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Towards a Resilient City: An Adaptive Planning Model for a Healthy & Happy City

Shaimaa A. Magdy[1,a]

[1]Faculty of Engineering, Fayoum University, Cairo, Egypt
E-mail: [a]sam06 @fayoum.edu.eg

Abstract

The urban resilience process maximizes the response capability to disasters' effects. Planning resilient cities requires identifying multidisciplinary attributes for increasing resistance and adaptability. Hence, urban planning models with new trends are needed to deal with cities with adaptive approaches to produce powerful plans to create resilient healthy happy cities. This paper aims at widening the understanding of readjusting planning for resilient cities to identify healthy and happy attributes. Moreover, to provide an adaptive planning model for a healthy, happy, resilient city, descriptive exploratory analysis methods used to evaluate factors that affect planning for the quality of life and satisfaction. The suggested approach performs a complete review of the outstanding situation of two case studies (Madinaty, Zayed City), in this paper One-way ANOVA test used in statistically significant differences between the means of positive and negative healthy-happy indicators through respondents' satisfaction This study elaborates a new adaptive planning matrix that addresses what cities should move toward a more resilient state while conserving the quality of life and increasing residents' satisfaction.

Keywords: Resilience; Adaptive planning; Healthy city; happy city

1. Introduction

Cities perform complex relationships with multiple increasing functions. Therefore, it is important to implement evolutionary planning which can produce synergy effects [1].

To mitigate the risk of a disaster, it is necessary to provide a better and more resilient urban future for cities. This study proposes an adaptive planning model to explore cities as complex systems. The need to enhance resilience and adaptability of the city spatial system. An integrated approach with multiple indicators could cover different goals of planning for healthy and satisfactory city.

2. Contextual Framework

Is a healthy and happy city a dream? Or could it be tomorrow's reality? Holistic development should meet the present needs and enhance the ability of well-being achievement, as it describes the capacity of systems to continually change to a better state [2].

Achieving the objective of creating resilient communities requires a fundamental change how planning is conceptualized and practiced [3]. Hence, there is an urgent need to formulate new approaches for transformation into a healthy, happy, and resilient city as adoptive planning could help provide multiple functions.

2.1. Problem Statement

The exponential and unplanned growth of cities leads to multiple complexities, which cannot be solved effectively by technical solutions alone. This requires multiple approaches with a variety of parameters at different levels and across all sectors to achieve coherence and long-term solutions. However, many aspects of resilience city, from the urban perspective are not fully understood. In addition, there is a large research lack on urban resilience effects. Thus, this study evaluates urban resilience and explores the temporal and spatial characteristics and the influencing factors comprehensively. The main questions investigated in this study are:

- How do we determine resilient parameters?
- What are healthy city indicators?
- Could a healthy city partially be a resilient city?

A dynamic and actionable spatial model is needed for explaining and measuring required models that can formulate future scenarios.

2.2. Objectives and Hypothesis

Adaptive planning with new approaches is essential to develop a resilient city. The main objective of this research is to formulate an adaptive planning model that can manage the future of city plans complexity. Following are the secondary objectives of this study:

A- Debate and explore different visions and indicators for Healthy-Happy Cities in order to support and strengthen Healthy-Happy City capacities and skills.
B- Demonstrate and learn from the practices of Healthy- Happy- Resilient Cities and highlight important contributions of such practices to improve health and wellbeing of individuals.
C- Integrate the Happy / Healthy paradigms into the adaptive planning model in order to fulfil resilience.

Thus, this study integrates multiple approaches: resilience - happiness - healthy indicators in order to achieve resilience. Resilience and healthy-happy parameters are analyzed to examine the convenience of merging multiple approaches for adaptive planning.

2.3. Methods

Theoretical and practical significance of integrating healthy, happy city approaches leads to a resilient city-state. Section 1 of the study introduces a contextual framework and study methodology to prove the hypothesis while Section 2 presents a theoretical approach with main terminologies and a literature review. Section 3 contains an analytical approach for multiple resilience and happiness models, and Section 4 details of domains and attributes that influence happiness, health and resilience of a city. Section 5 presents the applied approach to formulating the Homeless and Housing Resource Centre (HHRC) planning model and gives two case studies. The concluding section summarizes the findings and makes policy recommendations. Overall, the study develops two levels of analytical investigations. An expert's online questionnaire measures statistically tested attributes within the Delphi technique for data gathering during repetitive rounds leads to results accuracy [4].

Second, a detailed resident questionnaire aims to assess HHRC attributes for measuring the level of resilience in both case studies within the Greater Cairo Region (Zayed and Madinaty). Statistical techniques were used to measure happy and healthy city indicators. The methodology contains three main approaches shown in 3 parts (Figure 1).

3. Understanding a City's Complexity: Literature Review

As resilience becomes an alternative to sustainability, it is required to develop novel frameworks for achieving resilience. Resilience can be defined as the socio ecological capacity which manage hazardous pressures. With high efficiency in responding, adapting, and restoring alternatives to improve the main city functions for balanced infrastructure and lifestyle. There are five aspects of great livable cities: complete neighborhoods, accessibility and sustainable mobility, a diverse and resilient local economy, vibrant public spaces [5].

3.1. Planning for Resilience

Making cities and human settlements inclusive, safe, resilient, and sustainable is one of the 17 goals in the post-2015 sustainable development agenda (United Nations, 2015) to be achieved by 2030. Planning for resilience requires methods of working with data and systems which can be easily translated to decision-makers to develop evidence-based and easily-communicated scenarios that can enhance the resilience planning process [6]. The quantitative measurement of cities' resilience is key to urban management and planning. Thus, governments should work on developing new approaches and involve different stakeholders to build resilient city and community wellbeing life.

3.2. Moving Towards Resilience

Many studies have classified the urban resilience framework into five dimensions (Figure 2) [7]. Addressing the complex problem of urban resilience requires active collaboration among governments, experts, and communities in all planning stages. Urban planning strategies are needed to maximize accessibility for people mobility. Accessibility is important for all levels of mobility of the disability, community have a right to realize their potential for movement in the community [8]. This shows that resilience parameters could lead to developing healthy happy city approaches.

4. City Between Resilient and Vitality: A Theoretical Approach

Happiness is a collective concept; happy city is a green city with low rate of carbon emission to protect residents [9]. Accordingly, happiness can be introduced as a basic quality in urban life [10]. While a city's resilience is sometimes weighed against vitality and happiness, especially in a pandemic, this research focused on collaborating comprehensively on happy- healthy- resilient city approaches.

4.1. Reviewing Resilient Approach

In the context of promoting resilient cities by highlighting the link between the built environment, public health, and community resilience, the next section provides an approach for building resilience through healthy-happy indicators in urban planning.

Global studies have shown that the quality of a city is a key factor for happiness so happiness parameters can be created for citizens' happiness at the planning scale.

These studies were selected in order to address different patterns with multiple approaches. From this section, we can conclude the parameters for each approach.

4.1.2. China

China added a new planning system of four stages considering financial planning and strategic management as the main dimensions. This system consists of the following:

1) Governance and community ability to deal with disasters and pressures.
2) Changing and adapting into resilient state with ability to survive. 3) Responding to changes and meeting new urban challenges.

This system highlighted important factors in evaluating the resilience level, particularly improving the supporting facilities and augmenting infrastructure. As shown in (Figure 3) [11].

4.1.2. Sicily, Italy

To improve the level of resilience of the *city,* Sicily's government established a planning-based approach which developed multiple supporting alternatives to enhance urban resilience in existing urban pressures [12]. The important urban resilience spatial and temporal patterns and factors will enhance the adaptability to urban risk and the potential for sustainable urban development as shown in (Figure 4).

4.2. Reviewing Healthy and Happy Approaches

Nature boosts productivity as the more access we have to parks and nature, the better we feel, and the longer we live. Just having a view of trees or a park from a work or study space reduces stress and improves mental performance. Nature may lead us to more sustainable thinking [13].

4.2.1. Malaysia

Malaysia found that exposure to nature leads people to care more about the future. Thus, investments in green and healthy places are not just good for population health; they make for happier space visitors, more productive employees, and more connected and supportive local relationships [14]. A Multidimensional family happiness indicator was developed in this study, the family wellbeing was classified into six dimensions: 1- Economic situation, 2- Family relationship, 3- Community relationship, 4- Health and safety, 5-Religion, 6-Housing and environmental conditions. These indicators were examined and validated. The results showed most important key indicators in family wellbeing: Economic situation, Health and safety, Community involvement, Family relationship.

4.2.2. Dubai

The interest of well-being concept or happiness approach in city development knowledge- based, practical methods, as well as the focus of the United Nations' World Happiness Report [15]. However, several researchers begins in measuring happiness by multiple ways using various types of artificial intelligence (AI) methods conducted from different data categories such as socio - economic, geospatial, behavioural or emotional data. The ABCDE model of happiness developed for Dubai city [16] helps focus on the affective emotional need of people for basic daily needs that lead to increase in happiness. It is based on Gross National Happiness Index (GNH) classification mechanism (Table 1).

Living Standards	**Ecological diversity**	**Wellbeing**	**Health**	**Community vitality**	**Education**
Assets	Wild life damage	Life satisfaction	Mental	Donations	literacy
Housing	Ecological issues	Positive emotions	Selfreported health	Community relations	schooling

Household income	Urbanization issues	negative emotions	And another entry	Family safety	knowledge

Table 1. GNH index [17]

This index aimed at psychological satisfaction with life or positive/negative emotions by giving a location and temporal description of wellbeing across a geographical area. Smart Dubai went a little further and used machine learning to develop a *Happiness algorithm [18]*. The previous method utilized different types of large datasets for city and community.

Here, some key lessons can be learned from the previous approaches that quality of healthy city indicators may even be of higher significance than that of quantity-strong indications.

The previous section provided a basis for urban planners to contribute to closing the health gap and promote community resilience through improved public health. Finally, we conclude that healthy happy city indicators are mostly common with resilience indicators.

4.3. Concluding Domains and Attributes

The process of conducting domains starts from primary selection to optimization and ends with formulation of merging approaches such as urban agglomeration and indicator aggregation. (Figure 5).

4.3.1. Concepts

Cities have economic, social, and ecological aspects which are important components of urban resilience. This study applied a quantitative research method to analyse happiness/healthy city indicators, their effect on the quality of life and satisfaction. The effective analysis process combines the benefits of expert analysis with elements of the visions of specialists and experts [19].

4.3.2. Domain's Verification

A Delphi survey done into two-rounds to conclude the main domains of the concept of healthy /happy/resilient cities. Using the Delphi questionnaires of two rounds sent to three groups of experts: group A with 5- 10 years of experience, group B with 10-15 years of experience, and group C with more than 15 years of experience. The Delphi survey explored multiple opinions within the suggested three city approaches to achieve consensus about the hypothesis and concluding domains and attributes for HHRC. In this study we used 5point Likert scale to evaluate each attribute's importance. Integrators are asked to rank their answers on a five Likert scale and results ranked as follows: (1: strongly disagree, 2: disagree, 3: neutral, 4: agree and 5: strongly agree).

This scale was used to represent recorded scores for domains and attributes. Oneway ANOVA (analysis of variance) test compares the means of two or more independent groups to determine whether there is statistically significant difference between the associated population means. Weights for each conducted domain were assigned as shown in Table 2.

Domains	**Urban -Infrastructure UI**	**Socio _ Cultural SC**	**Economic EC**	**Environmental Ecological EE**	**Amenity / Responses AI**	**Governmental Facilities GF**
Healthy / Happy / Resilient common Attributes	1. Extended workplaces	2. Improving health care	1. Wellbeing principles	1. Healthy food less rates	1. Accessibility	1. Administrative services
	2. Access to exist transportation	3. Elderly activities	2. Economy skills / facilities	2. Access to nature	2. Walkable access.	2. smart facilities
	3. Recreational activities	4. Family relationships	3. Years of healthy life.	3. Avoid Noise pollution	3. Walking Time	3. Healthcare facilities
	4. Green spaces / Public spaces	5. Childcare facilities	4. Housing affordability	4. Improve Air quality	4. Bicycle routes Parking spaces	4. regulations quality
	5. Recreational Facilities	6. positive interactions	5. Income	5. Water consumption	5. Cyclists' safety	5. High speed services

6. Sports facilities	7. Life satisfaction	6. Remote Working	6. Waste Collecting System	6. Security	
7. Social interaction.	8. Social system connectivity		7. Health life balance	7. crime rates	
8. Walkability	9. Enabling effective emotions		8. Recycle systems	8. Amenity	
9. No. of bedrooms/unit	10. Meaning & sense of belonging		9. Positive nature impact	9. Police station	
10. No. of people in household	11. Community involvement		10. Temperature Comfort	10. Emergency medical care	
11. Housing conditions			11. Reduction of emissions		
12. Satisfaction with the community			12. Provide energy savings		
13. Usable, active traffic control					
14. Comfortable transportation					
15. Liveability and Vitality					
1. Place making	1. Community services	1. Affordable Services/Entertainment	1. Reduce car use	1. Sense of Safety	1. Political system stability
2. Mixed uses					

Extra Happy City Indicators	3. Changed land uses	2. Gender equality.	2. Economi c activities		2. Local Security	2. Smart solutions
	4. Increase banking spots	3. Ability to live	3. Econom y of place work	2. Nature daily interaction	3. Direct paths	3. Regulatio ns
	5. Free of charge to spaces	4. Ability to learn,	4. Economi c revenue		4. Comfortable paths	4. Voting Nodes
	6. Quality landscape	5. Ability to play	5. Remote working rate		5. speed limit	5. Volunteer ing spots
	7. Joyful elements Urban	6. Volunteer activities.	6. Job security		6. smart-traffic control	6. Maintena nce system
	8. Pedestrianoriented spaces	7. Outside visitors.	7. Business survival		7. Signaging	
	9. Bicycleoriented spaces	8. Festivals and Arts	8. Business development		8. Bicycle parking	
	10. Tourist attractions	9. Cultural events	9. Income inequality		9. Car parking	
	11. Flexible/freque nt Transportation	10. Concerts, Festivals and exhibitions	10. Employm ent rates		10. Crossing points	
	12. Transportation nodes		11. Fuel problems			
	13. Attractive streets		12. Innovate Ability			
	14. Pedestrian's satisfaction					
	15. Well provided arts in the city					
	1. Reliable transportation	1.Population & density	1.Economic capacity	1.Ecological vitality		1.Public service efficiency

Extra Resilient city indicators	2. Transit hubs		2.Ability to adapt			
	3. Smart transportation		3.Ability to change			
	4. Alternative routes variety	2.City Capacity				
	5. Usable floor space			2.Conserving non-renewable		
	6. Safe Public Spaces		4.Ability to respond to risks			

Table 2. Ranking Domains results

Ranking Domains	**Urban-Infrastructure**	**Socio - Cultural**	**Economic**	**Environmental**	**Amenity Responses**	**Government**
Ordinal				**Ecological**		**Facilities**
Attributes Code	**UI**	**SC**	**EC**	**EE**	**AR**	**GF**
Assigning proportional weights due to ranking [20]	**1**	**0.8**	**0.6**	**0.5**	**0.T3**	**0.1**

Table 3. HHRC Domains / Attributes

5. HHRC Model Formulation

This paper elaborates the abovementioned multi-dimensional attribute matrix and

proposes actions for cities to move toward a more resilient state in the future. Results showed that six attributes are not significant and will be deleted in the measuring spatial model. These attributes are EE7: Health life balance – EC1: Well-being principles - EC16: Employment rates- AR13: Direct paths - AR18: Bicycle parking – Gf 9: Voting Nodes. This matrix is a multi-measurable attribute in quantitative and qualitative methods because some attributes could be calculated as a numeric entity such as urban attributes from 1-9. This model is illustrated in Figure 6.

The validity of the Delphi method does not depend on participants number, rather it depends on the scientific authentication of experts participating [21].

5.1. Verifying Proposed Model: Testing HHRC Matrix

The quantitative study explored and examined residents' daily life experiences in terms of the HHRC matrix. The objective of the interviews was to determine the impact of significant attributes on health well-being and resilience.

HHRC matrix was tested on two case studies and a random sample was taken from a community of residents from two cities: Madinaty and Zayed City. The number of respondents in each case was equal; 28 residents were randomly selected in each case. Resident's questionnaire aimed at testing and verifying the concluded attributes by measuring residents' opinions. Data was collected through an online questionnaire into four pillars:

1. Basic information.
2. Evaluation of Happy city parameters.
3. Evaluation of Healthy city parameters.
4. Evaluation of Resilience city parameters

Data collected, scored, and classified for each attribute in the average scores are presented in Qualitative-evaluative criteria. Attributes value could be shown in two steps as follows:

First: each parameter is referred to 1 or 0 value as true or false; second: If true, it was ranked into (1-2-3 value) as (poor – fair - good). Sample characteristics: residential community – sex – occupancy rate – residency – land use and service percentage.

5.2. Testing and Verifying Attributes within Case Studies

Two case studies have been selected (Madinaty, Sheikh Zayed) in Greater Cairo Region for informal areas according to the following selection criteria: (Figure 7-9)

- ✦ Areas are located into different governorates.

- Areas are at equidistant from the Cairo capital.
- Representative population and living conditions characteristics.
- 28 persons were investigated in each case study: the questionnaire was designed in evaluation parameters conducted from the analytical part.
- By reviewing master plans, we can calculate many attributes and indicative values.
- In this study, we limit assigning values to attributes due to the questionnaire.

5.3. Applying Matrices for Case Studies

In the last ten years, concepts such as urban health and liveability have become ever more prevalent in urban planning studies. It is possible to understand why a place is liveable, but it is difficult to design a place ensuring that it will be healthy and liveable. Accordingly, this section aims to investigate mixed connections of three attributes of resilience, happiness, and health in the two case studies.

A comprehensive evaluation of both case studies using the HHRC model resulted in a quantitative measurement within the matrix shown in (Figures 10-11) that classified each case study into three evaluation levels.

5.4. Analysis of Zayed City's Matrix

Analysis of Zayed city matrix showed that it achieved high performance in the residents' opinion in terms of urban infrastructure and fairness in the socio-cultural domain – a good attribute that formulated to an ordinal scale of 2-3 values, as shown on the second and third circles. Some attributes do not exist or exist poorly, which are formulated to 0-1 values shown in the centre and first circle. However, it lacked some attributes in governmental facilities and environmental domains, which should be readjusted with development plans through a spatial model.

5.5. Reading Madinaty City Matrix

Reading of the Madinaty matrix showed that it achieved high performance in the residents' opinion in all 6 domains of the fair – a good attribute formulated to an ordinal scale of 2-3 values, as shown in the second and third circles.

Some qualitative attributes should be calculated from the master plan in relation to population such as U 1-6 and U13-16. This is shown in the next section in formulating adoptive spatial model prototype. This evaluation ensured the objective and hypothesis of the study that achieving healthy-happy attributes could achieve a partial or fully resilient city.

5.6. Model Prototype

The proposed model shows the process of integrating healthy/happy attributes while influencing the analysis of resilient domain factors of HHRC city (Figure 12). This model could promote multiple modules (Explaining - measuring).

Domain **Layer**	**Attribute Layer**	**Indicator Meaning and Attribute**
Urban ecological environment resilience	Green coverage rate / built-up areas (%)	indicates nature and landscape elements
	Park green area (m^2/resident)	indicates vitality level in urban ecological
	wastewater discharge (tons)	indicates environmental pollution impact
	Financial revenue	Indicates performance of public service functions
Socio-environmental resilience	employment ratio	Indicates development level
	Universities students	Indicates city's innovation ability
	Number of hospital beds / 1000 people	Indicates urban& medical emergency level
	Bus number / 10,000 residents	Indicates urban transport system comfortability
	Percentage of international Internet users (%)	Indicates urban social connectivity level

Table 4. Input layers sample

In this model, the revision of the city master plan became an essential opportunity to redirect the city's development into environmental and landscape protection, employing adaptive strategies for health, vitality, and risk reduction. Some of these strategies are related to decisions on land-use allocation. In particular, land-use regulations are oriented to enhance the ecological dimension of the entire city master plan and not only through land-use zoning and contributing to enhancing the effectiveness of mitigation and adaptation policies.

6. Discussion

Some studies conducted happy city criteria and concluded the most relevant findings

into well-being principles, active mobility, places that matter sense of control, comfort, and agency [22].

As resilience refers to the ability of the system to achieve normal operations such as public safety and social order as to address the challenge of making our cities the healthiest, happiest, and most sustainable places [23].

Previous studies which examined happy city variables classified them into three sustainability dimensions: Equality & urban conditions, Education& work, Health, and community. In this study, a limited number of dimensions and indicators were considered. Though Gehl (2022) [24] believes that urban planners should strive to create cities that are livable, safe, sustainable, and healthy. A walking space should be useful, safe, comfortable, and interesting to a citizen. Thus, walking is encouraged, increasing social interactions as people pass each other at a walking space, resilient approach that encourages ecological, economic, and cultural diversity to help communities and places stay strong over . A vision for a better future is important. These dimensions must be considered as an organic whole. We conclude that cities must be responsive to the context in which they operate, and what constitutes intelligence is dependent on a variety of contexts [25].

7. Key Findings

When discussing the concept of a resilient city, people may consider excluding vitality and happiness. In this more inclusive study, we concluded many key components in order to integrate Resilient -Happy-Healthy approaches in city planning.

The study concluded six domains that are interconnected indicators: urban infrastructure, socio-cultural, economic, environmental/ ecological, amenity/responses, and governmental facilities. However, the main factors influence urban resilience or happy healthy attributes. Multiple indicators are needed for:

a) Increasing transportation efficiency.
b) Improving safety.
c) Increasing city attractiveness (social, environmental, and economic).
d) Improving Health and well-being opportunities.
e) Addressing equal concerns for community needs.

Hence, the evaluation of indicators 126 (attributes) was made, and a descriptive exploratory analysis was used for the main aspects of wellbeing and satisfaction. The paper developed two levels of investigation: the Delphi survey included three groups of experts and significantly statistically tested where 6 attributes were excluded.

Covering four perspectives (domains) conducted from a theoretical approach: Ecological environment, economic, social, and urban infrastructure services, then two domains were added for covering amenity responses and governmental facilities. Participants also had the opportunity to add new terms to the original list.

In the second round, a new question was added to assure their opinion in the hypothesis and the number of the agreeing respondents was calculated.

In this research, 36 experts participated. The weight of the criteria was considered in a range of 1-5 points showed in (very low, low, average, high, and very high).
One-way ANOVA test assures homogeneity with significance between tested groups descriptive independent random normality results and excluded case analysis by analysis conclude happy healthy resilient city attributes as shown in the appendices section.

One-Way ANOVA is a parametric test [26]. Domains have been ranked due to expert opinions. An adaptive spatial planning model was developed to improve the city's resilience. The spatial model was formulated for providing the necessary resilient healthy-happy city attributes for evolutional plans. This model was developed upon the 120 attributes and tested within residents' random sample in two case studies in Zayed City – Madinaty City. HHRC matrix showed graphically the city attributes performance as the HHRC model formulated to enhance planning stages and built future scenarios, through the proposed prototype designed to be built on Geomedia GIS Software.

8. Conclusions

As cities cannot easily copy good methods, appropriate approaches are needed to improve their conditions [27]. Our key point is that cities must be responsive to the context in which they operate, and what constitutes with variety of contexts that were not tested but included in the proposed model HHRC, such as the political system.

Overall, this study shows that using this model helps not only to investigate the city's resilient level in more detail but also helps the policymakers in their assessments. It can be considered an effective tool aimed at promoting the identification of city contexts.

The advantage of using the HHRC multi approaches matrix is that it could enhance the ability to achieve well-being and happier communities. Furthermore, the proposed framework describes each city's positive and negative attributes. HHRC model showed that achieving happy-healthy approaches could lead to a partially resilient city.

Limitations and Future Work

A limitation of this study is that it covers a small area and is not inclusive of more countries or cities. Further, it considers only the urban population, not the rural one which comprises the majority in Egypt. Factors affecting happy city can be identified by considering the relationship between happiness measures and urban indicators. Qualitative attributes should be tested with planning ratios and indicators. The proposed spatial model should be programmed by Geomedia professional GIS program to building cities of the future.

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