard can be illustrated in the following function: 'risk = f (vulnerability, hazard)'. (Fekete, 2009)

- Blaikie et al. (2014) states that the status of people who are exposed to hazards, caused by the vulnerability of physical structure, economy, and society, can influence their ability to anticipate, respond, resist, and recover from natural disasters. (Blaikie et al., 2014)

Therefore, these statements can be used to create a mutual definition. Birkmann (2006) identifies the main components of vulnerability as follows:

- **Hazard Exposure** organizes the internal characteristics of areas by hazard and by their potential to prevent those hazards. This includes exposure to natural disasters, climate change, globalization, etc. which is considered to be an external hazard, and economic changes to a community or city and income inequality caused by institutional weakness, which are considered internal hazards.

- **Sensitivity** is a characteristic or component of susceptibility that exposes negative impacts or hazards. These characteristics can be differentiated by unit of analysis such as individuals, communities, societies, institutions etc.

- **Adaptive Capacity** is a positive characteristic that is embedded in components or systems

Table 1: The factors of social vulnerability (Cutter et al. 2003)

Factors of Social Vulnerability	Indicators	Rationales
1) Security	1.1) Education	An education is linked to economic-social status. People with higher educational degree have more opportunities in earning income and higher career options.
	1.2) Housing ownership	The tenants tend to lack for the right to be helped after the disaster and ownership in their own properties, resulting in a small investment in residential development. The rental habitats are often deteriorated due to lack of maintenance from tenants.
	1.3) Accessibility to Funding Sources	The Accessibility to funding sources and welfares affect the stability of life, influence the absorptive capability and increase flexibility to encounter with negative effects.
	1.4) Infrastructure	The readiness of infrastructures affects the hazard exposure and duration spending with disasters.
2) Economic	2.1) Income	Income is economic capital. Those who earn high income tend to have more living option than low income people.
	2.2) Profession and Employment	Professions always correlate with economic-social status of people. The security in profession enhances the constant income and readiness to confront and recover from disasters.
3) Social	3.1) Age	Age determined the level of responsibilities to job and employment. It demonstrates roles to develop family and society including to be key person for taking care of children and elderly people.
	3.2) Gender	Gender links to physical performance in which females are less strong. In addition, females are usually the primary person that is responsible for looking after of household members.
	3.3) Household Structure	Household structure is related to the number of members, gender and age that indicate the responsibility for each member of the head of household. Therefore, the households with a number of dependent members are affected and limited the opportunity to develop other aspects of households.
	3.4) Social dependent	The dependent population affects the development and economic growth of household-level and urban-level that involves the provision of necessary social welfare providing by the government.
	3.5) Dependent Population	Population with specific needs, such as differently abled people, patients etc., has problem with protecting themselves and limited capacity to handle with negative situation. It also includes the disadvantaged such as homeless people who are often ignored during disasters.
	3.6) Ethnicity	Language and culture hinder communication during disasters and affect the accessibility to funding sources after disasters.
	3.7) Social Networks	Social Networks relate to interpersonal relationships affecting the information perception. Moreover, it affects political power and participation in decision-making process of government projects that has impacts on response and recovery after disasters.

that are exposed to hazards. It includes coping ability, responsiveness, self-organization, and an ability to recover from unexpected effects. It also includes long-term adaptive capacity through learning, validating, and forecasting from previous experiences.

1.3 Influenced Factors to Economic and Social Sensitivity of Population

Social sensitivity tends to be described as susceptibility of individuals or of a population. This includes factors such as low educational levels, a lack of access to resources (information, knowledge, and technology), limited access to political power and agents, a reduction of social capital including social networks and connections etc. Furthermore, it also includes economic factors such as low income, debt, job security, and employment, as well as social factors like gender, ethnicity, language, structure of household, social network, lack of political rights and ownership in habitation etc. These factors influence the ability of a population to encounter and adapt to negative situations. Sensitivity also leads to urban vulnerability (Cutter, Boruff, & Shirley, 2003). (Table 1)

2. Urban Decline Theory

Urban decline or urban shrinkage refers to the long-term loss of population related to demographic characteristics. It causes a reduction of population density, an increase in unoccupied residences, excess infrastructure, and abandoned land, each indicating significant spatial, economic and social changes in the city. These factors influence a city's ability to cope, adapt, and reorganize itself in the face of negative situations that indicate urban vulnerability (Eraydin, 2013).

The German Shrinking Cities Project identified four factors that lead to urban decline which are (Laursen, 2009):

- **De-industrialization** causes the loss of employment opportunities, the migration of the working-age population, and urban decline in several industrial city centers.

- **Change of urban structures** such as de-centralization and sub-urbanization results from the growth of large industries that attract investment and resources from other urban areas. This includes changes in road networks that cause the sub-urbanization and the potential re-location of the original city center, which can result in urban decline and the emigration of a population to the suburbs or to other cities that are more economically attractive.

- **Demographic changes** caused by the birth rate, death rate, and emigration rate of the working-age population that influences changes in household structure. These may result in a higher proportion of the dependent population in cities and an increase in the financial burden for the government while the income has decreased. Therefore, cities that experience urban decline tend to have low birth rates, high migration rates and higher rates of average age of the population.

- **Political Changes** The transition of former socialist countries to post-socialist countries has led to sudden changes in the market and politics. This was followed by economic problems resulting in the closing down of state institutions and government companies as the unemployed population increased and large numbers of people migrated from the former city center.

The effects of urban decline create distinct impacts that can be divided into four different categories as follows (Laursen, 2009).

- **Socio-cultural shrinkage** has impacted daily life and the quality of life of urban residents such as the reduction of social networks and social capital, the security of people etc.

- **Physical shrinkage** can be seen in completely vacant roads, abandoned buildings, and deteriorated dwellings. Decaying infrastructure is being used less frequently, resulting in a changing urban spatial configuration, which decreases the liveliness of the city.

- **Economic shrinkage** indicates a decreased value of property and land, a loss of employment opportunities, and a lack of investment that leads to economic decline, business disruption, unoccupied buildings, and a deficiency of urban grain and texture. The city center area loses utilities and duties due to a reduction of tax rates while the burden of expenses of the state has increased due to high unemployment, population decline, and the deterioration of social, cultural, and physical structures.

- **Demographic shrinkage** is caused by different factors such as high unemployment, de-industrialization, and economic decline including changes in population composition or structure such as low birth rates. The working-age population has emigrated, leaving only marginalized groups like elderly people, socially disadvantaged individuals, and uneducated people.

3. Economic base theory

The economic base theory is a technique developed by Robert Murray Haig in 1928. It is a technique for analyzing a local economy in relation to its income capability and the economic growth of the city. The main principle of economic base theory is to classify economic activities into two types: basic sector and non-basic sector.

- **Basic sector** includes economic activities that depend on external factors of the local economic systems like the export sector.

- **Non-basic sector** refers to economic activities that depend on local economic conditions. In other words, the production areas where all goods and services are consumed locally (and not exported).

The economic base theory has the hypothesis that we can classify all economic activities or local production areas into the basic sector or the non-basic sector. Another hypothesis is that the basic sector is the main cause of the growth of the local economy because it is the local economic base. Therefore, it is necessary to strengthen and develop the local economy and expand basic production branches. Identifying basic production branches and checking changes in those production branches is an important prediction tool regarding local economic changes. The growth of basic economic activities causes a multiplier effect and attracts labor into the area. It affects the expansion of non-basic sector economic activities from the production of goods and services to support those labors and the local population. Therefore, the variations in income or employment in the basic sector affect the income and employment in the non-basic sector.

On the other hand, the city's economic base that specifically aims to meet external needs, not responding to the local needs does not create employment in the basic and the non-basic sectors. As a result, the city cannot maintain economic diversity, economic activities, and employment attractions causing the working-age population to move out and the city is likely to lose its population in the long term, which is called "mono economy" in this research.

THEORETICAL FRAMEWORK

The theoretical framework is an integration of three important concepts, which are economic base theory, urban decline theory and vulnerability theory. These theories create a framework that supports the research hypothesis which is "A city with a primary economic base as a basic sector that is characterized by a mono-economy with a focus on production to meet external needs and without employment creation in the basic and non-basic sectors is the root cause of urban decline. As the growth of the mono-economy reduces the diversity of economic activities and does not create employment, the working-age population moves out and the city is likely to lose its population in the long run, leading to urban decline and the vulnerability of the city." (Figure 1)

Based on the study of the progression of vulnerability under the pressure and release model (PAR model) of Blaike et al. (2004), the root causes of vulnerability are the variety of structural imbalances in the city, including social inequality. It is assumed that the growth of a mono-economy is a root cause that creates dynamic pressures leading to urban decline and changes to the socio-economic structure of the population. These changes increase socio-economic sensitivity levels in cities with concentrated mono-economies. Significant changes in the physical structure of the city result in changes to the urban spatial configuration and de-centralization as well as a reduction in the quality of the city due to the decline in population density and a variety of economic activities, people, and periods of time. Therefore, according to the theoretical framework, to test the research hypothesis, the research methodology is specified into three parts as follows:

- Part 1: A study of the change in the central morphology of the city from the growth of the mono-economy by evaluating the quality of the city center according to the theory of spatial centrality to explain the factors of urban structure changes that lead to the reduction of the centralization of the city.
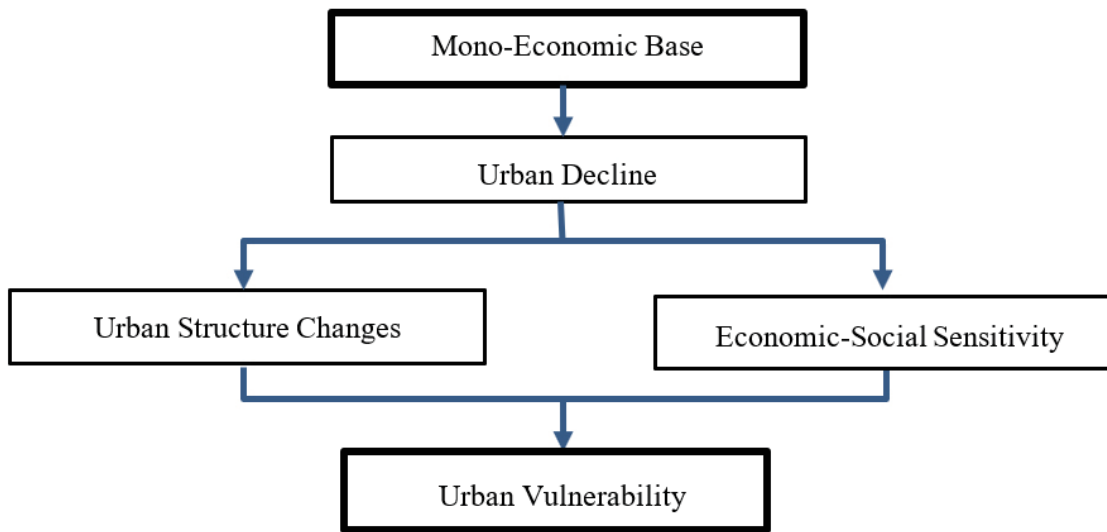
Figure 1:
Theoretical Framework

- Part 2: A study of the spatial distribution pattern of socio-economic sensitivity levels by using an indicator-based approach and quantitative research from the "The Social Vulnerability Index (SOVI)" which is a useful tool for comparing socio-economic and spatial vulnerability and for defining the indicators that systematically assess vulnerability. The result is a value showing the level of spatial vulnerability from a multivariate analysis. In this case, the principles of factor analysis are used.

- Part 3: A determination of a relationship between the socio-economic sensitivity map and a concentration of the mono-economy by using the overlay technique to test the hypothesis in the final step.

RESEARCH METHODOLOGY

The research methodology in this study combines quantitative and qualitative methods in studying the morphology of the city from the growth of a mono-economy that leads to urban decline and which has an influence on determining the socio-economic sensitivity of the population. The study process can be divided into three parts, which are:

Part 1:
A study of the urban morphological transformation of the city with the growth of the mono-economy

The study of the morphological transformation of central Pak Phanang focuses on changes to the transport network pattern and public areas at various periods of time to answer the important question: Can the city center area with a concentration of bird's nest businesses maintain its configurational attractor? Can the area attract a high level of trade and service activities and utilize the buildings along the road network in a variety of ways? Can it generate traffic through many periods of time? If it is unable to maintain the morphology, what are the factors of urban decline from de-centralization?

In the study of central Pak Phanang's morphological transformation, the theory of spatial centrality (Hillier, 1999) is used by studying the evolution of urban morphology from the year it formed through periodic social and economic changes. This explains the ability of the physical morphology of the city to maintain its centralization.

According to the theory of spatial centrality by Hillier (1999), the factors of centrality are (1) a high level of natural movement in a road network that is connected freely and densely, and (2) a concentration of a variety of economic activities through the utilization of the buildings. A road network that has a high level of natural movement and that supports pedestrian traffic (a "life center") creates a multiplier effect that accelerates changes in building utilization until it becomes a concentrated network of economic activities (a "configurational attractor"). This is called "centrality as a process" (Hillier, 1999).

Based on the theory of spatial centrality, the research methodology can be devised to assess the changes of the centralization over eras of the main economic base of the city, as follows:

1) The analysis of the accessibility of the global integration (RN) network that changes over time with space syntax can be divided into the following steps.

1.1) Prepare a map using Geographic Information System (GIS) by defining an axial line showing the relationship between the morphological structure and the level of natural movement and by dividing the public spaces of the city into convex spaces, drawing the longest lines and the smallest numbers in each sub-area.

1.2) Analyze the axial map of all traffic network systems and public areas, and conduct a mathematical evaluation to find the integration value of the axes. Then, the values will be ordered in a range from highest to lowest. This is represented by the rainbow caste from red, orange, yellow, green, light blue and dark blue. The axes with high access potential mean the roads with high traffic tendency are shown in 'hot' color tones with the highest value in red. Then, the color will be gradually changed to the group of lines that have low access potential, which will be shown as 'cool' tones with the lowest value in blue, which means the road has less traffic tendency.

Therefore, the city morphology that represents the city center has a high density of road networks with the integration value of the axes shown in red 'hot' tones, which are freely and densely linked to other roads in the system. As a result, the change of traffic networks and public areas from the city development

lead to the relocation of the city center to areas with higher access potential and cause a partial urban decline due to the loss of accessibility, which influences the attraction of economic activities and pedestrian traffic.

2) The study of the current situation of building utilization, building ownership, density of pedestrian traffic, and the continuation of economic activities between the front door and the sidewalk has a high integration value from the analysis of axial maps with a space syntax to assess the centralization of features that can attract a variety of economic activities and pedestrian traffic at many periods of time.

3) In-depth interviews with people involved in the development of the city in various time periods, in order to verify the center of the city from the results of the analysis of the accessibility of the traffic network and the public space that change over time.

The results of each step of the study can be used to analyze the root causes of urban deterioration caused by the changes in the physical morphology of the city from the growth of the mono-economy of the bird's nest businesses which result in socio-economic and structural imbalances and lead to the accumulation of negative external effects that influence the level of socio-economic sensitivity of the city.

Part 2:
The study of the distribution patterns of spatial socio-economic sensitivity

The indicator-based approach is used to study the distribution patterns of spatial socio-economic sensitivity, adapted from the Social Vulnerability Index (SoVI) (Cutter, Boruff, and Shirley, 2003), to create index indicators obtained from statistical data collection. The data is analyzed using a multitude of statistical methods. In this case, the Principal Component Analysis (PCA) is used to create a socio-economic sensitivity index, (Schmidtlein, Deutsch, Piegorsch, & Cutter, 2008) and the results are shown as a spatial distribution model to find relationships within the growth of the mono-economy from the bird's nest businesses in the area.

To meet the primary requirements for component analysis, it is necessary to provide a case study in order to create the socio-economic sensitivity index, which includes the following: (1) The number of units for a component analysis should be greater than thirty. (2) The number of indicators set for creating the socio-economic sensitivity index must have a proportion of at least three units of analysis per one indicator.

From the basic agreements, the area of Pak Phanang municipality is divided into sub-units of analysis. In this case, there are eighty-six units within the Pak Phanang municipality area. The number of analysis units is greater than thirty; therefore, from the number of analysis units or area units, the number of indicators can be proportionally specified not to exceed twenty-eight indicators (three area units per one indicator)

Data was collected by distributing questionnaires to 3,259 households from a total of 4,730 households in the Pak Phanang municipality. The number of questionnaires distributed was proportionate to the number of households in each area according to a stratified random sampling.

The socio-economic sensitivity calculation process

The Pak Phanang municipality spatial socio-economic sensitivity calculation process is adapted from the Social Vulnerability Index (SoVI) method, which contains the following steps (Schmidtlein et al., 2008):

1) **Indicator determination** is from the literature review to determine indicators that represent the socio-economic sensitivity status of the population and the households. (Table 2)

From the literature review, it shows that the indicators depend on the analysis scale. Past studies focused mainly on the city level based on secondary data collected by the government, such as population, geographic information, economic data, etc. The data integrity depends on the government's data collection methods that are sometimes incomplete and unable to penetrate the spatial level according to the context of the specified hazards, resulting in a general and unspecific distribution pattern of sensitivity, so it is difficult to validate the reality of the area. Therefore, to solve the problem about validation, as in the previous research, this research uses a method of distributing questionnaires that are closest to the population, and in proportion to the number of households in each unit according to stratified random sampling, so that the data can be verified by actual area surveys and in-depth interviews of the populations in the area. (Table 3)

Based on preliminary agreement, it was a requirement to have a ratio of the number of units of analysis per the number of indicators of at least 3:1 to analyze the components. This research determined twenty-one variables in total; therefore, representing the number of units per the number of indicators as 4:1 was considered appropriate for component analysis.

2) **The data transformation** In order to compare areas according to the determined indicators, the selected indicators must be continuous variable, or have a value in the interval scale and the ratio scale. In order to create spatial socio-economic sensitivity, the data will be displayed as a percentage.
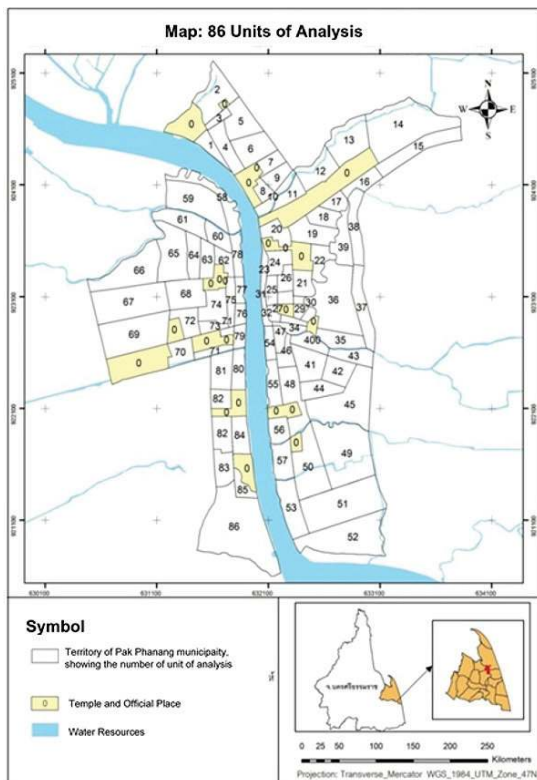

Figure 2:
Map: 86 Units of Analysis

Table 2: The research of social sensitivity index creating

Index	Scale of analysis	Natural hazard type	Data collection	Number of indicators	Keys indicators	Research
SoVI	County level, USA	All natural hazards	Secondary from the government	42	Personal stability, age, building density, dependency on mono-economy, number of housing and occupancy right, ethnicity, occupation, dependency on infrastructure	(Cutter et al. 2003)
Social and Infrastructure Flood Vulnerability Index (SIFVI)	County level, Germany	Flood	Secondary from the government	41	Dependent population, employment status, basic education, physical features of housing, population density per living area, building density per area unit	(Fekete and Brach 2010)
SoVI-Ch	US census tract	Earthquake	Secondary from the government	26	Income, housing occupancy rights, immigrant status, dependent population, population density per household, employment situation, occupation, ethnicity, gender, education	(Schmidtlein et al. 2011)
SoVI	US county and census tract	All natural hazards	Secondary from the government	26	Income, housing occupancy rights, immigrant status, dependent population, population density per household, employment situation, occupation, ethnicity, gender, education	(Schmidtlein et al. 2008)
Social Vulnerability Index (SVI)	German county	Flood	Secondary from the government	41	Dependent population, employment status, basic education, physical features of housing, population density per living area, building density per area unit	(Fekete 2009)

3) The indexing to assess spatial socio-economic sensitivity uses the following procedure:

3.1) The preparation of indicators by standardization, all data using a Z-score normalization method, finding the standard score (Z-score)

3.2) The correlation matrix To analyze the relationship between variables from the correlation matrix that is the correlation coefficient of variables, the value should not be less than (>) 0.3. Moreover, to measure the relationship using the KMO technique (Kaiser-Meyer-Olkin), the appropriate KMO value to analyze should be greater than 0.6.

Table 3: The economic-social sensitivity indicators

No.	Component	Index Code	Economic-Social Sensitivity Indicators
1	Income	index1_S	1) % of households with average income not over 30,000 Baht per person per year
		index2_S	2) % of households with income not over 120,000 Baht per year
		index3_S	3) % of households with more yearly expenditure than yearly income average income (with debt)
		index4_S	4) % of households without a variety of income (with main income but without secondary income and other income)
2	Gender and age	index5_S	5) % of households with all female members
		index6_S	6) % of number of female population in the area unit aged 60 years old and over and younger than 15 years old
3	Occupation and employment status	index7_S	7) % of households with an employed member or with all unemployed members
		index8_S	8) % of households with all uncertain income members (occupations with an uncertain income are agriculture, fishery, livestock, general labour, no occupation) or currently studying member
		index9_S	9) % of working age population in the area (working age population age between 15-59 years) with uncertain occupations (agriculture, fishery, livestock, general labour) and except for currently studying member
		index10_S	10) % of working age population in the area (working age population age between 15-59 years) without occupation and except for currently studying member
4	Social dependency	index11_S	11) % of households with all dependent population members(dependent ages are members that are 60 years and older and younger than 15 years old)
		index12_S	12) % of households with more dependent population member than working age member (dependent ages are members that are 60 years and older and younger than 15 years old, working age members are between 15-59 years old)
		index13_S	13) % of number of population in the area unit with members from 60 years old and over.
5	Household structure	index14_S	14) % of households with the only one member
		index15_S	15) % of household with female members and children younger than 15 years old or elderly aged 60 years and over
6	Education	index16_S	16) % of households with all members who have an education lower than a diploma
		index17_S	17) % of population aged 20 years and over with an education lower than a diploma
7	Population who needs special care	index18_S	18) % of the population younger than 5 years old and between 80 years and older
8	Ownership rights of residence	index19_S	19) % of the number of households with residence rights by renting

3.3) **The factor extraction** is the method to extract the correlated value of mentioned indicators to factors. The principal component analysis (PCA) was applied to reduce the complexity of the data by finding the fewest factors to explain covariation and the noticed indicators of a multivariate data set. The factor extraction results in the commonalities of each indicator. If the value is more than 0.5 or close to 1, this means that the mentioned indicator can be grouped together with the other indicators.

3.4) **The factor rotation** with orthogonal rotation of varimax was used to enhance the factor loading of each indicator and the percent of variance in each new factor. The factor loading of indicators after the orthogonal rotation can lead to the grouping of indicators and also expurgate some indicators to make them easier to interpret into new components. The consideration of grouping the indicators for new components will consider only the indicators with factor loading from 0.5 to 1, and -0.5 to 1.

3.5) **The interpretation of new components** that influence the socio-economic sensitivity and hazardous exposure levels from floods.

4) **The combination of the chosen components** to create the socio-economic sensitivity index and compare the units of analysis can be calculated by the following formulas (Tontisirin, Marome, & Anantasuksomsri, 2016)

$$\text{Index } j = \text{Variance}_i [(\text{Factor Loading}_{i1} \times \text{Zscore}_{1j}) + (\text{Factor Loading}_{i2} \times \text{Zscore}_{2j}) +... (\text{Factor Loading}_{in} \times \text{Zscore}_{nj})] +...+ \text{Variance}_n [(\text{Factor Loading}_{in} \times \text{Zscore}_{nj})]$$

Index	=	index value
Variance	=	the proportion of the percentage of variance of the indicator
Factor loading	=	the value of factor loading or the correlated value of the indicators
Z-Score	=	the value of calculated factors
i	=	the order of group of calculated indicator
j	=	the sequence of study areas
n	=	the order of end number

5) **The standardization of data from the combination of components** converts the data into standard values using the Z-score method to set the components from orthogonal rotation to a linear combination in the same way as the default variable which will result in the "sensitivity scores."

6) **The socio-economic sensitivity mapping** is achieved by grading the "sensitivity scores" into five levels before entering the data into Geographic Information System (GIS).

Part 3:
Finding relationships between socio-economic sensitivity map and the concentration of the bird's nest business by utilizing overlay techniques to examine the following hypothesis that is "the growth of the mono-economy that leads to urban decline influences the level of socio-economic sensitivity and increases urban vulnerability"

RESULT OF THE STUDY

Part 1:
A study of the morphology changes in the structure of the city center from the growth of a mono-economy

1. **The accessibility of the transport network and the city's public space (Global Integration (RN)), in 1967, 1974 and 1995**

Based on an analysis of the accessibility of the transport network and the city's public space (Global Integration (RN)) using the Space Syntax technique, the result is displayed according to the economic change period in 1967, 1974, and 1995 as follows: (Figure 3)

Based on the transport network and the city public space axial map in 1967, 1974, and 1995 which correspond to the periods of economic growth from rice production and trading, fisheries and fishing industry, and shrimp farming, respectively; the study reveals that the market community zone, Chai Nam road, and Panit Samphan road zones have the
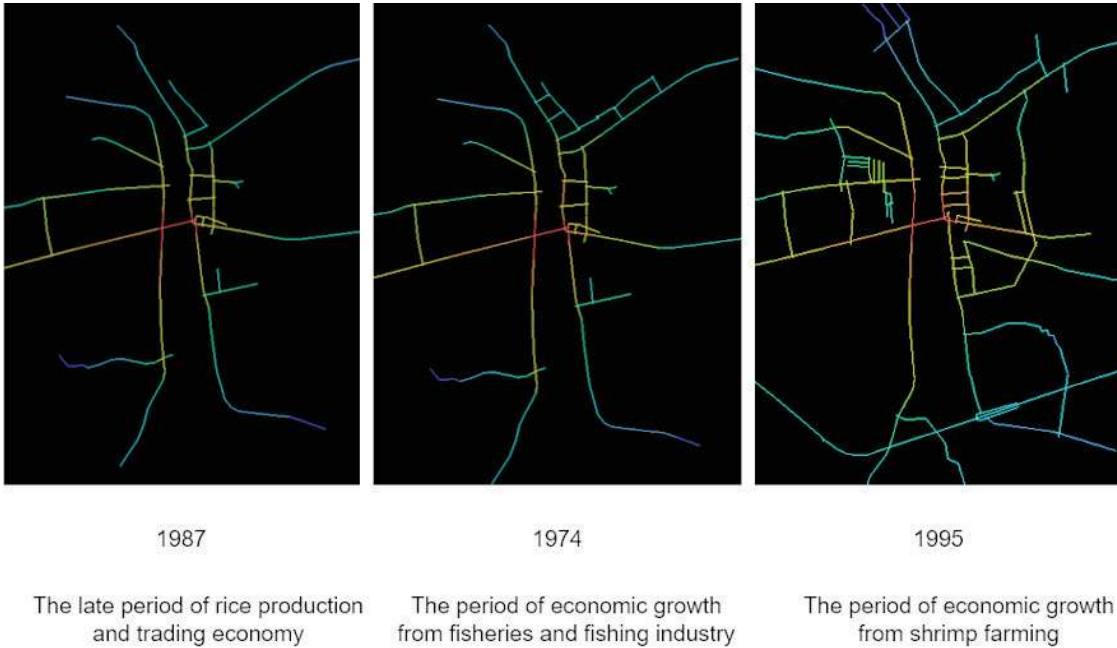
1987	1974	1995
The late period of rice production and trading economy	The period of economic growth from fisheries and fishing industry	The period of economic growth from shrimp farming

Figure 3:
The analysis of the accessibility of transport network and city public space (Global Integration (RN)) using Space Syntax technique, in 1967, 1974 and 1995.

ability to maintain a high level of natural movement which is shown in the integration value of the axial map in red. According to Hillier's theory (1999) the market community zone has the transport network and public space that tend to be systematically and intensively interconnected.

Based on interviews with the residents in the market community, it can be determined that the market community area before 1995 was very prosperous, especially the economic growth from fisheries which contributed to the growth of other related business such as ice plants, cold storages, shipyards, seafood processing plants, etc. These activities attracted laborers to move into the Pak Phanang municipality, resulting in a large number of shops and services along the main roads (Chai Nam road and Panit Samphan road) including various alleys that were systematically linked to support natural movement in many time periods. This shows the center of life of the market community in the past.

2. The accessibility of the transport network and the city's public space (Global Integration (RN)), in 2002 and 2015

According to an analysis of the accessibility of the transport network and the city's public space (Global Integration (RN)) using the Space Syntax technique, the result is displayed according to the economic change periods in 2002 and 2015 as follows:

Based on an analytical study of the road network and the public areas using geographic information maps and the analysis of the accessibility of the transport network of the whole area in 2002 and 2015 which correspond to the periods when the bird's nest business mono-economy was growing, using Space Syntax technique, it can be determined that the market community area (Chai Nam road and Panit Samphan road) still maintain higher accessibility levels than other areas. The data from 2002 and
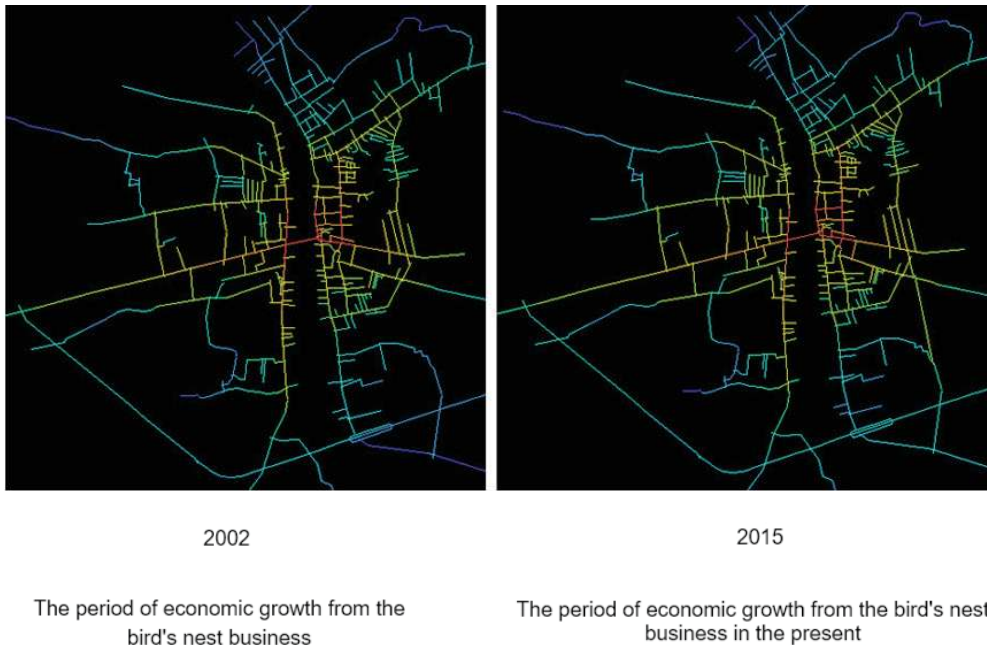
2002

The period of economic growth from the
bird's nest business

2015

The period of economic growth from the bird's nest
business in the present

Figure 4:
The analysis of the accessibility of transport network and city public space (Global Integration (RN)) using Space Syntax
technique, in 2002 and 2015.

2015 shows in a red 'hot' tone when comparing the integration value of the axial line. According to Hillier's theory (1999) it shows that the market community zone has a transport network and public spaces that tend to be more systematically and intensively interconnected, especially the construction of bypass roads connecting to the network of the existing main roads which provide better linking systems in order to support the expansion of the city and the increase in population. This operation increases the accessibility of the market community better than other areas, allowing traffic through or having the highest level of natural movement.

However, according to Hillier's theory of spatial centrality, a city center not only needs to have higher levels of natural movement than other road networks, but it also needs a configurational attractor that is able to attract a lot of trade and service activities and to utilize buildings and spaces along the road network with high levels of traffic at many times of the day. Therefore, to evaluate the center of the market community in terms of the mono-economic growth of bird's nest businesses, the interviews with residents in the market community are conducted,

the utilization and ownership of the buildings are explored, the density of traffic is investigated, and the continuation of economic activities from the front door of the buildings to the sidewalks of the city center in various periods is studied.

Based on interviews with residents of the market community, after the recession of the fishing business and the economic downturn in 1997, there was a significant population emigration and buildings were abandoned. Those old buildings have been converted into swiftlet farms since 1996, causing a dramatic change in the urban center, especially in the market community area (Chai Nam road and Panit Samphan road) as the buildings' owners have converted or modified their buildings' upper floors into the areas for birds to nest, while using the lower floors for other means such as residential and commercial areas. Some have converted their entire buildings into swiftlet farms. Moreover, some owners have demolished and reconstructed their buildings to be nesting places only, which are called "Swiflet houses." This dramatic change in urban morphology due to the growth of the swiftlet farming business has resulted in the following changes:

1)   Building usage changes: There are more buildings that have been converted to swiftlet farms. From 1996 to 2017, many building owners in the Pak Phanang municipality have requested permission for the construction or modification of more than 400 buildings for bird nesting. This covers more than 300,000 square meters, and there are at least 150 buildings that are in the urban center with a high level of accessibility. (Figure 5 & 6)

Figure 5:
The location of the "swiftlet house" building which is concentrated in the current city center area

2)   Ownership transformation and environment change: There are more rental buildings being used as swiftlet farms and more abandoned buildings that deteriorate the environment. The owners usually modify the upper floor into swiftlet farms and make the lower floors available for rent. Moreover, when the swiftlet farms are increasing, it causes urban residents to emigrate due to noise and air pollution problems that affect the well-being of residents in the urban area. When the owners move out, they make the lower floors available for rent or leave them closed without tenants and many buildings are left behind. (Figure 7)

3)   Changing alleys to private areas: The alleys between buildings are also used as areas for bird nesting. The alleys where people could travel through have been converted to bird nesting areas that block pedestrian passage. Because of the value of the bird nests, the proprietors have to build high fences to keep people out. The alleys that used to connect to main roads or other alleys where people used to travel through, and the buildings that used to be utilized in various activities, now have been changed into personal areas that prevent people from passing through to secure the bird's nests from people who might enter to steal them. This increasing lack of trust has damaged personal relationships and the larger social network among the residents.

4)   The links between pedestrians and buildings along the roads due to the diversity and the continuity of economic activities have been reduced: The fences and walls built to secure the bird nests and the other buildings along the main roads and alleys have caused a reduction in the diversity and continuity of economic activities. It has also accelerated the closing or re-purposing of existing commercial shops that have either been converted to residences or simply abandoned due
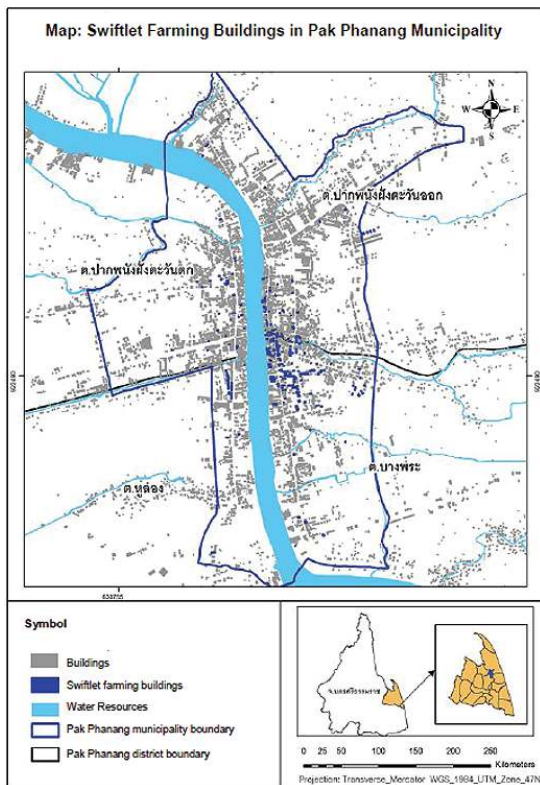
Figure 6:
The rental and abandoned buildings, or usage changing buildings causing the reduction of the diversity and the continuity of economic activities

Figure 7:
The alley in the past allowing people to pass by. Currently, there are "swiftlet farming" buildings in the alley with safety control prohibiting people to pass by.

Figure 8:
The swiftlet farm buildings along the main roads. They usually have high walls and fences resulting in reducing the links between buildings and pedestrians, which makes the areas isolated and can create insecurity at night.

to lower pedestrian traffic. This condition limits social interaction of pedestrians which decreases the quality of the city and creates insecure feelings at certain times of the day, especially at night, due to the lack of activities in the area. (Figure 8)

Therefore, the study of changes in the structure of the city center from the growth of a mono-economy by using the Space Syntax technique to analyze the access potential of city-level global integration (RN) of the Pak Phanang Municipality found that the central area with a concentration of bird's nest businesses cannot maintain a "configurational attractor" that can attract a variety of economic activities, even though the market community can still maintain a strong level of natural movement.

The urban decline due to the de-centralization of the city is the result of the growth of the mono-economy of the bird's nest businesses in the city center, which does not create a configurational attractor but rather accelerates the emigration of building owners and populations suffering from noise and air pollution from swiftlet farming in the area. Therefore, the central area of the market community is currently deteriorating. As shown, the ownership by rent has

changed, the urban environment has deteriorated, and there are more vacant and abandoned buildings, which breaks the relationship between pedestrians and the buildings due to a reduction in diversity and a continuation of economic activities. This situation creates a feedback loop accelerating the loss of urban population in the long run and transforming the city center into enclaves of derelict morphological units. This leads to changes in the population structure of the area and an influx of marginal households that diminish the area and create multiple negative effects, from which it will be difficult to recover.

Part 2:
The study of the distribution pattern of spatial socio-economic sensitivity levels

The quantitative research methods from the indicators-based approach are used in the study of the distribution pattern of spatial socio-economic sensitivity levels for evaluation and comparison. Based on statistical data collection with the

distribution of questionnaires to obtain data based on specific indicators, data is converted into rational scales or percentages. Then, the indicators are converted using a Z-score normalization method to create the socio-economic sensitivity index and a Principal Component Analysis (PCA) of factors. It shows factor loading and a percentage variance of the indicators after factor extraction and Varimax factor rotation using SPSS program. The data is shown as follows: (Table 4)

Based on a Rotated Component Matrix table, all twenty-one indicators can be grouped into seven components. Each component is considered by the indicators in the vertical column with factor loadings that are greater than 0.5 and close to 1

only. Each factor loading will be used in the next step to calculate in order to create a socio-economic sensitivity index. (Table 5)

The Total Variance Explained table can be described as follows:

(1)   The component column shows the extracted components which have the same amount as the extracted variables. The variables, in this case, are the socio-economic sensitivity variables. All sixteen variables are analyzed by their components.

(2)   The Rotation Sums of Squared Loadings column shows the eigenvalues of each indicator after component extraction and orthogonal rotation

Table 4: Rotated Component Matrix

	Component						
	1	2	3	4	5	6	7
Zindex13_S	.921	-.107	.086	.015	.079	.142	.050
Zindex11_S	.921	-.083	.013	-.016	.056	.073	-.022
Zindex12_S	.891	.017	.045	-.102	.224	.113	-.021
Zindex14_S	.825	-.114	-.212	.081	-.094	-.179	-.070
Zindex6_S	.794	-.118	.196	.034	.270	.259	.052
Zindex7_S	.752	.439	-.058	-.068	-.036	-.028	-.081
Zindex15_S	.613	-.146	.247	-.023	.123	.463	.317
Zindex2_S	.136	.807	.216	.143	.154	-.207	.085
Zindex1_S	-.241	.779	.167	.210	.145	-.024	.091
Zindex3_S	-.155	.706	.130	.018	-.181	-.014	.261
Zindex10_S	.034	.683	.073	-.405	-.161	.285	-.044
Zindex17_S	.100	.066	.866	.047	-.127	-.003	.058
Zindex16_S	.178	.148	.805	-.151	.145	-.170	-.090
Zindex8_S	-.098	.429	.746	.196	-.060	.102	-.020
Zindex9_S	-.538	.096	.631	.373	-.166	-.048	.057
Zindex4_S	-.128	-.083	.224	.764	.098	.225	-.097
Zindex19_S	-.141	-.314	.106	.723	.140	.237	-.010
Zindex18_S	.219	.027	-.127	-.019	.886	.107	.057
Zindex5_S	.272	-.008	-.136	.014	.770	-.101	
Zindex21_S	.120	.230	.038	-.031	.175	-.199	.810
Zindex20_S	-.258	.141	-.159	-.089	-.424	.291	.612

Table 5: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.822	27.722	27.722	5.822	27.722	27.722	5.425	25.834	25.834
2	3.776	17.981	45.702	3.776	17.981	45.702	2.881	13.720	39.554
3	2.098	9.992	55.694	2.098	9.992	55.694	2.731	13.003	52.557
4	1.493	7.109	62.803	1.493	7.109	62.803	1.569	7.473	60.030
5	1.222	5.818	68.621	1.222	5.818	68.621	1.360	6.476	66.507
6	1.141	5.431	74.053	1.141	5.431	74.053	1.354	6.449	72.955
7	1.041	4.959	79.012	1.041	4.959	79.012	1.272	6.057	79.012

Table 6: Indicators of new components

Component order	Index Code	Indicator	Factor loading	% of Variance
Component 1	Zindex13_S	% of area unit population with members age 60 years old and over	0.921	0.258
	Zindex11_S	% of households with all dependent members	0.921	
	Zindex12_S	% of households with dependent members more than working-age members	0.891	
	Zindex14_S	% of households with 1 member	0.825	
	Zindex6_S	% of area unit female population with age 60 years old and over, and below 15 years olds	0.794	
	Zindex7_S	% of household with the only employed member or all unemployed members	0.752	
	Zindex15_S	% of households with female member and children younger than 15 years old and members age 60 years old and over	0.613	
Component 2	Zindex2_S	% of households with income not over 120,000 Baht per year	0.807	0.137
	Zindex1_S	% of households with average income not over 30,000 Baht per person per year	0.779	
	Zindex3_S	% of households with more yearly expenditure than yearly income average income (with debt)	0.706	
	Zindex10_S	% of working age population in the area without occupation and except for currently studying member	0.683	
Component 3	Zindex17_S	% of population aged 20 years and over with an education lower than a diploma	0.866	0.130
	Zindex16_S	% of household with all members with an education lower than a diploma	0.805	
	Zindex8_S	% of households with all uncertain income members or currently studying member	0.746	
	Zindex9_S	% area unit working age population with uncertain income members or currently studying member	0.631	
Component 4	Zindex4_S	% of number of household without a variety of income	0.764	0.075
	Zindex19_S	% of the number of households with residence rights by renting	0.723	
Component 5	Zindex18_S	% of the population younger than 5 years old and between 80 years and older	0.886	0.065
Component 6	Zindex5_S	% of households with all female members	0.770	0.064
Component 7	Zindex21_S	% of households that are not eligible for government assistance programs	0.810	0.061
	Zindex20_S	% of the number of households that are not domiciled in Pak Phanang by birth	0.612	

according to varimax rotation. Only the indicators with eigenvalues greater than 1 are considered. The following are the components that were considered;

Component 1 has the eigenvalues
= 5.425 = 25.834 % of variance

Component 2 has the eigenvalues
= 2.811 = 13.720 % of variance

Component 3 has the eigenvalues
= 2.731 = 13.003 % of variance

Component 4 has the eigenvalues
= 1.569 = 7.473 % of variance

Component 5 has the eigenvalues
= 1.360 = 6.476 % of variance

Component 6 has the eigenvalues
= 1.354 = 6.449 % of variance

Component 7 has the eigenvalues
= 1.272 = 6.057 % of variance

The percentage of variance after orthogonal rotation is used to calculate the socio-economic sensitivity index. From the Rotated Component Matrix table and the Total Variance Explained table, the indicators are grouped into seven new components. Under these seven new components, it shows the factor loading of each indicator and a percentage variance of the new component groups. (Table 6)

Based on the Principal Component Analysis (PCA) of factor, the indicators are grouped to reduce complication of the data and to simplify interpretation of the new components. The components that affect the level of socio-economic sensitivity of the Pak Phanang municipality, from the most influential component to the least influential component, are as follows:

Component 1 :
Population structure and households with proportions of dependent population

Dependent populations affect city-level economic development and growth, which relates to the provision of essential social services by the government. Moreover, this group especially affects household level because working-age members have the primary obligation to take care of the dependents' health, education, and daily life. Therefore, the households with a larger proportion of dependents can indicate an increased responsibility for the head of the household because the burden of taking care of the dependents can limit the development of the households and the opportunity to improve the socio-economic status of each household.

Component 2 :
Economic conditions of the population and households

Economic conditions include incomes, debts, and employments. The populations with high incomes and savings usually have more choices of living than those with low incomes and higher debts. Moreover, the economic conditions are also related to the employment status of the working-age population because they essentially drive the economy of the household and the city. Therefore, the unemployment of the working-age population determines the status of the economic sensitivity of the household as well as the ability to provide and access needed resources. So, the emigration of the working-age population increases socio-economic sensitivity both at the household and city levels.

Component 3 :
Career and income security

Educational levels are related to career security. Populations with higher education tend to have more career options than those with low education, resulting in a more consistent income and access to resources as well as essential information to improve the quality of life. The careers that are insecure, such as low skill laborers or workers, including occupations related to agriculture or others that rely on natural systems, usually have unstable incomes without welfare or security in life. Therefore, career security is an important factor to indicate the ability to improve socio-economic conditions and to deal with negative situations.

Component 4 :
Rights and opportunities to access resources

The tenants of the buildings can rarely access funding and benefits from the government or obtain any kind of political power. Therefore, they do not have an opportunity to participate in the government decision-making apparatus that affects their lives. In
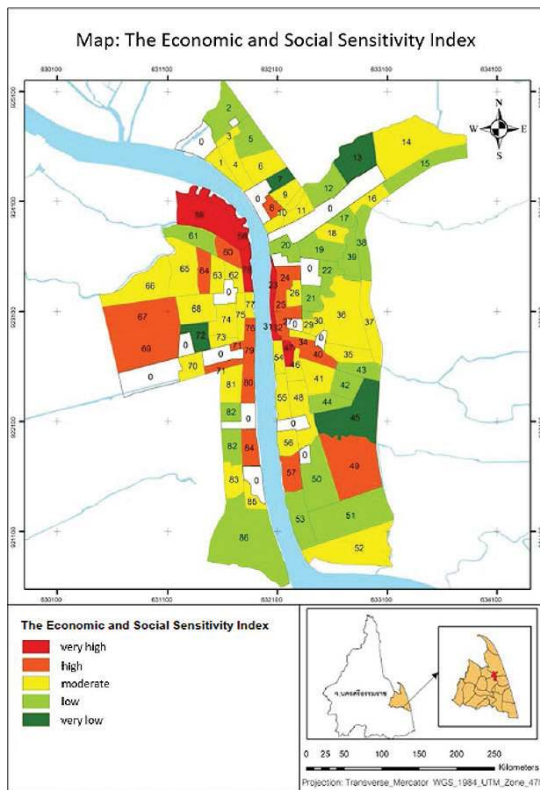
Figure 9:
The economic-social sensitivity map

addition, they rarely have economic stability because they are usually low to medium-wage earners and many of them use their rental building as a place to make a living, such as trading of goods, employment, etc., where the incomes and opportunities for jobs depend on the location. This is the reason why the tenants often have only a few career choices without a diversity of income, an important factor in determining the economic stability of the household.

Component 5 :
Population and households with special need members

Populations with special needs such as young children or very elderly members tend to have problems protecting themselves and have a limited capacity to emigrate and move themselves out of disaster situations.

Component 6 :
Household structure with all female members

The structure of the household is related to the number and the gender of its members. It can indicate the burden of responsibility of the head of the household and/or a lack of male leaders.

Component 7 :
The lack of political rights

The lack of political rights influences access to funding sources as well as various welfare mechanisms such as education, medical care, and assistance after disasters.

In the next step, socio-economic sensitivity index is created to compare the level of socio-economic sensitivity between areas by substituting the analyzed values obtained from the Principal Component Analysis (PCA) into the formula for calculating the sensitivity index as described above.

Standardizing the values obtained from the combined component scores and the Z-score normalization method, returns the component set by the orthogonal rotation into a linear combination similar to the original indicators. The results, called "sensitivity scores," can be used to classify socio-economic sensitivity into five levels. Importing socio-economic sensitivity data into the Geographic Information System (GIS) creates a socio-economic Sensitivity Map as follows: (Figure 9)

According to the socio-economic sensitivity index map of the Pak Phanang Municipality, one can see that there is a high level of spatial socio-economic sensitivity (indicated by the orange and red colors) in the central area of the market community (Chai Nam Road and Panich Samphan Road) when compared to other area units, especially when compared to the eastern Pak Phanang area which is the important location of both public and private sectors as well as the location of the market community, the economic center of the city.

Based on the Sensitivity Index calculation, by classifying the value of each area unit according to the new components obtained from the indicator grouping, it can be determined that the most
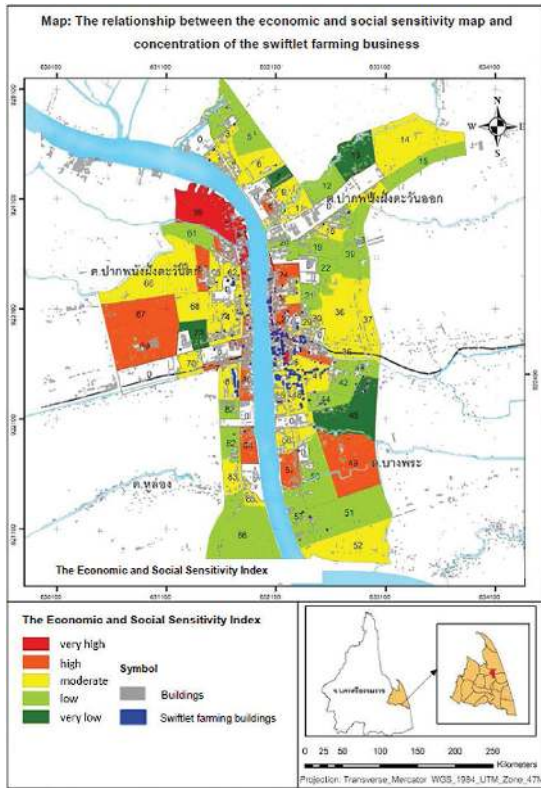
Map: The relationship between the economic and social sensitivity map and concentration of the swiftlet farming business

The Economic and Social Sensitivity Index

The Economic and Social Sensitivity Index

very high	
high	Symbol
moderate	
low	Buildings
very low	Swiftlet farming buildings

Figure 10:
The overlay map between the economic-social sensitivity map and the concentration of swiftlet farming buildings.

influential factors affecting the socio-economic sensitivity level of the central area are the population structure and households with a greater proportion of dependent-age members. This result is in line with the changing population structure of the Pak Phanang Municipality, according to the analysis of census data and civil registration data from 1997 onwards. When the city has had its main economic base as a mono-economy of bird's nest businesses, the population has decreased significantly, and there has been more emigration than immigration, especially of the working age population, resulting in a higher proportion of dependent population.

Other lesser factors that influence the Sensitivity Index are the economic conditions of the population and households, and job and income security, respectively. The results show that there are more low-income earners in the city center. Most of them have ownership rights by renting. Due to the construction or modification of the buildings for swiftlet farming,

the building owners make the ground floor of their buildings available for rent and adapt the upper floors to be swiftlet farms. In addition, many building owners who lived near swiftlet farm buildings have moved out and released their buildings for rent because of the concerns about noise and air pollution. This has resulted in the change of ownership of residences; there have been more rental buildings since 1997, which is the period of the mono-economic growth from the bird's nest businesses, as shown in the survey of building ownership by leasing or renting of the current downtown area.

Part 3:
The relationship between the sensitivity map and the concentration of bird's nest businesses

The study of the relationship between the socio-economic sensitivity map and the concentration of the bird's nest businesses by using an overlay technique shows that in the east side of the Pak Phanang River considered as the center of Pak Phanang city for a long time, there is a concentration of residents and various economic activities as well as important government buildings. However, the current central areas including the market community area (Chai Nam Road and Panich Samphan Road), which have a higher concentration of bird's nest farming businesses, have a high level of socio-economic sensitivity when compared to other areas.

CONCLUSION AND RECOMMENDATION

The paper examines how mono-economic growth relates to the sensitivity of the city. The case study of the Pak Phanang Municipality indicates that the mono-economic growth of the bird's nest businesses in the city center has caused urban decline due to the de-centralization of the city. This was caused by two important factors, which are:

(1) Changes in the urban morphology of the city; the city center is unable to maintain the configurational attractor that can attract employment and a variety of economic activities. Although the city center area is still able to maintain a strong level of

natural movement, it accelerates the emigration of the population due to the problems of pollution as well as the economic downturn of the city, leading to changes in the socio-economic structure of the city center.

(2)   Changes in the socio-economic structure of the city center; according to the Sensitivity Index and the indicators established based on the study of concepts, theories, and literature reviews to find the spatial distribution of social vulnerabilities, it can be determined that the central area of the city, with a concentration of bird's nest businesses, has a high level of socio-economic sensitivity when compared with other area units. Therefore, the city center area has a clear influence on the ability of the city to cope, re-arrange itself, and adapt to negative situations, as well as a higher sensitivity to external risks, particularly flooding in the case of Pak Phanang.

The results of the study indicate that the mono-economic growth is the root cause of urban decline due to structural, physical, economic, and social imbalances that have gradually accumulated negative external effects and that have influenced the level of socio-economic sensitivity. As a result, the city is more vulnerable to exposure to external risks.

The recommendation is that a city needs to create an appropriate economic base that benefits the creation of a variety of urban conditions in the city. It needs to be able to attract residents, concentrate economic activities, and provide employment in the basic and non-basic sectors, resulting in the integration of people, the exchange of knowledge and ideas, and the development of new innovations. An economic base that benefits the diversity of the city is considered to be a solution to reduce the socio-economic sensitivity of the city, strengthening the city's adaptive capacity to cope and respond to negative situations, and reducing urban vulnerability to create long-term urban resilience.

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