



## Enhancing Resilience from Pandemics in Urban and Rural Settlements of Nakhon Ratchasima Province, Northeastern Thailand

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<https://doi.org/10.18280/ijstdp.190707>

### ABSTRACT

**Received:** 21 March 2024

**Revised:** 29 April 2024

**Accepted:** 20 May 2024

**Available online:** 30 July 2024

#### Keywords:

*COVID-19, enhancing capacity, human settlements, social ties, urban resilience, urban system*

The COVID-19 pandemic has highlighted the vulnerabilities of urban systems during health crises, particularly in smaller cities and rural communities where resilience strategies remain underexplored. This study addresses this gap by examining urban and rural responses in Nakhon Ratchasima Province, Thailand, providing a comprehensive perspective on pandemic resilience strategies tailored to diverse environmental contexts and demographic setups. The study aims to identify key factors enhancing resilience and to assess the effectiveness of different strategies across these varied settings. Findings reveal significant differences in resilience capacities: urban and rural settings benefit from diverse occupational structures and infrastructures, supporting dynamic pandemic responses; rural areas leverage strong community bonds but are constrained by resource limitations. This underscores the need for context-specific strategies that integrate social capital into resilience planning, emphasizing community initiatives and participatory governance. However, the study acknowledges limitations, primarily its focus on COVID-19 and challenges in defining urban systems' parameters, suggesting that future research should expand to include a broader spectrum of pandemics and disasters.

## 1. INTRODUCTION

The COVID-19 pandemic has heightened awareness of the vulnerabilities inherent in urban systems during health crises. While extensive research has been dedicated to exploring how major metropolitan areas withstand such shocks, there remains a critical gap in our understanding of how smaller cities and rural communities respond to and manage these challenges.

The rationale for this dual focus is underscored by the varying capabilities and resources between urban centers and their rural counterparts. For instance, urban areas often benefit from more robust healthcare infrastructure but suffer from higher population densities that can accelerate disease transmission. In contrast, rural areas may lack advanced medical facilities but typically have stronger community ties that can be leveraged for rapid grassroots responses. This contrast prompts a need for resilience strategies that are not only effective but also adaptable to diverse environmental contexts and demographic setups.

The objectives of this study aim to:

- Determine the key factors that play a significant role in enhancing resilience in both urban and rural settlements during pandemics.
- Investigate the implementation and effectiveness of resilience strategies across these varied settings.

By focusing on these aims, the study intends to deliver new insights into the multifaceted impacts of pandemics and need

for tailored resilience strategies can mitigate these effects across different settlements. This will be achieved by examining both urban and rural settings for the case in Nakhon Ratchasima Province, Northeastern Thailand.

Although this study does not focus exclusively on the urban-rural context of Southeast Asia, it recognizes that Thailand is an integral part of this region. By focusing on Thailand, this research aims to contribute valuable knowledge that can be applied more broadly across Southeast Asia. The explicit statement regarding the gap in understanding urban resilience during a pandemic in a country of Southeast Asia highlights the need for more localized studies. Therefore, the contribution of this study is twofold: it provides insights at the national level for Thailand and serves as a case study that can inform resilience strategies in other Southeast Asian countries.

## 2. LITERATURE REVIEW

### 2.1 Urban system in the context of pandemics

Urban systems are complex networks and interactions of governance, infrastructure, energy-material flows, and socioeconomic that shape the life and development of cities. By each function, the governance networks facilitate decision-making and policy implementation, the networked flows of materials and energy that sustain urban life, the physical urban

infrastructure and form that constitute the city's backbone, and the socioeconomic dynamics that drive urban inequality and development [1]. Focusing on urban sub-systems is essential for achieving comprehensive resilience and sustainable development [2].

In the context of pandemic, critical areas for urban systems include enhancing public health infrastructure, implementing resilient urban governance, promoting socioeconomic equity, and fostering sustainable urban planning. Strategies emphasized include participatory community-led responses for inclusive policies [3], adaptable governance mechanisms for sustainability [4], and urban design improvements integrating transportation and green spaces to boost public health [5]. These approaches bridge the gap between urban resilience and effective pandemic response, underscoring the importance of adaptive and inclusive governance strategies in managing pandemic impacts on cities.

However, although those approaches full fill the gap between urban resilience and pandemic response, they remain focused on physical environments and mostly focused on a city area. There's a significant need to expand our understanding to rural and non-metropolitan regions to ensure comprehensive resilience and effective response across different geographical and socio-economic landscapes.

## **2.2 Sustainable development and resilience**

Sustainable development and resilience are interlinked concepts crucial for enhancing the capacity of communities and systems to endure and thrive amid challenges like pandemics. Sustainable development, defined as meeting present needs without compromising future generations' ability to meet theirs, includes social, economic, and environmental dimensions. This study grounds its resilience dimensions in these principles. Social resilience involves communities' ability to recover from disruptions through strong social networks and support systems, assessed via community engagement and public health infrastructure. Economic resilience includes the capacity of economic systems to absorb shocks and adapt to changes, measured by employment rates, income levels, and economic diversity. Environmental resilience refers to environmental systems' capacity to endure and recover from stresses, with indicators like biodiversity and resource availability. These dimensions align with urban system elements such as governance networks and socio-economic dynamics, emphasizing leadership, community participation, economic diversity, and sustainable practices for long-term resilience. Integrating these dimensions into the research framework provides a holistic understanding of resilience, capturing the interconnectedness of social, economic, and environmental factors within urban systems [6-9].

## **2.3 Urban resilience and pandemics**

Urban resilience refers to the ability of urban systems to withstand, adapt to, and rapidly recover from various shocks and stresses, including natural disasters, climate change, economic fluctuations, and pandemics. It ensures the continuity of critical functions and infrastructures, safeguarding the well-being and sustainable development of urban populations. Recent years have magnified the importance of urban resilience as cities face increasingly complex and interconnected challenges [10].

The evolution of urban resilience theory has focused on adapting cities to resist and recover from diverse shocks, integrating disaster risk management (DRM) principles into governance and urban planning processes. This comprehensive approach emphasizes proactive planning, preparedness, and adaptive strategies [2]. Key literature underscores the integration of ecological, social, and infrastructural aspects as crucial for enhancing urban resilience. Multidisciplinary approaches are necessary to manage and mitigate risks effectively [3, 4]. Studies highlight collaborative methods for disaster resilience across various countries, underscoring the need for interdisciplinary frameworks [5, 10].

However, a significant gap exists in urban resilience literature, which often overlooks the unique challenges posed by pandemics, such as medical resource shortages and the enforcement of public health measures [11-15]. The COVID-19 pandemic has exposed this oversight, underscoring the need for frameworks specifically addressing urban resilience to health crises [16]. Recent studies have begun developing general frameworks for pandemic resilience in cities and urban-rural communes. For instance, Tokyo neighborhoods leveraged social capital and innovation to navigate COVID-19 challenges, emphasizing local networks and community initiatives [17]. In Eastern Poland, place attachment was crucial during the COVID-19 crisis, highlighting the need for local governments to integrate urban and rural residents [18]. Similarly, a study in Indonesia examined the impacts and coping strategies of vulnerable groups during the pandemic, emphasizing the challenges faced by the government in providing timely assistance [15]. Findings from the U.S. highlighted the importance of leveraging local assets, maintaining diversified economies, and fostering strong community networks to enhance rural resilience [20].

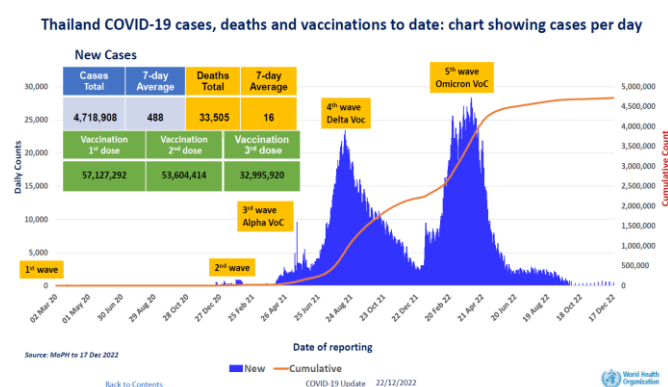
The growing body of research on urban resilience in pandemics underscores the necessity of expanding traditional disaster resilience frameworks to comprehensively address health crises. Case studies from Tokyo, Eastern Poland, Indonesia, and the U.S. illustrate the critical role of social capital, community networks, place attachment, and targeted government interventions in enhancing resilience capacities in both urban and rural settlements. These insights provide a pivotal transition from theoretical frameworks to specific policy implementations and responses, exemplified by Thailand's context.

## **2.4 Context and policy against COVID-19 in Thailand**

The World Health Organization's review of Thailand's COVID-19 response highlights initial success due to rapid action, robust healthcare infrastructure, and effective leadership, which built public trust. However, ongoing challenges included healthcare professionals' stress from information overload and economic difficulties from lockdowns for vulnerable urban populations. Consistent public communication and regional cooperation were emphasized to prevent pandemic fatigue and maintain resilience strategies (WHO, 2022) [21]. Figure 1 shows the COVID-19 case trends in Thailand from March 2020 to December 2022, with a surge in April 2021 followed by a decline [22].

Thailand's response has been praised for resilience and solidarity, leveraging early action, a strong healthcare system, and community engagement. Significant investments in health

infrastructure over four decades, including 1,000 public hospitals and 10,000 primary healthcare units, were crucial. Early screening and strict quarantine measures were implemented days after the first pneumonia reports in Wuhan, coordinated by the Center for COVID-19 Situation Administration (CCSA) led by the Prime Minister. Universal health coverage since 2002 ensured free COVID-19 treatment for all residents, including non-Thai citizens. Over one million village health volunteers played a key role in rural areas, conducting health education and virus surveillance. The government introduced economic stimulus packages worth about 15% of GDP, including cash handouts, soft loans, and social protection measures for the elderly, children, and people with disabilities. Innovative solutions like the "Bubble and Seal" approach helped contain outbreaks in high-risk areas. Comprehensive coordination across government, civil society, and the private sector ensured engagement in health and economic response efforts. This multifaceted response offers valuable lessons for other middle-income nations (WHO, 2022) [21, 23-27].



**Figure 1.** Thailand COVID-19 cases, deaths and vaccinations: chart showing cases per day  
Source: [21]

## 2.5 Challenges of enhancing urban resilience during a pandemic

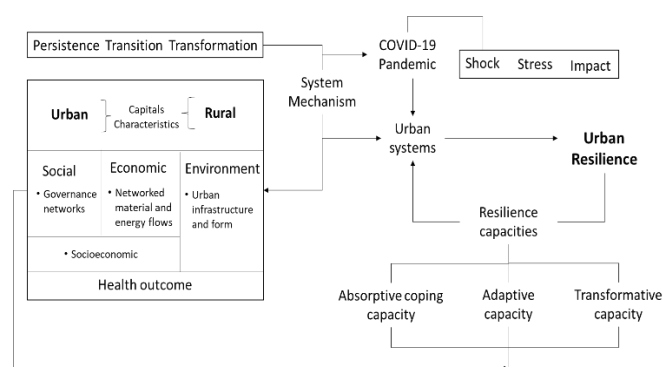
Building on the literature about urban resilience reveals a critical need to address health crises like pandemics more explicitly within resilience frameworks. Traditionally focused on ecological and economic shocks, recent studies have begun to confront the unique challenges posed by pandemics, such as issues in digital infrastructure [28], environmental concerns like plastic pollution [29], adaptation to new ways of working and learning [30], and the vital role of social capital [31]. These focuses provide valuable insights for tailoring resilience enhancing strategies.

## 3. METHODOLOGY

The study employs a mixed methods approach to understand urban pandemic resilience. The quantitative component relies on the epistemological assumption of measurable knowledge and utilizes numerical data to analyze social, economic, and environmental factors alongside health and well-being impacts during pandemics. This approach facilitates systematic data collection and statistical analysis to identify significant correlations and patterns. Additionally, the study incorporates qualitative data from stakeholders, experts,

and residents to gain deeper insights into their experiences and perspectives on urban resilience. By analyzing qualitative data separately, the study aims to complement and enrich the quantitative findings. This comprehensive approach seeks to elucidate the key factors shaping urban pandemic resilience and inform practical strategies for enhancing it in future public health crises.

Therefore, to examine urban resilience in the face of pandemics, the study's framework, as illustrated in Figure 2, examines the components of the urban system situated within three domains: social, economic, and environmental. These systems comprise governance networks, resource flows, infrastructure, and socioeconomics. The study investigates mechanisms for urban systems to build resilience in pandemics and explores how enhancing resources and local characteristics can create more resilient urban environments. Ultimately, it aims to understand how settlements can effectively response, recover, and improve their overall resilience in the face of pandemics.



**Figure 2.** Conceptual framework of the study  
Source: [1, 2, 32]

In addition to outlining the methodological details, the study adhered to the ethical principles for social science research as stipulated by the Forum for Ethical Review Committees in Thailand. This included upholding human dignity, ensuring free and informed consent, respecting privacy and confidentiality, minimizing harm, and promoting justice. All participants were fully informed about the study's aims and procedures, and their consent was obtained prior to data collection. These measures guarantee the integrity and reliability of the research, aligning it with the highest ethical standards required for studies involving human participants.

### 3.1 Approach and overall methodology

This study explores urban resilience during pandemics through a framework informed by urban and health literature. It considers various resources (social, economic, environmental) and local characteristics affecting urban systems' stability. These areas encompass the multifaceted nature of urban life and are critical to understanding how settlements can maintain functionality during health crises. The social component considers the human element, including community networks and public health responses. The economic aspect reviews the continuity of businesses and the impact on the workforce. The environmental dimension looks at how urban spaces and infrastructure can be adapted for resilience, such as through green spaces or redesigned public areas to promote social distancing. By integrating these components, the framework aims to provide a holistic view of

urban resilience, capturing the complex interplay between these sectors and identifying leverage points for enhancing the city's overall preparedness and response to pandemics. This integrated analysis is essential for developing multifaceted solutions that are responsive to the diverse challenges posed by pandemics in urban settings.

The key steps are as follows.

Step 1: explore capital resources of the settlements in urban and rural contexts.

Step 2: explore COVID-19 pandemic in settlements in urban and rural contexts.

Step 3: explore three system mechanisms and response to the pandemic.

Step 4: explore resilience capacities of the settlements in urban and rural contexts.

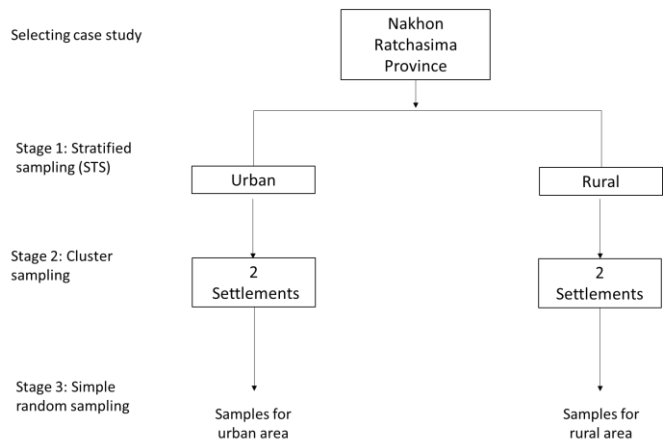
Step 5: discussion of the findings and implications.

### 3.2 Study area

Nakhon Ratchasima Province is selected as the area of study; it is located in the northeastern part of Thailand, which is also known as “the gateway to the Northeast.” There are various settings in Nakhon Ratchasima which are the largest province in Thailand. The province is experiencing tremendous development, where plans in the provincial Development plan 2018-2022 are huge. The diversity in the characteristics of Nakhon Ratchasima also makes it a suitable study area for examining pandemic resistance.

Moreover, this study employs multi-stage cluster sampling to analyze urban resilience at the subdistrict administrative organization level within Nakhon Ratchasima province.

Following Figure 3, the first stage involves stratifying the settlements into urban and rural areas based on predefined criteria. The second stage utilizes cluster sampling within each stratum, selecting two settlements from each urban and rural area. This selection assumes a degree of similarity within each area type. Finally, random selection determines the specific subdistrict organizations included in the study.



**Figure 3.** Steps in selection of study areas

The chosen settlements (also included in Figure 4) are:  
 Nakhon Ratchasima City Municipality: The provincial capital, serving as a central hub with critical administrative, economic, and social functions. It represents a core urban environment influencing and interacting with surrounding municipalities.

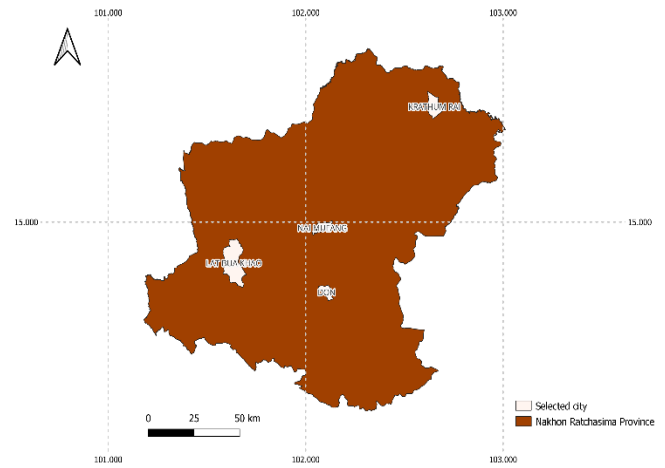
Lat Bua Khao Subdistrict Municipality: A smaller urban area with distinct economic activities, infrastructure

development, and community dynamics compared to the provincial capital.

Kratum Rai Subdistrict Administrative Organization: Another distinct rural scenario, potentially showcasing further variations in size, economic base, and social fabric.

Don Subdistrict Administrative Organization: A rural setting offering a different perspective on urban resilience strategies within the province.

The diverse characteristics of these settlements enable a rich analysis of how different settlements within the same province approach pandemic response and adaptation, ultimately revealing key factors influencing urban resilience. The population data for these settlements are provided in Table 1.



**Figure 4.** Map of selected province and study areas, Northeastern Thailand  
 Source: [33]

**Table 1.** Population data for selected settlements

Settlements	Type of Settlement	Population	Area (Km. sq)	Density (Person /km.sq.)
Kratum Rai Subdistrict Administrative Organization	Rural	7,216	59.256	122
Don Subdistrict Administrative Organization	Rural	4,193	50.00	84
Lat Bua Khao Subdistrict Municipality	Urban	4,156	7.54	551
Nakhon Ratchasima City Municipality	Urban	122,730	37.5	3,273

Source: [34]

### 3.3 Data collection and analysis methods

#### 3.3.1 Data collection

The study utilizes two primary data collection techniques: a cross-sectional survey and interviews. The cross-sectional survey involves administering a questionnaire at a single point in time to gather data from a representative sample of the population. This method efficiently collects data from many participants, targeting a sample size of 385 to ensure a 95% confidence level and a 0.05 margin of error. The ratio of rural to urban samples is set at 1.0:2.3, reflecting the population

distribution in Nakhon Ratchasima Province. The sample size ensures high confidence in the results, adequate power to detect real effects, and feasibility during pandemics. Sampling recruitment is based on geographical coverage and demographic representation, selecting participants from diverse environmental and socio-economic conditions and ensuring a wide range of ages, genders, and socio-economic statuses.

For qualitative data, in-depth interviews and focus group discussions involve key informants and community members from both urban and rural areas. The samples include 3 persons from rural settlements and 5 persons from urban settlements, chosen for their community roles, experience, and expertise. Key informants include healthcare workers, local government officials, business owners, and community leaders who provide insights into the community's response to pandemics. Additionally, individuals with specific knowledge or experience related to urban resilience, such as urban planners, emergency responders, and social workers, are included.

The integration of these selection criteria with the study's objectives ensures that both quantitative and qualitative methodologies contribute directly to understanding and improving urban resilience during pandemics. The quantitative component identifies and quantifies the prevalence and impact of various resilience factors and strategies, while the qualitative component provides depth, context, and insight into real-world applications. This dual approach enriches the data, ensuring well-rounded conclusions grounded in empirical evidence and human experience, leading to more effective and actionable recommendations for enhancing urban resilience in future pandemics.

Data collection occurred between January and October 2022, during the omicron variant outbreak in Nakhon Ratchasima Province, Thailand, involving 387 samples from four settlements: Nakhon Ratchasima City Municipality and Lat Bua Khao Subdistrict Municipality (urban areas), and Krathum Rai Subdistrict Administrative Organization and Don Subdistrict Administrative Organization (rural areas).

### 3.3.2 Data analysis

For analysis, this study employs multiple regression analysis to investigate the specific factors contributing to urban resilience during pandemics. This technique facilitates the exploration and quantification of relationships between urban resilience (dependent variable) and various explanatory variables (independent variables).

Dependent Variable (Y): Urban resilience from the pandemic, representing the primary outcome of interest.

Independent Variables (X): Various factors or indicators hypothesized to influence urban resilience. The selection of independent variables in the regression model was guided by a combination of theoretical considerations and empirical evidence, ensuring that the variables included are relevant and significant for understanding resilience in both urban and rural contexts. For example, capital including social, economic and environment in different settlements can contribute to different result of urban resilience.

Social capital includes variables such as shared living spaces and access to utilities, which impact the ability to maintain hygiene and social distancing.

Economic capital is influenced by the type of occupation and financial stability within households, contributing to the

community's ability to absorb economic shocks.

Environmental capital involves the physical characteristics and infrastructure of an area, where better urban planning and well-constructed housing enhance resilience by supporting effective crisis management and health practices.

Moreover, NVIVO's word cloud technique is utilized to analyze qualitative data from interviews. This method effectively visualizes word frequency, revealing recurring themes and ideas related to resilience capacity and urban resilience expressed by participants.

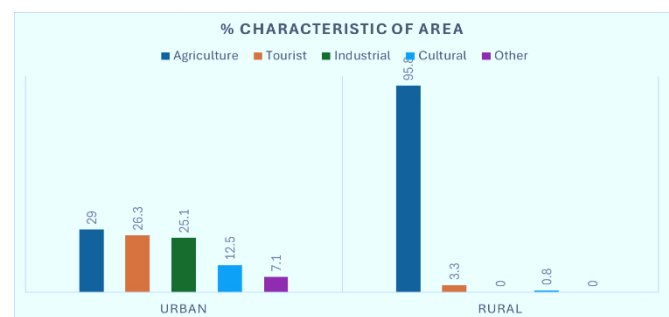
This combined approach provides a comprehensive and robust assessment of factors contributing to urban pandemic resilience, ultimately supporting the study's objectives.

## 4. RESULTS AND DISCUSSIONS

### 4.1 Capital resources of the settlements in urban and rural contexts

In examining the capital resources of settlements within urban and rural contexts, it is essential to consider the varied socio-economic and environmental landscapes that characterize these different settings.

Based on Figure 5, within urban settlement, predominantly characterized by a mixture of traveling (26.3%), industrial (25.1%), and cultural activities (12.5%) while rural settings heavily dominated by agriculture (95.8%), with very little representation of other activities.



**Figure 5.** Characteristics of study areas by settlements

Source: Questionnaire survey based on the four settlements and analyzed by descriptive statistics

Table 2 illustrates distribution of human capital across urban and rural settlements, revealing distinct occupational patterns and age demographics. Urban areas display a diverse occupational structure, with a significant 51.9% of individuals employed in government organizations and noticeable representation in business (12.1%), health (9.8%), and other sectors (12.5%). In contrast, rural areas are predominantly agricultural, with 55.1% of the population engaged in farming, and much lower percentages in other sectors, reflecting a less diverse job market. The average age is comparable between urban (46 years) and rural areas (47 years), but urban areas have a wider age range, indicated by a higher standard deviation (14 years) compared to rural areas (11 years).

Table 3 illustrates physical capital by urban and rural settlements. In urban settlement, the most common type of house is a detached house (69.4%), followed by provided accommodation (8.7%) and commercial buildings (5.7%). In rural settlement, detached houses are even more prevalent (92.5%), with very few residents living in other types of housing. When it comes to shared living spaces, 47.9% of



urban residents share a bedroom compared to 54.4% in rural areas. Bathroom sharing is more common overall, with 79% in urban settlement and 92.2% in rural areas sharing this facility. Nearly all residents in both urban (98.9%) and rural (99.1%) settings have access to electricity and water.

**Table 2.** Human capital by urban and rural settlements

Human Capital	Settlement			
	Urban Frequency	%	Rural Frequency	%
Occupation				
Government Organization	137	51.9	42	35.6
Business	32	12.1	2	1.7
Transportations	1	0.4	0	0.0
Agriculture	19	7.2	65	55.1
Education	8	3.0	2	1.7
Food	8	3.0	0	0.0
Health	26	9.8	5	4.2
Other	33	12.5	2	1.7
Total	264	99.9	118	100
	Mean	SD	Mean	SD
Age (years)	46	14	47	11

Source: Questionnaire survey based on the four settlements and analyzed by descriptive statistics

**Table 3.** Physical capital by urban and rural settlements

Physical Capital	Settlement			
	Urban Frequency	%	Rural Frequency	%
Types of house				
Detached house	184	69.4	111	92.5
Small room in other's house	15	5.7	1	0.8
Townhouse	12	4.5	2	1.7
Condominium/apartment	10	3.8	3	2.5
Commercial building	15	5.7	1	0.8
Provided accommodation	23	8.7	1	0.8
Recreational vehicle	0	0.0	1	0.8
Other	6	2.3	0	0.0
Total	265	100	120	99.9
Share a bedroom				
Share	127	47.9	62	54.4
Not share	138	52.1	52	45.6
Total	265	100	114	100
Share a bathroom				
Share	207	79	107	92.2
Not share	55	21	9	7.8
Total	262	100	116	100
Accessing electricity and water				
Accessible	258	98.9	116	99.1
Inaccessible	3	1.1	1	0.9
Total	261	100	117	100
Vehicle used for daily travel				
Drive a car to another place	168	44.1	67	42.1
Ride a motorbike to another place	124	32.5	65	40.9
Take taxi/grab to another place	37	9.7	4	2.5
Ride a bicycle to another place	24	6.3	17	10.7

Physical Capital	Settlement			
	Urban Frequency	%	Rural Frequency	%
Use public transportation to another place	22	5.8	2	1.3
Other	6	1.6	4	2.5
Vehicle used for traveling to work				
Drive a car to another place	168	44.1	67	42.1
Ride a motorbike to another place	124	32.5	65	40.9
Take taxi/grab to another place	37	9.7	4	2.5
Ride a bicycle to another place	24	6.3	17	10.7
Use public transportation to another place	22	5.8	2	1.3
Other	6	1.6	4	2.5
	Mean	SD	Mean	SD
Proximity to healthcare (minute)	18	14	20	10

Source: Questionnaire survey based on the four settlements and analyzed by descriptive statistics

Transportation habits show that 44.1% of urban and 42.1% of rural residents drive a car for daily travel, while 32.5% of urban and 40.9% of rural residents ride a motorbike. Public transportation is used by a small fraction in both settings (urban 5.8%, rural 1.3%), and a notable portion of rural residents ride bicycles to another place (10.7%) compared to urban dwellers (6.3%). The estimated time to reach the nearest hospital averages 18 minutes in urban areas, with a standard deviation of 14 minutes, indicating variability. In rural areas, the mean estimated time is slightly higher at 20 minutes, but with less variability as indicated by a lower standard deviation of 10 minutes.

Table 4 presents data on the financial status of families within urban and rural settlements. In the urban setting, the largest group reports being comfortable with some savings, accounting for 42.2% of responses. Those who are making ends meet represent 38.4%, while 9.1% are eking out a living, and 10.3% describe themselves as living well.

For rural areas, the most common financial status is making ends meet, with 45.3% of families falling into this category. A close second are those who are comfortable with some savings, at 40.2%. Families eking out a living constitute 10.3%, and a smaller percentage, 4.3%, report living well.

**Table 4.** Physical capital by urban and rural settlements

Financial Capital	Settlement			
	Urban Frequency	%	Rural Frequency	%
Family's financial status				
Eke out a living	24	9.1	12	10.3
Make ends meet	101	38.4	53	45.3
Be comfortable and some saving	111	42.2	47	40.2
Living well	27	10.3	5	4.3
Total	263	100	117	100

Source: Questionnaire survey based on the four settlements and analyzed by descriptive statistics

Table 5 provides a snapshot of health outcomes related to urban and rural settlements. In terms of health condition, in urban areas, 70% of respondents do not have a health condition, 25.1% report having a health condition, and 4.9% have never checked their health status. Comparatively, in rural areas, 71.6% do not have a health condition, 27.6% have a health condition, and a minimal 0.9% have never checked.

**Table 5.** Health outcomes by urban and rural settlements

Health Outcomes	Settlement			
	Urban		Rural	
	Frequency	%	Frequency	%
Health condition				
Not have	184	70	83	71.6
Never check	13	4.9	1	0.9
Have a health condition	66	25.1	32	27.6
Total	263	100	116	100
Close person with COVID-19 infection				
Not have	198	74.7	86	72.9
Have	67	25.3	32	27.1
Total	265	100	118	100
Area of infection				
Within area/local	58	92.1	23	88.5
Outside area	5	7.9	3	11.5
Total	63	100	26	100

Source: Questionnaire survey based on the organizations and analyzed by descriptive statistics

Regarding exposure to COVID-19, in the urban population, 74.7% have not had a close person with a COVID-19 infection, while 25.3% have. In rural areas, a slightly lower percentage of 72.9% have not had a close person with a COVID-19 infection, and 27.1% have had such an experience.

Looking at the area of infection, the majority of urban respondents who have had a close person with COVID-19 infection report the area of infection as within the local area (92.1%), while 7.9% report an outside area. Rural respondents show a similar trend, with 88.5% reporting the area of infection as local and 11.5% from outside the area.

## 4.2 COVID-19 pandemic

According to Table 6, during the COVID-19 pandemic, urban settlements experienced a marginally higher initial shock and impact, with average scores of 6.1 and 6.73, respectively, compared to rural areas, which scored 6.01 for shock and 6.17 for impact. This indicates that urban residents felt the effects of the pandemic slightly more acutely than those in rural areas. However, rural areas perceived themselves as having a slightly stronger resilience capacity with an average score of 6.22, suggesting they felt better equipped to adapt and recover, in contrast to urban areas, which scored 5.99. The response to the pandemic was nearly the same in both settings, with urban areas at a mean of 5.07 and rural areas close behind at 4.97, reflecting a moderate level of action taken in response to the pandemic.

## 4.3 System mechanism and response to the pandemic

Table 7 provides an assessment of three system mechanisms including persistence, transition, and transformation during a pandemic, based on a scale from 1 to 10. A higher mean score indicates a higher concerned mechanism during pandemic.

This part of data collected from sectors and organizations in both urban and rural areas.

**Table 6.** Overall situation during the pandemic by urban and rural settlements

Overall Situation During the Pandemic	Settlement			
	Urban		Rural	
	Mean	SD	Mean	SD
Shock from pandemic	6.10	2.43	6.01	2.53
Impact from pandemic	6.73	1.87	6.17	2.02
Response to pandemic	5.07	2.1	4.97	2.05
Resilience Capacity	5.99	2.05	6.22	1.76

Note: Mean score 1-10, using descriptive statistics

Source: Questionnaire survey based on the organizations and analyzed by descriptive statistics

Persistence mechanism concerns how well systems continue operating as normal despite the pandemic. Urban areas show a higher average concern for maintaining regular operations (mean of 7.90) with a relatively low variability among responses (SD of 1.20). Rural areas, with a lower mean of 6.90 and a higher SD of 2.50.

Transition mechanism concerns the capacity to adjust to the pandemic with temporary or intermediary changes. Again, urban areas score higher (mean of 8.50) with lower variability (SD of 1.00), suggesting a strong and consistent concern for adaptability in the face of disruptions. Rural areas have a slightly lower mean concern (7.00) and a higher SD (2.50).

Transformation mechanism reflects concerns for substantial, long-term changes in response to the pandemic. Both urban and rural areas show similar mean levels of concern (7.80 and 7.30 respectively), but the variability in rural responses is higher (SD of 2.10 versus urban's 1.50).

**Table 7.** System mechanism during a pandemic by urban and rural settlements

Concerned System Mechanism During Pandemic	Settlements			
	Urban		Rural	
	Mean	SD	Mean	SD
Persistence mechanism	7.90	1.20	6.90	2.50
Transition mechanism	8.50	1.00	7.00	2.50
Transformation mechanism	7.80	1.50	7.30	2.10

Note: Mean score 1-10, using descriptive statistics

Source: Questionnaire survey based on the organizations and analyzed by descriptive statistics

Table 8 provides an evaluation of the effectiveness of various implemented measures in response to the COVID-19 pandemic, rated on a scale from 1 to 10. In urban and rural settlements, the pandemic elicited a spectrum of responses, with urban regions imposing stricter measures like closing non-essential businesses (mean of 7.25) and promoting social distancing (mean of 6.00), compared to rural areas, which recorded a lower mean of 5.76 and 5.12, respectively, for these strategies. Support for economic stability was demonstrated through moratoriums on debts and support for small businesses, with both areas showing moderate implementation (mean scores ranging from 4.74 to 5.20). Strategies aimed at

public spaces and services, such as providing shelter and closing public parks, saw urban areas reporting higher engagement. Essential services, particularly for health workers, including providing accommodation and emergency childcare, scored above 5.50 in both contexts, underscoring the critical support for healthcare systems. Food security measures, like direct food provision and maintaining takeaway services, scored highly, reflecting the importance of food access during the crisis. Lower emphasis was placed on transportation strategies, with scores for free public transportation and bicycle rental services falling below 4.10, suggesting a lesser focus in this area. Overall, urban areas tended to report a slightly stronger application of pandemic response strategies, while rural responses, especially in supporting essential workers and ensuring food security, indicated a strong, community-centric approach to resilience during the pandemic.

Table 9 reveals the expectations of various urban sub-systems' roles in responding to the pandemic in both urban and rural settings. For distancing response, governance networks were considered key by 39.2% of urban respondents and 28% of rural respondents. Socio-economic dynamics took precedence in both environments, with 51.2% in urban and 52.8% in rural areas emphasizing their role.

In supporting small businesses, networked material and energy flows, urban infrastructure, and governance networks all were considered important, with rural areas slightly more inclined to rely on governance networks (26.9%).

When it came to supporting households and citizens, urban respondents placed most emphasis on governance networks (34.9%) and urban infrastructure (33.2%), while in rural areas, governance networks were viewed as even more pivotal (46.3%).

**Table 8.** Strategies responding to pandemic by urban and rural settlements

Strategies for Responding to Pandemic	Settlements			
	Urban		Rural	
	Mean	SD	Mean	SD
Social distancing	6.00	2.15	5.12	2.40
Closing unnecessary business	7.25	2.66	5.76	3.21
Providing shelter	6.44	2.59	5.48	2.64
Closing public park	6.34	2.74	5.46	2.83
Closing road	4.01	2.95	3.68	2.84
Small business	4.94	2.97	4.74	2.61
Voiding fee	4.95	3.22	4.77	3.04
Supporting an artist	4.54	3.01	4.47	2.73
Moratorium on debts for trader	5.10	3.21	4.90	2.90
Supporting small business	5.04	3.21	4.74	2.80
Household	4.97	2.90	4.96	2.49
Moratorium on debts for home loans	5.20	3.31	5.04	3.04
Moratorium on utilities	5.06	3.24	4.78	2.84
Providing an accommodation for homeless	4.47	3.21	4.42	2.91
Providing isolation center	5.63	3.20	5.63	2.62
Supporting for utilities paid and rental	4.59	3.25	4.94	2.70
Helping family violence victim	4.88	3.21	4.92	3.01
Food security	5.32	2.39	5.50	2.16
Providing food as needs	6.02	2.78	5.85	2.64
Allowing takeaway	6.92	2.56	6.22	2.51

Strategies for Responding to Pandemic	Settlements			
	Urban		Rural	
	Mean	SD	Mean	SD
Providing food for children	4.44	2.92	5.28	2.67
Providing food for elder people	4.58	2.98	5.21	2.76
Providing food for low-income people	4.53	2.95	4.93	2.78
Providing food delivery	5.44	3.21	5.55	2.90
Necessity labor	5.55	2.60	5.76	2.43
Supporting health worker	6.45	2.81	6.37	2.56
Providing free pickup service for necessary labor	4.77	3.03	5.19	2.80
Providing an accommodation for health worker near a hospital	5.51	2.96	5.58	2.81
Providing an emergency child care service for health worker	5.50	3.06	5.81	2.92
Transportation	3.69	2.91	3.81	2.83
Free-riding public transportation	3.98	3.21	4.09	2.93
Installing temporary bicycle lens	3.77	3.06	3.69	2.87
Providing bicycle rental service	3.34	2.98	3.54	2.99

Note: Mean score 1-10, using descriptive statistics  
Source: Questionnaire survey based on the four settlements and analyzed by descriptive statistics

For food security, the roles were more evenly distributed across all sub-systems in both urban and rural responses, conversely, socio-economic dynamics were noted slightly more in both settings.

For necessity worker support, urban infrastructure was seen as crucial in rural areas (38.6%), compared to socio-economic dynamics (29.0%) in urban settings.

Lastly, the role of urban infrastructure was deemed most significant in managing transportation, with 63.5% of urban dwellers and 57.4% of rural dwellers highlighting its importance. Governance networks and socio-economic dynamics also held considerable weight, but to a lesser extent.

This data illustrates the perceived importance of various urban sub-systems in pandemic response, with governance networks and socio-economic dynamics consistently recognized across both urban and rural settings for their roles in facilitating adaptation and resilience.

**Table 9.** Urban systems and expected role to response during pandemic by urban and rural settlements

Urban Sub- Systems	Expectation of Role to Response to Pandemic			
	Urban		Rural	
	Frequency	%	Frequency	%
Role for distancing response				
Governance Network	137	39.2	103	28.0
Networked Material and Energy Flows	2	0.6	16	4.2
Urban Infrastructure and form	32	9.1	55	14.9
Socio-Economic Dynamics	179	51.2	194	52.8
Role for supporting small business				



Urban Sub- Systems	Expectation of Role to Response to Pandemic			
	Urban Frequency	Urban %	Rural Frequency	Rural %
Governance Network	83	24.5	95	26.9
Networked Material and Energy Flows	101	29.9	107	30.3
Urban Infrastructure and form	81	24.1	92	26.1
Socio-Economic Dynamics	73	21.6	59	16.7
Role for supporting household and citizens				
Governance Network	118	34.9	164	46.3
Networked Material and Energy Flows	19	5.6	16	4.4
Urban Infrastructure and form	113	33.2	124	34.9
Socio-Economic Dynamics	89	26.3	51	14.5
Role for food Security				
Governance Network	65	19.5	66	18.4
Networked Material and Energy Flows	65	19.3	80	22.4
Urban Infrastructure and form	88	26.3	84	23.4
Socio-Economic Dynamics	117	34.8	128	35.8
Role for supporting necessity worker				
Governance Network	84	25.1	78	21.9
Networked Material and Energy Flows	70	21.0	67	18.7
Urban Infrastructure and Form	84	24.9	137	38.6
Socio-Economic Dynamics	97	29.0	74	20.8
Role for transportation				
Governance Network	29	8.8	50	14.0
Networked Material and Energy Flows	25	7.4	31	8.5
Urban Infrastructure and form	212	63.5	207	57.4
Socio-Economic Dynamics	68	20.3	73	20.2

Note: Multiple response

Source: Questionnaire survey based on the four settlements and analyzed by descriptive statistics

#### 4.4 Resilience capacities

Table 10 provides assessing resilience capacities across urban and rural settlements, urban areas indicated an absorption capacity with a mean of 5.91 and plans for pandemic response at 5.81, alongside an established emergency system at 6.22, while corroborative efforts to mitigate and prevent pandemic risks were rated at 5.74 and

5.84, respectively. Rural settlements reflected slightly higher scores across these domains, with an absorption capacity mean of 6.41, planning at 6.08, and emergency systems at 6.57; they also rated higher in collaborative mitigation and prevention, with means of 6.38 and 6.63. For adaptation capacity, urban settlements scored a mean of 6.00, with a willingness to adapt at 6.37, whereas rural settlements were close behind at 6.10 for adaptation and 6.47 for willingness. Transformation capacities revealed that both urban and rural areas are relatively aligned in transforming services or infrastructure (6.32 and 6.33, respectively) and systems (6.31 and 6.07), with rural settlements marginally higher in involving people in change (6.05) and decision-making (6.12), compared to urban's 5.97 and 5.89.

**Table 10.** Resilience capacities by urban and rural settlements

Resilience Capacity	Settlements			
	Urban Mean	Urban SD	Rural Mean	Rural SD
Absorption capacity	5.91	2.31	6.41	1.99
Have a plan to response to pandemic	5.81	2.55	6.08	2.32
Have an emergency system	6.22	2.52	6.57	2.06
Corroborate people to mitigate a risk and unexpectable from pandemic	5.74	2.65	6.38	2.15
Corroborate people to prevent a risk and unexpectable from pandemic	5.84	2.59	6.63	2.24
Adaptation capacity	6.00	2.09	6.10	1.88
Struggle of a city to adapt from pandemic	6.15	2.28	6.23	2.17
Have a system to support adaptation	5.95	2.51	5.83	2.03
Helping from outside to adapt	5.56	2.43	5.81	2.21
Welling to adapt	6.37	2.49	6.47	2.36
Transformation capacity	6.12	2.33	6.15	1.94
Transform in services or infrastructure for supporting and preventing people	6.32	2.64	6.33	2.14
Transform in system for supporting and preventing people	6.31	2.40	6.07	2.23
Involving people to participate in changing the situation for the better.	5.97	2.56	6.05	1.91
Involving people in decision making process	5.89	2.62	6.12	2.27

Note: Mean score 1-10, using descriptive statistics

Source: Questionnaire survey based on the four settlements and analyzed by descriptive statistics

##### 4.4.1 The factors influencing urban resilience in the urban settlements

Multiple regression analysis in Table 11 provides a detailed various factors influencing urban resilience capacities during a pandemic within urban settings. The analysis highlights that experiencing shocks and robust pandemic responses are key drivers that significantly enhance urban resilience. Positive impacts are also noted from factors such as sharing a bedroom, being employed in government roles, and having financial

stability, all of which suggest that social support networks, stable employment, and financial resources play crucial roles in bolstering urban resilience. Conversely, factors like age, sharing a bathroom, and access to utilities like electricity and water do not show significant effects, indicating that while these factors may not directly influence resilience, they could present underlying challenges in urban settings.

For absorptive capacity, which reflects an area's ability to absorb shocks, the analysis indicates that effective pandemic responses, communal living arrangements, and financial stability positively impact absorptive capacity.

In terms of adaptive capacity, which measures the ability to adapt to adverse conditions, positive influences are seen from the initial shock of the pandemic, the impact experienced,

robust responses, and sharing living spaces.

Lastly, the transformative capacity, which assesses the ability to make fundamental changes in response to a pandemic, is positively influenced by factors like experiencing shocks, strong responses, stable employment, financial security, and close person with COVID-19 infection.

The model's goodness-of-fit, as indicated by the ANOVA F test, was significant for all resilience capacities. The adjusted R squared values ranged from 29.2% for absorptive capacity to 40.15% for overall urban resilience capacity, showing a moderate level of explanation power by the model. The standard error of the estimate indicates the average distance that the observed values fall from the regression line, with lower values reflecting a better fit.

**Table 11.** Multiple regression results for urban resilience in urban settlements

Independent Variables	Dependent Variables			
	Urban Resilience Capacity	Absorptive Capacity	Adaptive Capacity	Transformative Capacity
(Constant)	1.591	1.862	1.946	0.966
Shock	0.128**	0.094	0.155**	0.134*
Impact	0.087	0.044	0.173**	0.044
Responses	0.503**	0.533**	0.446**	0.531**
Share a bedroom (1= Share)	0.656**	1.003**	0.527**	0.440
Share a bathroom (1= Share)	-0.370	-0.464	-0.117	-0.528
Accessing electricity and water (1= Accessible)	-0.192	-0.737	-0.034	0.196
Age	0.006	0.011	-0.007	0.013
Estimate time to reach to the nearest hospital	-0.394	-0.009	-0.002	-0.009
Occupation (1= Government)	0.413*	0.418	0.289	0.532**
Financial (1=affordable and well living)	0.401*	0.744**	0.030	0.429*
Characteristics of area (1= Agriculture)	-0.311	-0.275	-0.337	-0.322
Types of houses (1= Detached house)	-0.236	-0.202	-0.237	-0.268
Close person with COVID-19 infection (1= Not Have)	0.303	0.445	-0.169	0.632**
ANOVA F test	13.283**	8.134**	11.816**	10.209**
Adj. R square	0.415	0.292	0.385	0.347
Std. Error of the estimate	1.494	1.982	1.560	1.798

Note: \*\*. Significant at the 0.05 level.

\*. Significant at the 0.1 level.

Source: Questionnaire survey based on the four settlements and analyzed by multiple regression analysis

**Table 12.** Multiple regression for urban resilience in rural settlements

Independent Variables	Dependent Variables			
	Urban Resilience Capacity	Absorptive Capacity	Adaptive Capacity	Transformative Capacity
	Beta	Beta	Beta	Beta
(Constant)	3.830	1.919	5.393	4.179
Shock	0.148*	0.082	0.167*	0.193**
Impact	-0.240	0.066	-0.058	-0.078
Responses	0.448**	0.411**	0.448**	0.486**
Share a bedroom (1= Share)	0.062	0.530	-0.065	-0.280
Share a bathroom (1= Share)	0.377	1.211*	-0.073	-0.006
Accessing electricity and water (1= Accessible)	-1.530	-1.091	-2.057*	-1.444
Age	0.028**	0.033**	0.029*	0.021
Estimate time to reach to the nearest hospital	0.001	-0.005	0.007	0.001
Occupation (1= Government)	0.137	0.077	0.007	0.230
Financial (1=affordable and well living)	0.735**	0.790**	0.798**	0.618*
Characteristics of area (1= Agriculture)	-0.091	0.279	-0.673	0.121
Types of houses (1= Detached house)	-1.113*	-0.945	-1.231*	-1.162*
Close person with COVID-19 infection (1= Not Have)	-0.063	-0.074	-0.148	0.033
ANOVA F test	6.473**	5.126**	5.961**	5.277**
Adj. R square	0.404	0.338	0.381	0.346
Std. Error of the estimate	1.430	1.653	1.541	1.652

Note: \*\*. Significant at the 0.05 level.

\*. Significant at the 0.1 level.

Source: Questionnaire survey based on the four settlements and analyzed by multiple regression analysis

#### 4.4.2 The factors influencing urban resilience in the rural settlements

Table 12 presents a comprehensive multiple regression analysis focusing on the determinants of resilience in rural settings during a pandemic. The analysis identifies key factors such as shock, responses, age, and financial status that significantly enhance rural resilience by demonstrating positive impacts. These findings suggest that effective pandemic response mechanisms, the experience of shocks, older age demographics, and financial stability are crucial in bolstering resilience within rural communities. Intriguingly, the type of dwelling emerges as a significant factor, with residence in detached houses showing a negative impact on resilience, pointing to potential disadvantages associated with such housing in rural areas.

The analysis further explores absorptive capacity in rural areas, where effective responses, advancing age, communal bathroom facilities, and financial security positively influence resilience.

In terms of adaptive capacity, factors such as shock, responses, age, and financial status continue to show positive influences, highlighting their role in enhancing the adaptability of rural communities. Conversely, negative impacts from factors like access to electricity and water and dwelling types suggest that these may weaken traditional social bonds and local knowledge systems, which are critical for rural adaptability.

For transformative capacity, which focuses on the ability to undergo significant changes during a pandemic, similar positive contributions come from experiencing shocks, effective responses, and financial stability. Conversely, living in detached houses is associated with reduced transformative potential, indicating challenges linked to this housing type in facilitating change.

Overall, this analysis underscores the importance of shock experience, effective responses, demographic factors like age, and financial stability as key enhancers of rural resilience. It also highlights potential challenges associated with housing type and access to utilities, which may impede the capacity to respond, adapt, and transform effectively in the face of a pandemic. The models explained between 33.8% to 40.4% of the variance in resilience dimensions, offering valuable insights into the dynamics shaping resilience in rural settings.

#### 4.4.3 Qualitative analysis for people's perspectives by settlements

By using semi-structured interview to collect data from various opinions of people in the settlements. NVIVO facilitated finding the domains of conversations based on word frequency technique. Figure 6 illustrates a comparison of urban and rural resilience across various domains reveals intriguing disparities, highlighting the need for tailored strategies. While both prioritize economic, social and health modestly, a distinct difference emerges in environmental considerations, policy and measurement, and role of government organization.

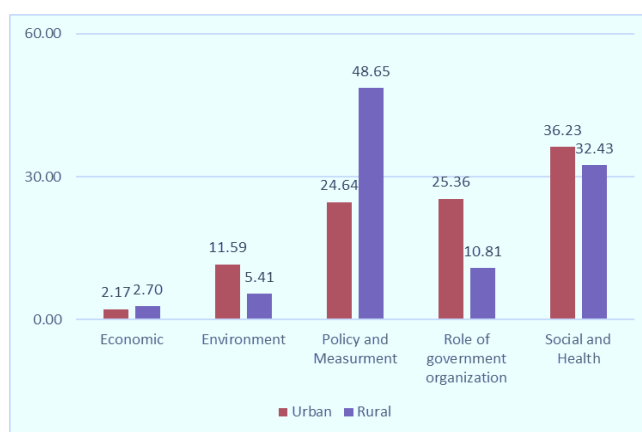
Urban residents are more concerned about environmental factors (11.59%) compared to rural residents (5.41%). This higher concern in urban areas is due to issues like greater population density and environmental stresses, including waste management and the need for sustainable practices, as reflected in the quantitative data.

Regarding policy frameworks, rural settlements place more emphasis (48.65%) on policies and measurement tools than

urban areas (24.64%). This is likely because rural areas often have less stringent measures, necessitating clearer policies and robust tools to manage challenges effectively. Rural participants emphasized the need for well-defined policies, supporting the quantitative findings.

Urban settlements value government organizations more (25.36%) than rural settlements (10.81%). Urban residents expect significant government action for policy enforcement and resource provision, while rural residents rely more on local networks. This reliance highlights the importance of social capital in rural areas.

Social and health considerations show a smaller difference, with urban areas emphasizing these factors slightly more (36.23%) compared to rural areas (32.43%). Both urban and rural residents recognize the importance of social support systems and healthcare infrastructure for building resilience, which is consistent with the quantitative findings. These diverse priorities indicate the need for tailored strategies that address the specific needs of urban and rural contexts.



**Figure 6.** Frequency of key words based on qualitative data collected

Source: Semi-structured interview and analyzed by NVIVO

#### 4.5 Discussions

The study's comprehensive assessment of urban and rural resilience, using both quantitative and qualitative analyses, aligns with key themes from the literature. The mixed-methods approach highlights the multifaceted nature of urban resilience, integrating governance, infrastructure, and socio-economic dynamics to manage pandemic risks [2, 5, 10]. The complexity of urban systems, with intricate interactions among these factors, shapes resilience, as evidenced by the regression analysis where governance roles and socio-economic dynamics are significant determinants of resilience capacities in both contexts [1, 2]. This supports the importance of adaptable governance and community-led responses [3, 4].

The distinction between urban and rural responses in terms of capital resources underscores the need for tailored strategies [5, 10]. Urban areas, with diverse occupational structures and robust infrastructure, face different challenges compared to agricultural rural settlements. Urban areas experienced higher initial shocks, aligning with literature on urban centers' complex challenges [10, 16]. The study also underscores unique patterns of family resilience, with the 'shared bedrooms' variable indicating close-knit family arrangements in urban areas, providing essential support networks in high-density settings [35]. This contrasts with findings from Western and Southeast Asian contexts where urban resilience

often leans heavily on public and governmental infrastructure, underlining the unique aspect of family dynamics in resilience within urban Thai context. In rural areas, the community-based resilience aligns with findings from other parts of Asia, where social ties and shared responsibilities are pivotal in managing crises [17, 18], reflecting a strong alignment with traditional rural setups across Southeast Asia, where community cohesion often supersedes individual agency in crisis contexts.

Qualitative insights from our study reveal the critical role of local networks and community initiatives in navigating pandemic challenges. For example, rural communities effectively utilized local health volunteers for active case finding and health education, aligning with studies from Tokyo and Eastern Poland that highlight the importance of social capital and community engagement [17, 18]. These findings underscore the importance of social capital and local community engagement in building resilience, resonant with the literature's call for comprehensive, multidisciplinary approaches to urban resilience [3-5].

The study's practical implications emphasize tailored strategies for urban and rural settlements: robust healthcare systems and infrastructural adaptability for urban zones, and fortified local healthcare networks and improved communication for rural settings. Integrating social capital into urban planning, promoting community-led responses, and supporting local leaders are key recommendations for enhancing resilience. This approach ensures adaptable, inclusive pandemic preparedness plans, bridging the gap identified in the literature and extending the discussion with empirical evidence on operationalizing resilience strategies in diverse settings. The findings highlight adaptive, inclusive governance and community engagement's pivotal role in enhancing resilience in urban and rural settlements alike.

## 5. CONCLUSIONS

The study reveals significant differences in resilience capacities between urban and rural settings, underscoring the necessity for context-specific resilience strategies tailored to each area's unique challenges. Urban settlements display a diverse array of occupational structures and robust infrastructures, facilitating dynamic responses to pandemics, whereas rural areas benefit from strong community bonds but are hindered by resource limitations. The integration of social capital into resilience planning is identified as a critical element, emphasizing the importance of community initiatives and participatory governance in bolstering pandemic resilience. This aligns with the study's focus on economic resilience and the need for policy frameworks and governmental roles to be customized according to the distinct needs of each community, which significantly contributes to the understanding of how urban and rural areas can effectively manage economic shocks during pandemics.

The study also acknowledges limitations, including its primary focus on COVID-19 and challenges in defining parameters for urban systems, suggesting future studies should broaden their scope to include various pandemics and disasters. This expansion aims to refine the urban resilience framework, enhancing its applicability and relevance. Furthermore, the study advocates for more research into measuring the impact of social capital on resilience and the integration of digital technologies in urban planning.

These future directions are intended to improve environmental management and societal adaptation, further enriching the strategic approaches to building resilience in diverse urban and rural contexts. Additionally, examining the real-world implementation of recommended policies could provide valuable insights into practical challenges and successes, enhancing the utility and impact of research in urban and rural pandemic resilience.

## ACKNOWLEDGMENT

We would like to acknowledge the respondents in the settlements of study urban and rural areas who provided the valuable data to increase our understanding about urban and rural resilience under the COVID-19 pandemic.

## REFERENCES

- [1] Zhang, J., Wang, T. (2023). Urban resilience under the COVID-19 pandemic: A quantitative assessment framework based on system dynamics. *Cities*, 136(104265): 1-35. <https://doi.org/10.1016/j.cities.2023.104265>
- [2] Afrin, S., Chowdhury, F.J., Rahman Md, M. (2021). COVID-19 pandemic: Rethinking strategies for resilient urban design, perceptions, and planning. *Frontiers in Sustainable Cities*, (3): 668263. <https://doi.org/10.3389/frsc.2021.668263>
- [3] Likitswat, F., Dejnirattisai, S., Sahavacharin, A., Irvine, K., Chua, L. (2023). Designing ecological floating wetlands to optimize ecosystem services for urban resilience in tropical climates: A review. *Future Cities and Environment*, 9: 4. <https://doi.org/10.5334/fce.168>
- [4] Rezvani, S.M., Falcão, M.J., Komljenovic, D., de Almeida, N.M. (2023). A systematic literature review on urban resilience enabled with asset and disaster risk management approaches and GIS-based decision support tools. *Applied Sciences*, 13(4): 2223. <https://doi.org/10.3390/app13042223>
- [5] Lakhina, S.J., Sutley, E.J., Wilson, J. (2021). "How do we actually do convergence" for disaster resilience? Cases from Australia and the United States. *International Journal of Disaster Risk Science*, 12: 299-311. <https://doi.org/10.1007/s13753-021-00340-y>
- [6] Aldrich, D.P., Meyer, M.A. (2015). Social capital and community resilience. *American Behavioral Scientist*, 59(2): 254-269. <https://doi.org/10.1177/0002764214550299>
- [7] Rose, A. (2004). Defining and measuring economic resilience to disasters. *Disaster Prevention and Management*, 13(4): 307-314. <https://doi.org/10.1108/09653560410556528>
- [8] Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3): 253-267. <https://doi.org/10.1016/j.gloenvcha.2006.04.002>
- [9] Brundtland, G.H. (1987). *Our Common Future: Report of the World Commission on Environment and Development*. Oxford University Press.
- [10] Moradpour, N., Pourahmad, A., Hataminejad, H., Ziari, K., Sharifi, A. (2022). An overview of the state of urban resilience in Iran. *International Journal of Disaster*

- Resilience in the Built Environment, 14(2): 154-184. <https://doi.org/10.1108/IJDRBE-01-2022-0001>
- [11] The Center for Global Health Science and Security. (2022). Urban Pandemic Preparedness. Georgetown University. <https://ghss.georgetown.edu/urbanprep/>.
- [12] WHO. (2021). Urban health. <https://www.who.int/news-room/fact-sheets/detail/urban-health>.
- [13] Hamis, A.A., Bukhori, M.A.B., Heng, P.P., et al. (2023). Strategies, challenges and opportunities in the implementation of COVID-19 field hospitals: A scoping review. *BMJ Open*, 13(3): 1-8. <http://doi.org/10.1136/bmjopen-2022-067227>
- [14] Frank, L., Concannon, T.W., Patel, K. (2020). Health care resource allocation decision making during a pandemic. Santa Monica, CA: RAND Corporation. [https://www.rand.org/pubs/research\\_reports/RRA326-1.html](https://www.rand.org/pubs/research_reports/RRA326-1.html).
- [15] Talic, S., Shah, S., Wild, H., Gasevic, D., Maharaj, A., Ademi, Z. et al. (2021). Effectiveness of public health measures in reducing the incidence of COVID-19, SARS-CoV-2 transmission, and COVID-19 mortality: Systematic review and meta-analysis. *BMJ*, 375: e068302. <https://doi.org/10.1136/bmj-2021-068302>
- [16] Wang, H., Cao, C., Ma, X., Ma, Y. (2023). Methods for infectious disease risk assessments in megacities using the urban resilience theory. *Sustainability*, 15(23): 16271. <https://doi.org/10.3390/su152316271>
- [17] Imai, H., Ji, Y. (2021). Social capital, innovation, and local resilience: Tokyo neighbourhood in times of crisis. *Asian Studies*, 9(1): 283-313. <https://doi.org/10.4312/as.2021.9.1.283-313>
- [18] Guzal-Dec, D.J., Zwolińska-Ligaj, M.A. (2023). How to deal with crisis? Place attachment as a factor of resilience of urban-rural communes in Poland during the COVID-19 pandemic. *Sustainability*, 15(7): 6222. <https://doi.org/10.3390/su15076222>
- [19] Fillali, R., Tamyis, A.R., Mawardi, S., Sawiji, H.W. (2022). Impact and coping strategies among vulnerable groups: An urban-rural resilience trajectory of the COVID-19 pandemic. *Masyarakat, Jurnal Sosiologi*, 27(1): 6. <https://doi.org/10.7454/MJS.v27i1.13510>
- [20] Love, H., Powe, M. (2020). Building Resilient Rural Places: Strategies from Local Leaders to Strengthen Rural Assets, Diversity, and Dynamism. Brookings Metro.
- [21] World Health Organization. (2020). Joint intra-action review of the public health response to COVID-19 in Thailand. <https://www.who.int/publications/m/item/joint-intra-action-review-of-the-public-health-response-to-covid-19-in-thailand>.
- [22] World Health Organization. (2022). WHO Thailand situation report – 254. COVID-19 - WHO Thailand Situation Reports. [https://cdn.who.int/media/docs/default-source/searo/thailand/2022\\_12\\_21\\_tha-sitrep-254-covid-19.pdf?sfvrsn=4741bfb3\\_1](https://cdn.who.int/media/docs/default-source/searo/thailand/2022_12_21_tha-sitrep-254-covid-19.pdf?sfvrsn=4741bfb3_1).
- [23] Cutter, S.L., Burton, C.G., Emrich, C.T. (2010). Disaster resilience indicators for benchmarking baseline conditions. *Journal of Homeland Security and Emergency Management*, 7(1). <https://doi.org/10.2202/1547-7355.1732>
- [24] SEADS. (2020). 5 key lessons from Thailand's COVID-19 response. <https://seads.adb.org/solutions/5-key-lessons-thailands-covid-19-response>.
- [25] Samutachak, B., Ford, K., Tangcharoensathien, V., et al. (2023). Role of social capital in response to and recovery from the first wave of COVID-19 in Thailand: A qualitative study. *BMJ Open*, 13: e061647. <https://doi.org/10.1136/bmjopen-2022-061647>
- [26] UN RC. (2020). Thailand's COVID-19 response an example of resilience and solidarity. <https://news.un.org/en/story/2020/08/1069191>.
- [27] WHO. (2022). Thailand shares lessons learned from the COVID-19 pandemic with WHO. <https://www.who.int/thailand/news/detail/12-05-2022-thailand-shares-lessons-learned-from-the-covid-19-pandemic-with-who>.
- [28] Shi, Y., Zhang, T., Jiang, Y. (2023). Digital economy, technological innovation and urban resilience. *Sustainability*, 15(12): 9250. <https://doi.org/10.3390/su15129250>
- [29] Patrício Silva, A.L., Prata, J.C., Walker, T.R., Duarte, A.C., Wei, O., Barceló, D., Rocha-Santos, T.A. (2020). Increased plastic pollution due to COVID-19 pandemic: Challenges and recommendations. *Chemical Engineering Journal*, 405: 126683-126683. <https://doi.org/10.1016/j.cej.2020.126683>
- [30] Adedoyin, O.B., Soykan, E. (2020). COVID-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*, 31: 863-875. <https://doi.org/10.1080/10494820.2020.1813180>
- [31] Shahid, M., Rana, I.A., Jamshed, A., Najam, F.A., Ali, A., Aslam, A. (2022). Quantifying the role of social capital for enhancing urban resilience against climate crisis: Empirical evidence from formal and informal settlements of Pakistan. *Cities*, 130: 03851. <https://doi.org/10.1016/j.cities.2022.103851>
- [32] Béné, C., Wood, R.G., Newsham, A., Davies, M. (2012). Resilience: New utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. *IDS Working Papers*, 2012: 1-61. <https://doi.org/10.1111/j.2040-0209.2012.00405.x>
- [33] Open Development Thailand. (2020). Thailand (THA) administrative boundary common operational database (COD-AB). <https://data.thailand.opendevelopmentmekong.net/th/dataset/thailand-provincial-boundaries>.
- [34] Department of Provincial Administration. (2020). The number of population by sub-district. <https://stat.bora.dopa.go.th/stat/statnew/statMONTH/stamonth/#/view>.
- [35] Bin, L., Soo-Yeon, Y. (2020). Burdens, resilience, and mutual support: A comparative study of families in China and South Korea amid the COVID-19 pandemic. *Journal of Comparative Family Studies*, 51: 337-346. <https://doi.org/10.3138/JCFS.51.3-4.009>