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The Development of the Structural Relationship Model of Factors Affecting Success for Coastal Erosion Management at the Upper Gulf of Thailand

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ABSTRACT

The research aims to 1) study the direct and indirect effects of factors affecting the success in coastal erosion management in the upper Gulf of Thailand, and 2) develop and test the congruence of the measurement model and the structural equation model of the factors affecting the success of coastal erosion management in the upper Gulf of Thailand with empirical data. The conduction of research was divided into two stages. The first stage was qualitative research through 1) document analysis and 2) in-depth interview. The second stage was quantitative research by survey questionnaires, a total of 420 samples. Data were analyzed by descriptive and inferential statistics, including the analysis of structural equation model (SEM).

The results of this study showed that 1) factors relating to policies, strategic plans, and laws have a positive direct effect on the integrated coastal zone management of coastal erosion and people's participation, but has no statistically significant effect on success in coastal erosion management. The integrated coastal zone management of coastal erosion and people's participation has a positive direct effect on the success of coastal erosion management. For indirect effects, the success in coastal erosion management factor is indirectly influenced by policies, strategic plans, and laws through the integrated coastal zone management of coastal erosion and people's participation. 2) The developed model is found to be congruent with empirical data at a statistical significance level. Therefore, to successfully manage coastal

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erosion, those involved in coastal erosion management have to adopt sustainable development concepts, maintain the value of the functional structure of the coastal environment, develop maximal economic efficiency, and concern about social equity.

Keywords: Coastal Erosion Management, Structural Equation Model, Sustainable Development

Background and Significance of the Problem

The coastal environments are important to human life, ecosystems and the livelihoods of marine organisms that consist of various systems having relationship and mutual benefit. It also has economic importance and the history of the Thai nation. Thailand has a coastline and maritime areas with potential of high biological production. The coastal environment changes over time because of the influence of the wind waves changed by seasons and also influenced by fresh water flowing from the upstream producing the area rich in nutrients for marine and coastal animals. It is also an important source of human occupation. Therefore, the coastline is a complex and fragile dimension of the ecosystem so it is easy to deteriorate and loss of the environment. In addition, the coastal area is also an economic base for the production of many products and services such as industrial sites, communities, tourist attractions, aquaculture and coastal fisheries. At the same time, developing various activities at the coastal areas will cause environmental and pollution problems in the Gulf of Thailand and Andaman coastal areas as well.

Thailand has a coastline of 3,148.23 kilometers, covering 23 coastal provinces. The coast of the Gulf of Thailand has a length of 2,055.18 kilometers, covering 17 provinces. The length of the Andaman Sea coastline is 1,093.14 kilometers, covering six provinces. Coastal erosion is recognized that urgent remedies are needed because it affects over 12 million people living in the coastal area. Coastal area of Thailand is tidal flat, mostly mangrove forests, such as the upper Gulf of Thailand which is the accumulation of small sediments and the use of coastal areas as a living and shrimp farming community, causing the original mangrove forest to be destroyed and hence, severe erosion. Moreover, there is erosion along the mainland beaches caused by the construction of the buildings blocking the direction of the current. (Department of Marine and Coastal Resources, 2012)

The problem of coastal erosion causes changes in the physical condition of the coast, affecting investment in the development of the country, both the tourism service industry in the coastal areas as well as the economy at the household level because people have lost

land due to the erosion, unable to work as before resulting in income reduction. Both central and local governments have to spend enormous amounts of national budgets to solve problems in coastal erosion by the construction of engineering structures such as seawalls or groin, offshore breakwater and other structures. (Chanan Saengnapa, 2017) According to the Cabinet's resolution on the framework of the integrated budget plan for the management and prevention of coastal erosion problems in 23 provinces indicates that the government must use a budget of 19,580.8 million baht to implement 933 projects to manage and solve coastal erosion problems in 23 provinces of the country. (Sitawee Teerawirun, 2017)

The upper Gulf of Thailand has five consecutive coastal provinces which are Samut Songkhram, Samut Sakhon, Bangkok, Samut Prakan and Chachoengsao. There are 4 large rivers flowing into the Gulf of Thailand, namely Mae Klong River, Tha Chin River, Chao Phraya River and Bang Pakong River. The area is characterized by the sediment of the river mouth. The layer of the soil is about 19 - 21 meters thick, covered with abundant mangrove forest which is considered to be the largest mangrove forest in Thailand covering the entire coastline of 108 kilometers. In addition, it has always encountered the problem of coastal erosion for a long time, causing the coastline to be washed away in the sea by the waves about several meters per year. Some places may reach 10 - 20 meters per year. Severe erosion areas are considered critical areas such as coastal areas of Bang Khun Thian, Bangkok which has a sea boundary of 4.7 kilometers has been eroded over a thousand Rai, coastal areas of Song Khlong Subdistrict, Bang Pakong District, Chachoengsao Province and Khlong Dan Subdistrict, Bang Bo District, Samut Prakan Province also experienced severe coastal erosion as well causing economic and social losses including the coastal ecosystems in that area and still not being able to develop the land to its full potential in the upper Gulf of Thailand, so the coastal areas that have been eroded should be restored to grow mangrove forests to become public areas. However, in the past, some studies for coastal erosion have been conducted to solve the problem of coastal erosion. (Sin SinSakul., et al., 2002)

There are many forms and different levels of government agencies to consider integrated coastal management, integration between departments with different powers and duties but operating in the same area, integration between coastal communities upstream and downstream, integration between past, present, and future concepts, or integration of links between ecology, society, economy, traditions and culture. Management, prevention and problem solving of coastal erosion has been continuously developed both in terms of advanced engineering techniques to the extension of folk wisdom or local wisdom with a variety of styles

that is effective and ineffective in some cases. There are impacts on the adjacent areas and decision-making conflicts when choosing methods or patterns to be used in solving problems. (Department of Marine and Coastal Resources, 2007) In order to ensure long-term coastal stabilization of the coastline, the proper guidelines for the management of coastal erosion at the upper Gulf of Thailand are necessary.

Accordingly, the study of the factors affecting success of coastal erosion management of Thailand is very crucial for providing essential guidelines for managing effective marine environment, especially coastal erosion at the upper Gulf of Thailand towards the utmost benefits for the public and for the nation in the future.

From literature review, Coastal management refers to the control or implementation of the objectives, plans, policies for coastal management, which are solving the degradation of coastal resources by managing the use and solving conflicts to be effective. (United Nations, 1995) However, after the management of the coast for a period of time found that coastal management is not as successful as it should be because the management is still modular or each person doing so there are efforts to find a way to manage it in the same way or together to implement or be an integrated coastal management.

Thailand has abundant coastal resources that make coastal area is the source of Thai people occupation such as fishing, tourism and industry. Coastal areas are therefore an important source of income for the country which cause the expansion of urban communities to coastal areas more. The utilization of coastal resources from various activities is resulting in the coastal resources of Thailand to deteriorate, including conflicts of use. Coastal erosion management in the country has the same development as in other countries, which in the initial phase focused on management for coastal exploitation, in the later stages and therefore gave importance to the environment and allowing more people to participate in coastal erosion management but natural resource management problems and the environment in the past is still lacking unity and lack of integration. (Suvaluck Satumanatpan, 2011)

However, even if the concept of integrated management and the concept of people's participation have been used, however, Thailand's coastal erosion management is not as successful as it should be due to many problems such as lack of coordination and cooperation among various related agencies, lack of budget and personnel management, law enforcement, not accepting changes, fear of losing power in coastal management, poverty of people causing lack of participation.

Therefore, the process of managing, preventing and solving coastal erosion problems is roles and responsibilities of related departments and tools that support coastal erosion management are one of the mechanisms in managing coastal erosion problems in which the management process must integrate the work and knowledge from many parts together to analyze problems, causes, plans, and then create a project with appropriate budget support that is sufficient to prevent and solve the problem of coastal erosion efficiently in line with the needs of the people and the national policy including transparency can be traced from all parts. Therefore, in order to successfully manage coastal erosion in the upper Gulf of Thailand, the following factors should be considered: Policies, strategic plans, and laws related to coastal erosion management, integrated coastal zone management of coastal erosion, and people's participation in coastal erosion management in the area.

Research Objectives

This study is aimed towards the following three research objectives:

1. to study policies, strategic plans, and laws related to coastal erosion, including the integrated coastal zone management of coastal erosion and people's participation in managing coastal erosion that affect success in coastal erosion in the upper Gulf of Thailand
2. to study the direct and indirect effects of the variables in the structural equation model that affect the success of coastal erosion management in the upper Gulf of Thailand
3. to develop and test the congruence of the measurement model and the structural equation model of the factors affecting the success of coastal erosion management in the upper Gulf of Thailand with empirical data

Scope of Research

1. Scope of the population

The population of this study is stakeholders in managing coastal erosion in the upper Gulf of Thailand, both public and private sectors, including entrepreneurs in the public sector that are an important part of the mobilization and other related sectors.

2. Scope of the area

This research is a study in the coastal area of the upper Gulf of Thailand covering 5 coastal adjacent provinces, namely Samut Songkhram, Samut Sakhon, Bangkok, Samut Prakan, and Chachoengsao.

Research Methodology

1. **Sample Size**

Due to a large number of population, sampling was conducted to obtain samples or representatives of the study. According to Leslie Kish (cited in Suchart Prasitratthasin, 2007), a sampling expert, the proper size of samples depends on several factors. One of them is the technique used for analysis. Since this research uses the analysis of the Structural Equation Model, the size of samples or units should not be less than 20 times of the observed or manifest variables. (Zhu, Walter, Rosenbaum, Russell, & Raina, 2006). As there are 12 manifest or observed variables in this study, the total number of samples that will be proper must not be less than 240 samples.

2. Variables

1) Exogenous variables mean the variables whose value is not determined by the model or variables that are not affected by other variables, such as policies, plans, strategies, and laws related to coastal erosion management. The researcher synthesized variables from the qualitative research in the initial stage, including concepts, theories, and related studies, and found that there were two observed variables, namely 1) the implementation of policies, plans, and strategies, related to coastal erosion management into practice, and 2) the enforcement of laws related to coastal erosion management. The researcher modified them to be eight questions in the questionnaire.

2) Endogenous variables mean the variables whose value is determined by the model or are affected by other variables. For this research, there were three principal variables:

i. The coastal erosion management in the upper Gulf of Thailand. From synthesizing its components from qualitative research at the first stage and from the literature review, three observed variables were found: 1) integration of space and resources, 2) integration of concerned agencies and 3) integration of techniques and knowledge. The researcher modified them to be 7 questions in the questionnaire.

ii. People's participation in managing coastal erosion in the area. From synthesizing its components from qualitative research at the first stage and from the literature review, four observed variables were found: 1) Participation in the initial stage of projects or activities related to coastal erosion management in the area. 2) Participation in the planning stage of projects or activities related to coastal erosion management in the area. 3) Participation in the implementation stage of projects or activities related to coastal erosion management in the area. 4) Participation in the evaluation stage of projects or activities related to coastal erosion management in the area. The researcher modified them to be 14 questions in the questionnaire.

iii. Success of the management of the coastal erosion in the upper Gulf of Thailand. From synthesizing its components from qualitative research at the first stage and from the literature review, three observed variables were found: 1) sustainable development, 2) implementation and 3) evaluation. The researcher modified them to be 11 questions in the questionnaire.

3. Research Procedure

This research is mixed-method research. The conduction of research was divided into two stages. The first stage is qualitative research through 1) document analysis and 2) in-depth interview by a semi-structured interview sheet as a tool in data collection.

The second stage is quantitative research by survey questionnaires with close-ended questions as a tool for data collection. The questions in the questionnaire were synthesized and compiled from the qualitative research in the first step, combined with data gained from a literature review of theoretical concepts and related previous studies to acquire questions in accordance with the actual context of the area. Besides, the researcher also consulted with experts of various sectors: government, private, community, and academic. and had them confirm the research findings. From the consultation, the recommendations were given to improve the study to be more complete and be able to be applied for managing coastal erosion in the upper Gulf of Thailand further.

Regarding the data analysis for testing the congruence of the structural equation model and empirical data, the researcher analyzed the data by estimating parameter values of the model through Maximum Likelihood Estimates and using an index to test the congruence between the model and empirical data. The index criteria for seven indexes, based on the concept of Diamantopoulos & Siguaw (2000) (as illustrated in Table 1), were applied.

The criteria used for testing the congruence are that more than three indexes from the total of seven indexes must pass the determined criteria (as illustrated in Table 1) as follows:

Table 1 the criteria for analyzing the congruence between SEM and empirical data

	Statistics for measuring the congruence	Criteria accepted as congruent
1.	χ^2	At the statistical significance level
2.	χ^2/df	< or = 5.00
3.	Comparative Fit Index (CFI)	> or = 0.90
4.	The goodness of Fit Index (GFI)	> or = 0.90
5.	Adjusted Good of Fitness (AGFI)	> or = 0.90
6.	Root Mean Square Error of Approximation (RMSEA)*	< or = 0.08
7.	Standardized Root Mean Square Residual (SRMR)	< or = 0.05

Note: 0.000 - 0.050 = a close fit, 0.051 - 0.080 = a reasonable fit

Source: Author's Study

From documentary analysis and in-depth interviews for developing the structural equation model of factors affecting the success of the coastal erosion management in the upper Gulf of Thailand, including from literature review of concepts, theories, and related studies, a research conceptual framework based on all analyses was developed.

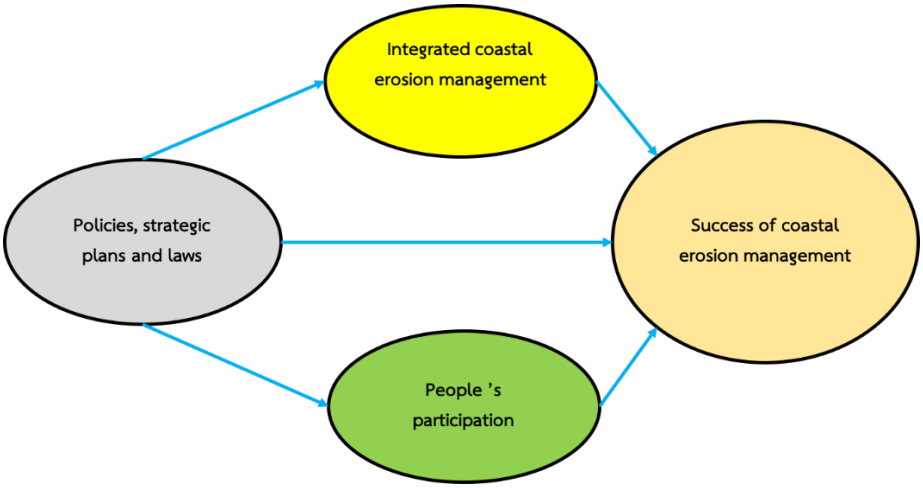

Figure 1 Research Conceptual Framework of the Structural Equation Model of Factors Affecting Success for Coastal Erosion Management in the Upper Gulf of Thailand

Source: Author's Study

Results and Discussion

1. Relationship between variables

Pearson's product moment correlation coefficient of all 4 latent factors in 6 pairs have a high level of positive correlation (.800 - .854) with statistical significance ($p < .01$) and Pearson's product moment correlation coefficient of 12 observed variables, 66 pairs, have a high level of relationship with 42 pairs and a moderate level of 24 pairs. Therefore, it was used to check the harmony of the model with empirical data.

2. Confirmation elements of the measurement model

The confirmatory factor analysis found that after adjusting the model between variables according to the program's suggestion by allowing the tolerance of some observed variables to be related for 3 times, then the measurement model according to the original conceptual framework which has harmony with empirical data ($x^2/df = 0.99$, GFI = 0.95, AGFI = 0.92, RMSEA = 0.063 and SRMR = 0.018)

3. Inspection of measurement models

3.1 Validity of observed variables

For the 12 observed variables, the adjusted standardized component weight values were between 0.559 - 0.889 in the positive direction and statistically significant ($p < .01$ in total.) The integrated coastal zone management of coastal erosion factor has the adjusted standardized component weight values between 0.715 - 0.793, the factor of people's participation has the adjusted standardized component weight values between 0.559 - 0.921 and the factor of success for coastal erosion management has the adjusted standardized component weight values between 0.765 - 0.869 (> 0.50).

3.2 Confidence of latent variables

Four latent variables have structural confidence and the mean variance of the extracted values which are higher than the specified criteria and are in good criteria in every latent variable. The structural confidence is between 0.883 - 0.932, which is in accordance with the criterion (CR> 0.70). The factor of success for coastal erosion management has the highest structural confidence, followed by the people's participation, integrated coastal zone management of coastal erosion and the policies, strategic plans, and laws related to coastal erosion management respectively, while the extracted variance mean values are between 0.736 - 0.821 (AVE> 0.50), which the management success factors have the highest extracted variance values, followed by the policies, strategic plans, and laws related to coastal erosion management, the integrated coastal zone management of coastal erosion and the people's participation respectively.

4. Structural model

The analysis found that after adjusting the correlation between the variables until they harmonize with the empirical data according to the harmony index according to the program's instructions, by allowing the error of some observed variables to be correlated 3 times, then get the model structural equation according to the original conceptual framework which are in harmony with empirical data ($x^2/df = 2.65$, CFI = 0.99, GFI = 0.95, AGFI = 0.82, RMSEA = 0.063 and SRMR = 0.019) where the RMSEA values are at a reasonable level of consistency. Therefore, this research accepted the research hypothesis that "The structural model is consistent with the empirical data.

5. Path of influence of structural model

5.1 Quality inspection of observed and latent variables

The results of the analysis of precision and the standard component weight of each observed variable show that 12 observed variables have moderate to high precision (0.63 - 0.87) and the standard component weight is acceptable (> 0.30) ranged between 0.55 - 0.86. The observed variable with the highest precision is the implementation of the policies, strategic plans, and laws related to coastal erosion management. The participation in the evaluation has the lowest the standard component weight value. For the relationships between the 4 latent variables, it was found that the latent pairs of the policies, strategic plans, and laws related to coastal erosion management and integrated coastal zone management of coastal erosion have the most correlation with coefficient of 0.96 and the latent pairs of the integrated coastal zone management of coastal erosion and the people's participation have the least correlation with coefficient of 0.87.

5.2 Direction and influence size

The analysis shows that the policies, strategic plans, and laws related to coastal erosion management has a positive direct influence on the integrated coastal zone management of coastal erosion and the people's participation (Influence values are 0.956 and 0.919) statistically significant ($p < .01$) but not statistically significant ($p < .01$) on the success for coastal erosion management. The integrated coastal zone management of coastal erosion and the people's participation have a positive direct influence on the success for coastal erosion management with statistical significance ($p < .01$) (the influence values are 0.539 and 0.438). For indirect influence, it was found that the success for coastal erosion management is indirectly influenced by the policies, strategic plans, and laws related to coastal erosion management (indirectly through integrated coastal zone management of coastal erosion and people's participation) with Statistical significance ($p < .01$) with the influence equals to 0.918. The total influence shows that the success for coastal erosion management is positively influenced by the policies, strategic plans, and laws related to coastal erosion management with statistical significance ($p < 0.01$) and the influence value of 0.935 from the integrated coastal zone management of coastal erosion with statistically significant ($p < .01$) and the influence value of 0.539 and from the people's participation with statistical significance ($p < .01$) and the influence value of 0.438. (as shown in Figure 2)

5.3 Predictive coefficients and structural equations

The analysis found that the predictive coefficient of the success for coastal erosion management can be explained by the combined variation of 3 factors: Policies, strategic plans, and laws related to coastal erosion management, integrated coastal zone management of

coastal erosion, and people's participation in coastal erosion management in the area with the percentage of 91.80 which the structural equation is 0.0823+ 0.539 * integrated coastal zone management of coastal erosion + 0.438 * people's participation + 0.0174 * Policies, strategic plans, and laws related to coastal erosion management

From the analysis of the structural equation model of the factors affecting the success of coastal erosion management in the upper Gulf of Thailand, it found that the developed model is congruent with empirical data and has all significant statistical values. This shows that the factors affecting the success of coastal erosion management in the upper Gulf of Thailand comprise the component of policies, strategic plans, and laws related to coastal erosion management, integrated coastal zone management of coastal erosion, people's participation, and success of coastal erosion management separating into 12 observed variables and 40 indicators. Therefore, in order to successfully manage coastal erosion, the above factors should be considered. This research is consistent with the related studies as follows:

1) The factor of the policies, strategic plans, and laws related to coastal erosion management has a positive direct influence on the integrated coastal zone management of coastal erosion and the people's participation but not on the success for coastal erosion management. In general, coastal erosion management is often initiated by the government or known as a top-down approach. The advantage is to look at the problem state and formulate a management strategy in the whole system but there may be restrictions on access to issues that are not profound. Policies and action plans are not appropriate for local human resources and not meeting local needs.

2) The factor of the integrated coastal zone management of coastal erosion and the people's participation have a positive direct influence on the success for coastal erosion management because coastal resources are public or public property, coastal erosion management by the government without the cooperation of the people in the management may result in unsuccessful coastal erosion management. It is important to have a mechanism for enabling those involved in coastal erosion management knowledgeable and understanding and the essential for integrated coastal zone management of coastal erosion as well as having mechanisms to negotiate benefits by changing concepts to benefit both parties to achieve acceptance and cooperation in management and lead to a truly integrated coastal zone management of coastal erosion.

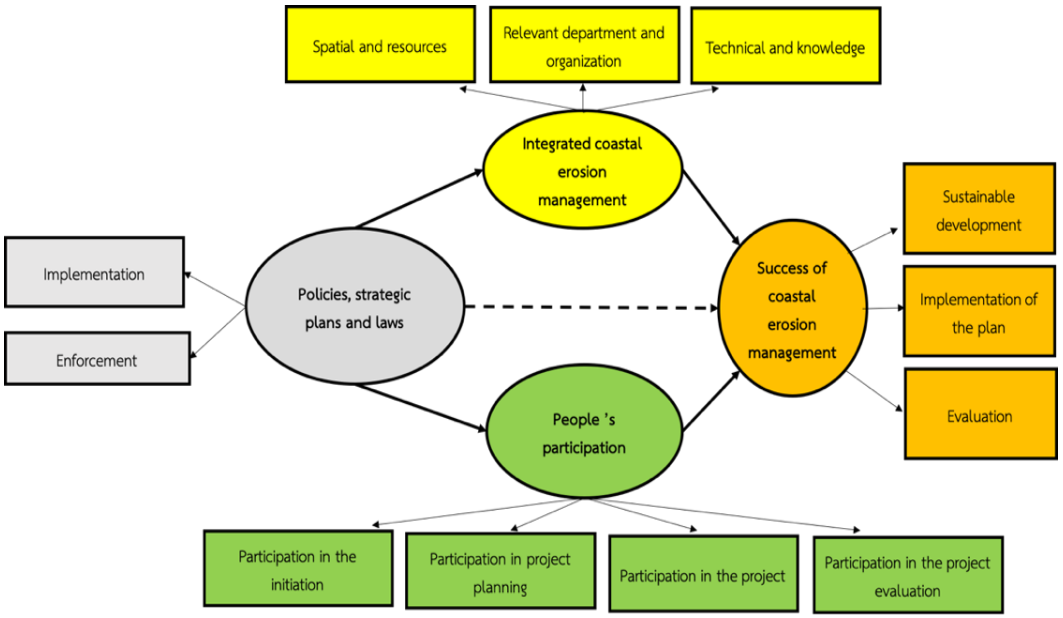

Figure 2 The Structural Equation Model of Factors Affecting Success for Coastal Erosion Management in the Upper Gulf of Thailand (Modified from the last step of the Study)
Source: Author's Study

Recommendations

1. Recommendations for Policies and Application

1.1 The government should encourage people to participate in coastal erosion management and shift its role from an operator to be a facilitator via some mechanisms, which may be applied in various forms, such as community-based management, cooperative management with some motivational measures, or having the private sectors to take parts in management. The enhancement of people's participation can help people to be well aware of the importance of the coast and stimulate their conscience for conserving and utilizing it worthily and sustainably.

1.2 It is very essential to provide some mechanism to equip concerned agents with knowledge, understanding, and awareness of necessities for integrated coastal zone management. Besides, some mechanisms should be used for negotiation towards mutual benefits, which will lead to acceptance and collaboration in management, especially integrated coastal zone management, genuinely.

1.3 The government sector must empower local personnel to be able to implement management plans, including regulating and monitoring coastal areas effectively.

1.4 Coastal erosion management needs to be conducted continually and adapted to be suitable for situations in each area and period. Thus, the structural equation model affecting success in coastal erosion management in the upper Gulf of Thailand developed from this study, is not a prototype for all areas. Those who are responsible for coastal erosion management, i.e., policymakers, planners, practitioners, etc. have to adjust patterns that are compatible with problems, political conditions, or management style of each area. Nevertheless, coastal erosion management may take time to see its accomplishment explicitly.

1.5 To ensure effective coastal erosion management, policy, or strategy planning requires an integration of both top-down and bottom-up patterns. Specifically, all stakeholders: central, regional, community, and other sectors have to collaborate in the planning or policy-making stage.

2. Recommendations for Further Studies

2.1 The study should be extended to other coastal areas to see if components of the factors of this study, namely factors of policies, plans, strategies, and laws related to coastal erosion management, integrated coastal zone management, people's participation, and success in coastal erosion management, could be applied similarly or differently.

2.2 Additional research should be conducted for preparing action plans of coastal erosion management, i.e., studies on the design of plans, projects, or activities for empowering personnel's and people's potential in integrated coastal zone management towards the success in coastal erosion management in Thailand.

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