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IMPACTS OF THE URBAN EMBANKMENT IN THE STRONG TIDAL CONDITION ON SOCIO-ECONOMIC DEVELOPMENT: A CASE STUDY OF BUNGXANG CANAL, CANTHO CITY

BY

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Abstract

The study aims at determining the impacts of the urban embankment of Bungxang Canal in the strong tidal condition on socio-economic development. Interview data for 209 people living inside and outside the area collected by convenience sampling. The author used descriptive statistical methods, Testing Cronbach's Alpha, Exploratory Factor Analysis (EFA) and Factor Score Matrix to identify 05 influencing factors including: Environment, Society, Economy, Transport and Entertainment. The observable variables in each factor are proportional to each factor in the model. From the research findings, we suggest several suitable solutions from the people and from the local authorities to socio- economic development of the embankment of Bungxang Canal in the strong tidal condition.

Keyword: Bungxang Canal, Can Tho City, Factor Analysis, Strong tide

1. INTRODUCTION

In this day and age, the world has been witnessing many changes in terms of economy, society, and environment. These fluctuations have a great influence on the development and stability of countries and regions on a global scale. One of the important issues that countries have agreed on is climate change of the Earth (Thang et al., 2010). It is considered as an urgent, global issue that no country or individual stands on the sidelines because of its direct impact on socioeconomic life and human health (Linh et al., 2022).

Vietnam is considered as one of the countries that is seriously affected by climate change (Thanget al., 2010). According to the Ministry of Natural Resources and Environment (2012) by 2100, sea level will have been rising by more than 01 meter (high scenario). As a result, around 90% of the land area of The Mekong Delta is flooded. Can Tho city, which is the center of the Mekong Delta region, will be flooded over 70% of the area. Climate change and the development of the upstream Mekong region have been greatly affecting and changing the hydrologic regime in the Mekong Delta. These impacts result in challenges in land and water use as well as economic development of the Mekong Delta Plan.

Can Tho city is located in the middle-downstream region and in the center of the Mekong Delta, stretching over about 65 km along the West bank of the Hau River, with a total natural area of 1,401.61 km2, accounting for 3.49% of the whole area. Can Tho city has no natural forest and is 75 km from the East Sea. Distances to other urban centers in the region are as follows: Long Xuyen 60km; RachGia 116km; Ca Mau 179 km, Ho Chi Minh City 169 km. (The portal of the Ministry of Natural Resources and Environment, 2020).

Since Can Tho City is located in a delta near the sea, the hydrologic and hydraulic regimes of rivers and canals in the Mekong Delta will be impacted by the tides, thus affecting the speed and height of water levels in rivers and canals in the region (Thai, 2014; Vinh, 2013). Hence, in the research process, the tidal mechanism in the river should be taken into account. At present, flood tides may exert detrimental impacts on people's lives in general and road and embankment in particular. In addition, the canals in Can Tho City also receive wastewater from households on both sides of the river, causing serious pollution to the water environment, one of which is Bungxang Canal. (Lien et al., 2019). Consequently, within the scope of this study, the authors selected

the topic "Impacts of the urban embankment in the strong tidal condition on socio-economic development: A case study of BungxangCanal, Cantho city" to analyze and evaluate the socio-economic efficiency and sustainability of this project.

2. LITERATURE REVIEW

In the research by Lechowska(2016), the impacts of embankments for land use in floodplains were analyzed. The study was carried out based on the case study of two cities along the Odra river in Poland: Olawa and Brzeg. Research has shown that with the urbanization of the delta, more and more people have faced flooding. Increasing urbanization makes it difficult to relocate households from flood areas and threatens politics as well as social security (Liao, 2014). As a result, infrastructure can only be relied on to tackle flooding in order to boost urbanization and economic growth. In addition, the study also shows the impacts of floods on agricultural production, services, and industry in the region. At the same time, flood prevention work needs to be balanced between the socioeconomic development needs of the city and the environmental issues in the region (Lechowska, 2016). In another study, Tuan and Hong (2012) conducted an interview survey on the impact of disasters and climate change on household scale. The survey results show that the information obtained is relatively realistic and reflects the expectations of local residents. People living in rural areas are more vulnerable to the effects of climate change than urban or peri-urban dwellers. Children, the elderly, the disabled, and the poor are the most vulnerable groups. Additionally, the disaster prevention of local people is not well-prepared. Preparation of inhabitants, information, and training from the government and civil organizations related to pollution, natural disasters, and climate change are inadequate. They also have not significantly changed people's behavior (Tuan & Hong, 2012).

In another research Linh (2020), a model for flood resilience and mitigation in cities, which allows floods to enter cities and restores interactions between floods and riverside ecosystems, was proposed. This is the flood-adaptive ecological awareness approach. Furthermore, the study also shows that the design of flood storage spaces in urban areas, especially open spaces, has provided local inhabitants with better understanding about the dynamics of floods. This helps them get a good grasp of natural and potentially harmful floods in order to implement self-adaptation measures to the change of strong tide (Linh, 2020). Another study by Ninh in 2007 shows that climate change is caused by human activities, which create changes in the hydro-climate system and exert long-term effects on the socio-economic development in the Mekong Delta. Also in this study, the lack of knowledge and education in response to changes in natural disasters or high tides is one of the reasons for the increased vulnerability of the vulnerable. The study shows that there is an urgent need for coordination between government agencies and the public in the development of feasible and effective mitigation and adaptation plans to strong tides and its impacts on the socio-economic of the region (Ninh, 2007).

3. OBJECTS AND METHODS

3.1. Objects

The study was conducted within the scope of Bungxang Canal Project, located in NinhKieu District, Can Tho City. This work is part of the Urban Upgrading Project in the Mekong Delta - Can Tho City Subproject. According to the project, the embankment of Bungxang Canal is funded by the World Bank's (WB)'s preferential credit with a total capital of 90.4 million USD (equivalent to 1,850 billion VND). The project has a total cost of VND 222 billion with a total area of over 12 hectares, located in Hung Loi, Xuan Khanh, and An Khanh wards of NinhKieu district. The project includes items for dredging mud; building a road around the Canal with a total length of over 2,800m connecting with existing traffic axes around the Canal area on the side of Nguyen Van Cu and Mau Than streets; building embankments around the Canal with a length of over 2,500m; building domestic water supply and drainage system connected to the city's common water supply system to supply domestic water for residential areas around Bungxang Canal (Urban Development Agency, 2015). Currently, the Bungxang Canal project has also been planned to be developed into a food street to attract tourists.

Picture 1: Bungxang Canal

Source: Cuu Long (2022)

The study collected a sample of 209 people and was conducted using the convenience sampling method. The selected subjects are those who enjoy the benefits or suffer the negative impacts in the strong tidal condition of Bungxang Canal construction.

3.2. Methods

3.2.1. Data collecting methods

This article uses secondary data collecting method: data is collected from domestic and foreign scientific articles, theses, and dissertations related to the study of socio-economic impacts of the Bungxang Canal project.

Additionally, the article also uses the primary data method: quantitative data collection with 209 people. The data collection process is conducted through two steps: Qualitative research (Step 1) and Quantitative research (Step 2). Step 1 includes building and developing a system of concepts, scales, and observable variables and calibrating to suit reality. Step 2 is conducted by formally interviewing inhabitants with a questionnaire consisting of two parts: general information and indicators. The questionnaire uses a 5-point Likert scale to exploit the information for the research in the most efficient way.

3.2.2. Data processing methods

The study uses descriptive statistics to identify, measure and present some information related to the research sample in table

form. In addition, the assessment of the socio-economic impacts of the Bungxang Canal is carried out through 3 steps.

Step 1: Using the reliability coefficient Cronbach's Alpha to test the degree of correlation of the items in the scale (Trong& Ngoc, 2008). Variables that do not guarantee reliability will be excluded from the research model.

Step 2: Using the factor analysis method EFA to test the factors influencing socio-economic development of the Bungxang Canal project.

Step 3: Using the Factor Score Matrix method to identify strong or weak variables of each factor in the model.

4. RESULTS AND DISCUSSION

4.1. Research sample description

Collect general information of the respondents as a basis for making relevant discussions. General information includes gender, age, and education level (Table 1).

Table 1: Research sample description (n = 209)

		Number	Value (%)
Gender	Male	112	53.6
	Female	97	46.4
Age	Under 16	03	1.4
	From 17 to under 30	115	55
	From 31 to under 59	88	42.2
	From 60 or above	03	1.4
Education level	Under high school	11	5.3
	High school	38	18.2
	Intermediate/ College	28	13.4
	University/Higher education	132	63.1

Source: Survey result, 2023

The results of the collection of 209 research samples showed that 53.6% of the respondents were men, while 46.4% were women. The age group under 16 years old comprised 1.4%. The age group from 17 to under 30 years old made up 55%, which accounted for the highest proportion in the sample. The proportion of the age group from 31 to under 59 years old and that of 60 years old and above was 42.2% and 1.4%, respectively. The highest percentage of respondents' education level was University/Undergraduate with 63.1%. The level below high school accounts for 5.3%; however, 18.2% and 13.4% respectively graduated High School and Intermediate/ College.

4.2. Factor analysis

4.2.1. Analysis of Cronbach's Alpha

The results of testing the reliability of the scale (Cronbach's Alpha) (Table 2), with 27 observable variables belonging to 3 groups of factors, show that most of the Cronbach's Alpha coefficients of the factors are high and the Corrected Item-Total Correlation is equal, ranging from 0.305 to 0.773 (Excluding the variable "RR7. Contributing to the development of the waterway economy" that has only a Corrected Item-Total Correlation of 0.28). According to Nunnally (1978), variables with total correlation coefficient ≥ 0.3 are eligible. Thus, there are 26 variables that are further included in the exploratory factor analysis EFA.

Table 2: Results of reliability test (Cronbach's Alpha) of the scale

Factor	Cronbach's Alpha	N of Items
1. Economy (E)	0,676	08
2. Society (S)	0,817	09
3. Environment (En)	0,863	09

Source: Survey results, 2023

4.2.2. The analyzing results of exploratory factor EFA

The scale of the influencing factors was tested for reliability (Cronbach's Alpha) with 26 variables all meeting the requirements. The author moves to the step of exploratory factor analysis EFA. The method used is Principal Components Analysis (PCA) with Varimax. The scale is accepted when $0.5 \leq KMO \leq 1$ (Hair et al., 1992); The coefficient Sig.= 0.000 of Bartlett's Test of Sphericity shows that the observed variables are correlated with each other, which is statistically significant. Total Variance Explained is ≥ 50% (Gerbing& Anderson, 1988). In addition, according to Hair et al. (1992), Multivariate Data Analysis from 0.5 is observable variable with good quality, with the minimum should be 0.3.

The results of the first and second-factor analysis have eliminated inappropriate observable variables in the research model. Specifically, the variables RR23, RR3, RR16, RR6, and RR27 were removed since they violated discriminant in exploratory factor analysis EFA.

Table 3: Result of variable type of exploratory factor test

No.	Symbol	Name	Reason for elimination
1	**RR23**	RR23. Soil: Reducing the condition of marsh, do not disturb the microorganisms in the soil.	Violation of discriminant in exploratory factor analysis EFA.
2	**RR3**	RR3. Contributing to better trade and transportation of goods.	

3	**RR16**	RR16. Contributing to increased security in the region.
4	**RR6**	RR6. Exploiting land funds, increasing land value and budget revenue.
5	**RR27**	RR27. Contributing to reducing dust and noise by minimizing traffic jams.

Source: Survey results, 2023

After eliminating inappropriate observable variables, 21 observable variables were included in the third exploratory factor analysis.

Table 4: Result of the third exploratory factor analysis EFA

Observable variables	**Component**				
	1	**2**	**3**	**4**	**5**
RR21. Contributing to preventing water from stagnation after rain	0.903				
RR25. Contributing to reducing stagnation of waste in the canal	0.88				
RR22. No more stench rising from waterlogging	0.87				
RR20. When the tide rises, water level will circulate faster	0.762				
RR26. Improving the water ecosystem	0.696				
RR24. View, green trees, water surface create a green - clean - beautiful environment for the city.	0.589				
RR11. Facilitating access to educational institutions		0.804			
RR10. Facilitating access to medical facilities		0.757			
RR14. Contributing to the improvement of transport infrastructure in the area		0.741			
RR13. Contributing to the development of a better public electricity system		0.665			
RR12. Contributing to the provision a better drinking water system		0.595			
RR15. Contributing to mitigating traffic jams on main roads		0.514			
RR1. Contributing to the development of service industries			0.839		
RR4. Contributing to promoting night economic models			0.758		
RR2. Contributing to increasing job opportunities			0.704		
RR8. Creating a safe route, reducing property and human damage				0.77	
RR9. The traffic system helps to increase the speed of traffic, save time, and fuel				0.639	
RR5. Having the potential to become a tourist attraction in the future				0.563	
RR19. Improving air quality due to many green parks				0.424	
RR17. Contributing to the creation of entertainment spots					0.834
RR18. Creating a new landscape, enhancing urban beauty					0.786
Eigenvalue	4.761	4.077	1.930	1.369	1.084
Cumulative	22.673	19.413	9.188	6.518	5.160
Total Variance Explained (%) = 62.953 ≥ 50%					
Sig. Bartlett = 0.000 < 0.05; 0.5 ≤ KMO = 0.777 ≤ 1					

Source: Student results, 2023

The results of the third EFA factor analysis (Table 4) with the KMO index = 0.777, mean that the factor analysis is completely consistent. The value of Bartlett's test is significant with Sig.= 0.00, showing that the observable variables are correlated with each other in terms of the total number of observations. At the same time, the eigenvalue value is 1.084 (>1), 21 variables are grouped into 05 groups of factors with a Total Variance Explained of 62.953% (≥ 50%), that is, the ability to use these 05 groups of factors to explain the original 21 observable variables is 62.953%.

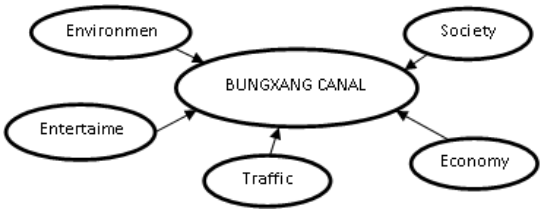
The first factor is formed with a total of 06 observable variables that are correlated with each other, including RR21, RR25, RR22, RR20, RR26, and RR24. The content of the first factor is related to environmental issues. More specifically, the first factor refers to the environmental element of Bungxang Canal that influences people's lives: contributing to reducing water stagnation after rain, allowing water to circulate faster during high tides, or solving problems related to the improvement of water ecosystems in the area. Therefore, the first group of influencing factors is named “Environment” (En) and denoted as F1 in the factor score matrix analysis.

The second factor is also formed with 06 observable variables, including RR11, RR10, RR14, RR13, RR12, and RR15. The content of the second factor refers to issues related to the social benefits of the Bungxang Canal construction; for instance, facilitating better access to healthcare facilities, schools or improving electricity, water, and social security systems in the area. Therefore, the second factor is named "Social" (S) by the author and denoted as F2 in the factor score matrix analysis.

The third factor is named “Economy” (E) and denoted as F3 in factor score matrix analysis. This third factor is formed by 03 observable variables in the whole model: RR1, RR4, and RR2. The group of factors is named "Economy" since it refers to the effects of the Bungxang Canal project on economic growth in the region, especially on models of night business. At the same time, the project also provides residents with opportunities to boost their income and improve their life quality.

The fourth factor in the model is formed by 04 observable variables that are correlated with each other, including RR8, RR9, RR5, and RR19. This group of factors is directly related to traffic issues in the area. More specifically, it considers the effects of the building on traffic flow as well as transport system safety inside and outside the area. Hence, it is named the factor “Traffic” (T) and denoted as F4 in the factor matrix analysis.

The final factor, or the fifth factor, is formed with only 02 observable variables, including RR17 and RR18. The content of this group of factors refers to the impacts of the Bungxang Canal project on the entertainment aspect of inhabitants inside and outside the area. Therefore, the author named the factor "Entertainment" (Ent) and denoted it as F5 in the factor score matrix analysis.



Picture 2: Research models
(Source: Author, 2023)

4.2.3. Result of factor score matrix analysis

Next, the researcher conducts a factor score matrix analysis to consider the contribution of the component variables in the five groups of factors, whether they have a strong or weak impact, in the same direction or in the opposite direction with each factor from F1 to F5. The results of the factor score matrix analysis are presented in Table 5 below.

Table 5. Results of factor score matrix analysis

Observable variables	Component				
	F1	F2	F3	F4	F5
RR21. Contributing to preventing water from stagnation after rain	0.234				
RR25. Contributing to reducing stagnation of waste in the lake	0.232				
RR22. No more stench rising from waterlogging	0.226				
RR20. When the tide rises, water level will circulate faster	0.177				
RR26. Improving water ecosystem	0.170				
RR24. View, green trees, water surface creates a green - clean - beautiful environment for the city.	0.124				
RR11. Facilitating access to educational institutions		0.275			
RR10. Facilitating access to medical facilities		0.263			

RR14. Contributing to the improvement of transport infrastructure in the area	0.27
RR13. Contribute to the development of a better public electricity system	0.2
RR12. Contributing to providing a better drinking water system	0.201
RR15. Contributing to reducing pressure of traffic jams on main roads	0.175
RR1. Contributing to the development of service industries	0.433
RR4. Contribute to promoting night business models	0.383
RR2. Contributing to increasing job opportunities	0.328
RR8. Create a safe route, reducing property and human damage.	0.529
RR9. The traffic system helps increase the speed of traffic, save time, and fuel	0.411
RR5. Having the potential to become a tourist attraction in the future	0.386
RR19. Improving air quality due to many green parks	0.25
RR17. Contributing to the creation of entertainment spots	0.527
RR18. Create a new landscape, enhance urban beauty	0.479

Source: Survey results, 2023

From the results of the factor score matrix analysis in Table 5, it can be seen that: The first factor (F1) is represented as a factor of "Environment" with the following form F1 = 0.234*RR21 + 0.232*RR25 + 0.226*RR22 + 0.177*RR20 + 0.170*RR26 + 0.124*RR24. This proves that the observable variable "RR21. Contributing to preventing water from stagnation after rain" has the strongest impact on the environmental factor among 06 observable variables with a coefficient of 0.234.

The multiplier of the second factor (F2) expressed for the "Social" factor has the following form: F2 = 0.275*RR11 + 0.263*RR10 + 0.27*RR14 + 0.2*RR13 + 0.201*RR12 + 0.175*RR15. Accordingly, the variable "RR11. Facilitating access to educational institutions" has the strongest impact among the six observable variables of the model.

The multiplier the third coefficient (F3) is expressed as: F3 = 0.433*RR1 + 0.383*RR4 + 0.328*RR2. This is the multiplier representing the "Economy" factor in the research model discussed in the topic. As a result, it can be seen that the observable variable RR1 "Contributing to the development of service industries" has the largest contribution to the F3 factor of the model.

The multiplier of the fourth factor (F4) representing the factor "Traffic" is written as F4 = 0.529*RR8 + 0.411*RR9 + 0.386*RR5 + 0.25*RR19. This proves that the variable "RR8. Creating a safe route, contributing to reducing property and human damage" has the most significant impact among the four observable variables of this factor.

The multiplier of the fifth factor (F5) is written as follows: F5 = 0.527*RR17 + 0.479*RR18. This is the multiplier representing the factor "Entertainment" in the research model and the observable variable "RR17. Contributing to the creation of entertainment spots" is the variable with the strongest impact on the factor.

In general, all observable variables have positive coefficients. This shows that the variables have a proportional impact with each factor in the model. As a consequence, it can be concluded that any positive effect on an observable variable in the model increases the value of each factor influencing the sustainable development of the Bungxang Canal in the strong tidal condition.

5. CONCLUSION AND SOLUTION

The research results identify five factors heavily affecting the sustainable socio-economic development of the Bungxang Canal under the impact of strong tides. These five factors include Environment, Society, Economy, Transport, and Entertainment. All three factors explain 62.953% variation of satisfaction and the remaining 37.047% variation is explained by other variables outside the model that the limited scope of the study has not mentioned. This is an issue that needs to be considered for future studies. The study also provides a scientific basis for studying the socio-economic impacts of the Bungxang Canal project in the strong tidal condition and also a basis for politicians to make policies for sustainable development for the area. On that basis, the article authors propose the following solutions:

The role of residents living inside and outside Bungxang Canal area

Firstly, city dwellers living inside and outside the Bungxang Canal area need to improve their responsibility and understanding for environmental protection and be more environmentally conscious. Good environment protection not only brings immediate practical

benefits to local people but also benefits future generations. In addition, inhabitants should be conscious of the dire consequences of electric fishing that causes serious biodiversity loss both inside and outside the area. What is more, they need to have standard behaviors in discharging waste into the environment. As a result, raising awareness and halting actions leading to environmental degradation is essential, especially when climate change is taking place on a global scale.

Second, residents need to be fully aware of the public property's preservation of the state in the Bungxang Canal area. The public properties of the country include street light systems, traffic systems on sidewalks (embankments) or green tree systems beautifying the environment, etc. All contribute to creating an ecosystem for the area. Therefore, good preservation of public properties helps the country and local authorities save repair costs, ensure social security and promote tourism.

Third, local residents and people coming to Bungxang Canal need to comply with the law, especially the Traffic Law. Compliance with the law in general and the Traffic Law, in particular, helps ensure security and minimize the number of traffic accidents in the area. At the same time, restaurants and services in the area are required to follow the rule to provide customers with the best service experience.

Fourth, inhabitants need to participate in proposals and contribute their opinions to functional agencies or local authorities to improve the socio-economic situation in the Bungxang Canal area. Contributing and proposing opinions from the community perspective are likely to be a necessary database for the state to plan sustainable development policies for the region.

Fifth, city dwellers in the Bungxang Canal area need to take measures to adapt to the change of high tide until the flooding problem is completely solved by the authority, making their lives and businesses less affected by flooding.

Sixth, Bungxang Canal has now been invested in and planned to become one of the most famous Food Streets in Can Tho City. Every year, this place attracts a great number of visitors using the services in the area. Therefore, businesses and services in Bungxang Canal not only need to comply with the law of business, food safety, and hygiene (for restaurants) but they also need to welcome visitors with a good service attitude. This helps boost the tourism industry in Can Tho City as well as provide income for household businesses in the area.

The role of local authorities

Firstly, local authorities should regularly propagate and mobilize to raise people's awareness of environmental protection. This issue should be solved by mass organizations such as the Youth Union, Women's Union, Labor Federation, or NGOs working on environmental issues in Vietnam. This will allow citizens to change their views and perceptions, thereby promoting actions in protecting the living environment in the Bungxang Canal. In addition, the government needs to coordinate with mass organizations to organize "Environment Day" for inhabitants to collect waste and renovate the environment at the canal surface. Garbage collection should be carried out on a frequent basis to limit floating and decomposing waste and prevent bad odors.

Secondly, local authorities need to increase investment and equip more facilities for Bungxang Canal area, especially for street lights in some areas. Lack of lighting system at night may negatively affect local security and cause traffic problems. Hence, investment in more facilities in general and street lights in some areas in Bungxang Canal in particular helps increase security and create psychological stability for people in the area.

Thirdly, local authorities need to have appropriate, long-term urban planning plans for the Bungxang Canal area to tackle the problem of flooding at times of high tide. The sudden rise of strong tides at certain times can greatly affect people's lives inside and outside the area. Along with measures for residents to adapt to strong tides, local authorities need to take more feasible measures to cope with flooding, bringing positive impacts to residents living inside and outside the area.

Fourthly, the government needs to strictly punish violations of the Government Law, especially for local household businesses to ensure food hygiene and safety and preserve urban landscape. Additionally, it is necessary to establish a network of inspection and assessment of food hygiene and safety at restaurants and food businesses by checking the origin of each type as well as kitchen supplies for processing food and beverages. This will enhance tourists' confidence when using services at Bungxang Canal food street, thus promoting tourism.

Fifthly, the government should regularly organize consultation sessions for people inside and outside the area to express their views and opinions. This is an important database for the authorities to plan development policies for the Bungxang Canal area in general and Can Tho City in particular.

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