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Modeling Quality of Urban Life Using Grey Analytical Hierarchy Process

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Abstract – Economic growth has recently been crowded out by life quality in the new development pattern. Unlike the income-based measurement of economic growth, the life quality measure has become a challenge because it is a multi-dimensional concept that relies on the subjective evaluation of the involved stakeholders in a particular context. The objective of this study was to investigate the model of quality of urban life in Ho Chi Minh City, Vietnam based on subjective indicators. The grey analytical hierarchy process were employed to analyze the data from thirty in-depth interviews with experts in the field. The empirical model of quality of urban life in Ho Chi Minh City was found with three levels. The ranking results at the second level emphasized the high shares of health, employment, and income compared to self-esteem, socialization, and family happiness. The ranking results at the second level emphasized the high shares of health, employment, and income compared to self-esteem, socialization, and family happiness. Further investigation at the third level has confirmed the superiority of non-material components in the quality of urban life model in Ho Chi Minh City, Vietnam. The findings were critical in implying the policy concentration on non-material values enhancement to raise the quality level of urban life. It was a milestone in switching the focus from material to non-material factors in the life quality model in Vietnam.

Keywords – Grey system theory, grey analytical hierarchy process, life quality, Ho Chi Minh City, Vietnam

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1. Introduction

Income has no longer been the only goal pursued by human beings [1]. The preference for life quality has driven welfare economics, which has recently become the trendy approach for public policy to improve lives because it affects people's behaviors as well as their life satisfaction and happiness [2]. Life quality has been theoretically and empirically proven to benefit various aspects of human lives. Kaplan [3] concluded that life quality did not heal the sickness but it provided a favorable effect on the physical health of the healthy population. Life quality has levered happiness which leads to good health. This was supported by Sabatini [4] when analyzing 817 residents in Trento, Italy to show the positive impact of happiness on self-rated health. In terms of mental health, Schiffrin and Nelson [5] contributed empirical evidence of an inverse relationship between happiness and stress when examining the data of 100 full-time college students in the mid-Atlantic region. Oswald, et al. [6] revealed the approximation of 12% greater productivity when experimenting with the random group of higher and lower happiness.

Life quality has been defined as a lasting, complete, and legitimate satisfaction with life in general. According to Mulligan, et al. [7], life quality included the satisfaction received from surroundings. Life quality has also been conceptualized as an inner positive experience and the ultimate driver of all human behavior [7], [8]. Life quality was the degree to which an individual rated their overall life favorably [9]. Diener, et al. [10] argued that life quality was the preponderance of positive influence over negative influence with a distinct focus on the affective evaluation of a person's life situation. Quality of life has also been used interchangeably as well-being, happiness, or life satisfaction [11], [12]. However, life quality was a concept that much depended on cultural traits in a particular context [2], [13], [14]. In fact, a unanimous definition of life quality has not been reached. Moreover, a diversified definition of this concept led to the debate on its measurement. Life quality was often measured as a set of social indicators and individual perceptions of life quality fulfillment [15]. In fact, life quality was not only an expression of an individual's condition in the short term but also in the long term [16]. This argument should be noted when measuring life quality. Moreover, life quality perceptions might differ between people under different circumstances [17]. A similar philosophy was applied to life quality criteria ranking. Therefore, a hierarchical model of life quality for specific stakeholders in a particular context was essential for proper strategy to promote life quality.

Ho Chi Minh City is among the largest economic, cultural, and social centers in Vietnam, contributing more than 20% of the nation's GDP despite sharing only 0.63% of the national area [18]. According to the City Statistics Office [19], Ho Chi Minh city is ranked as the top populous city with 9.1 million people, accounting for 9.35% of the country's population and 50.44% of the population in the Southeast region. These unique features of Ho Chi Minh City have motivated the livable city development strategy to sustain the vibrant hub of social and economic activity [20]. Therefore, ensuring and improving people's quality of life is a matter of concern to policymakers.

In the context of emerging technology for analyzing text data, a comprehensive understanding of numerous words is meaningful in exploring people's perceptions [21]. The objective of this study is to investigate the model of life quality in Ho Chi Minh City, Vietnam using the grey analytical hierarchy process (Grey-AHP). The Grey-AHP, a combination of grey system theory and analytical hierarchical process (AHP) has been employed to provide a confident ranking choice based on the interval instead of a concrete value. Finally, the indicative importance of criteria and sub-criteria in the measurement model of urban life quality implies the priority of proper policies to boost the life quality of urban residents in the context of Vietnam.

2. Research background

Life quality was regarded at the personal level with two attributes, satisfaction and happiness [22]. For instance, satisfaction and happiness were regarded as the person's distinctive qualities, which meant that each person's level of life quality relied on his or her specific traits and perspective on life. Human nature is at the foundation of the human concept of life quality.

Subjectively perceived life quality is better understood by those who are content and patient than by those who are impatient and hurry. According to Oleson [22], life quality was firmly anchored on an individual level in both the short and long terms. Life quality was based on chance or usefulness. Outside and environmental variables also have an impact on life quality, in addition to internal causes. One of the things that contributes to happiness and satisfaction is one's view of oneself. A person may overcome obstacles and create a better life by using his or her skills if they discovered their inner power and core. When people faced a problem, they could not remain indifferent but should overcome it and try to get rid of the problem based on existing resources [23]. Another definition of subjectively perceived life quality is the total joy and pain [24]. Life quality was the outcome of a life and was much more than the prerequisites for a good life, such as the living environment and the ability to live a good life. This is considered a combination of good things in life. The hedonists claimed that happiness, then good life, entirely consisted of a balance between pleasant and unpleasant experiences [25], [26]. This was confirmed by Haybron [27]. Desire fulfillment theory defined satisfaction and happiness achievement as reaching the needs or the fulfillment of some ideal variant of the desire. Life satisfaction is perceived as life quality as an individual's attitude toward life as a whole in either the short or the long term [28]. This could be understood in many different ways, but the core idea was that subjective life quality was not centered on feeling but on a kind of assessment of how well life based on each individual's standards. In short, theories of subjective life quality equated it with pleasure-related experiences. The difference was that they had nothing to do with the value of pleasure. Subjective life quality was not simply a term for pleasant states of mind. The affective-state theory defined it as a whole or some significant part of the emotional state. Accordingly, it referred to whether a person was generally happy, energetic, comfortable; or the opposite of anxiety and depression [27]. Just as depression was not merely an experiential state but a broad psychological one. Indeed, depression would be seen as a marked form of

unhappiness from this point of view. Researchers that conduct experiments frequently do this. However, it was difficult to separate this viewpoint from hedonistic viewpoints. Thus, the desire theory required external conditions that matched the wishes.

Objective theories of life quality provided a list of items covering knowledge, friendship, achievement, and joy [29]. Views of natural perfection, also known as naturalist or perfectionist, were also objective, but did not simply provide a list. Instead, they viewed life quality as the fulfillment of an ideal list based on each individual's foundation. A person was living happily and satisfactorily only if he realized his achievement of the important things he valued, or if he came reasonably close to this high standard. In other words, one could only be happy and satisfied if one lived up to the standards one set for themselves. He could nevertheless lead a happy and satisfied life even though many people thought his standards were too low and would never swap places with him. A person may be content if their life fulfilled their own standards, but in order to thrive, they needed to be aware of their abilities and perform at least somewhat close to them. So one could be happy but not flourish. In short, happiness or life quality was the ultimate goal to be achieved when people clearly realized their needs. Therefore, it much depended on human values and aspirations. It was impossible to suppose that life quality was total and all-encompassing. People who felt that their goals were more significant and likely to be realized are experiencing better life quality. People who are unhappier need to have greater conflict with their objectives.

Maslow's theory of human motivation implies that a good life will mostly depend on the level of satisfaction you've had [30]. People enjoy the good life when more wants are met. According to Maslow's theory, some needs can be organized hierarchically. Safety requirements will surface if physiological demands are satisfied, then love and belonging, self-esteem, and self-actualization. In contrast to high requirements, which are global and boundless, lower needs will be more regional, practical, and constrained. Satisfying higher needs makes people happier and reaches better life quality but satisfying high needs requires better environmental conditions such as family, economy, politics, and education. The prerequisite for living happily is setting certain attitudes towards the life, followed by standards, including both objective and subjective aspects to provide key information about people's quality of life. Empirical measurement of life quality has employed the perceived questions of people's lives that relate to either feelings or evaluation of objective conditions [31]. Income, employment and health have been referred as objective conditions in the interpretation of life quality [32]. Other reliable measurement ways were to focus on the presence of positive emotion on income, employment and health [33]. This revealed the importance of the hedonic aspects of experience.

Subjective life quality varied directly with income and was inversely proportional to material aspirations [34]. Early in life, those with greater earnings were happier because the population's material desires were quite equal and those with higher

salaries were more likely to achieve all of their goals. However, because it led to an equal increase in material desires and their detrimental effects on subjective well-being, income growth did not boost welfare for people with greater or lower incomes. Despite the fact that individuals can afford more products to consume because of increased salaries, this positive impact on wellbeing is countered by people's constant need for more. Moreover, D'Ambrosio, et al. [35] clarified the better happiness and satisfaction predictors of permanent income and wealth compared to current income.

Health encompasses a condition of physical, mental, and social wellbeing in addition to the absence of sickness [36]. In the lengthy history of human development, elements of well-being such as physical, mental, and spiritual health have developed as an adaptive reaction to the difficulties of life [37]. As for Vietnamese society, given the prominent ideal of Confucianists, family happiness which covered family harmony and sense of security also equated to subjective life quality [38]. A harmonious family was considered an environment to nurture supportive contexts for family members. Eudaimonia or psychological well-being also measured self esteem because it was linked to higher life satisfaction, social support perception, and health perception. It was the foundation for an individual's hopes and desires, especially regulating the views on autonomy, life purpose, environment, and personal progress. Higher socialization was strongly associated with greater social support. It included cooperativeness and positive relations in the network, which substantially increased wellness and reduced emotional damage [39], [40], [41].

Table 1. Measurement model of quality of life

Criteria	Indicators
Health	Physical health
	Mental health
	Social health
Family happiness	Family sense
	Relationship with family
	Marital status
	Children education
Employment	Teaching satisfaction
	Research evaluation
	Social needs
	On the job training
	Administrative system evaluation
Income	Wage
	Welfare
Socialization	Being supported upon adverse impacts
	Friendship needs
	Relationship with colleagues
	General trust
Self-esteem	Individual's views
	Individual's pleasure

	Individual belief
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3. Research Methodology

The grey analytical hierarchy process combined the grey system theory with the analytical hierarchy process (AHP) decision-making approach. Its use will help to minimize subjective judgments in weighting the criteria in the quality of urban life model. Instead of using crisp sets and crisp numbers, the Grey-AHP technique uses grey numbers [42]. Pairwise comparisons using linguistic and grey scales are employed in the Grey-AHP technique. The Grey-AHP technique involves several steps, all of which are detailed in this section [43], [44]:

Step 1. Define the hierarchical structure, and construct the pairwise comparison matrix using construction experts' evaluations with linguistic scales containing grey numbers in Table 2.

Table 2: Grey-AHP scale.

Level of importance	Linguistics Scale	Grey Numbers
1	Equivalent Importance	[1, 2]
3	Medium Importance	[2, 4]
5	Strong Importance	[4, 6]
7	Very Strong Importance	[6, 8]
9	Extreme Importance	[8, 10]

The grey comparison matrix is constructed as follows:

$$D = \begin{bmatrix} \otimes z_{11} & \otimes z_{12} & \cdots & \otimes z_{1n} \\ \otimes z_{21} & \otimes z_{22} & \cdots & \otimes z_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \otimes z_{m1} & \otimes z_{m2} & \cdots & \otimes z_{mn} \end{bmatrix} \quad (1)$$

where

$\otimes z_{ij}$ is the pairwise comparison concerning the i^{th} criterion over the j^{th} criterion.

Step 2. The normalization for the grey numbers is given in equations (2) through (4).

$$D^* = \begin{bmatrix} \left[\begin{smallmatrix} \underline{z}_{11}^* & \bar{z}_{11}^* \end{smallmatrix} \right] & \left[\begin{smallmatrix} \underline{z}_{12}^* & \bar{z}_{12}^* \end{smallmatrix} \right] & \cdots & \left[\begin{smallmatrix} \underline{z}_{1n}^* & \bar{z}_{1n}^* \end{smallmatrix} \right] \\ \left[\begin{smallmatrix} \underline{z}_{21}^* & \bar{z}_{21}^* \end{smallmatrix} \right] & \left[\begin{smallmatrix} \underline{z}_{22}^* & \bar{z}_{22}^* \end{smallmatrix} \right] & \cdots & \left[\begin{smallmatrix} \underline{z}_{2n}^* & \bar{z}_{2n}^* \end{smallmatrix} \right] \\ \vdots & \vdots & \vdots & \vdots \\ \left[\begin{smallmatrix} \underline{z}_{m1}^* & \bar{z}_{m1}^* \end{smallmatrix} \right] & \left[\begin{smallmatrix} \underline{z}_{m2}^* & \bar{z}_{m2}^* \end{smallmatrix} \right] & \cdots & \left[\begin{smallmatrix} \underline{z}_{mn}^* & \bar{z}_{mn}^* \end{smallmatrix} \right] \end{bmatrix} \quad (2)$$

$$\underline{z}_{ij}^* = \frac{\underline{z}_{ij}}{\frac{1}{2} \left(\sum_{i=1}^m \underline{z}_{ij} + \sum_{i=1}^m \bar{z}_{ij} \right)} = \frac{2\underline{z}_{ij}}{\sum_{i=1}^m \underline{z}_{ij} + \sum_{i=1}^m \bar{z}_{ij}} \quad (3)$$

$$\bar{z}_{ij}^* = \frac{\bar{z}_{ij}}{\frac{1}{2} \left(\sum_{i=1}^m \underline{z}_{ij} + \sum_{i=1}^m \bar{z}_{ij} \right)} = \frac{2\bar{z}_{ij}}{\sum_{i=1}^m \underline{z}_{ij} + \sum_{i=1}^m \bar{z}_{ij}} \quad (4)$$

Step 3. Calculate the grey weight of each criterion by using equation (5) as follows:

$$\otimes w_i = \frac{\sum_{j=1}^n \otimes z_{ij}^*}{n} = \frac{\sum_{j=1}^n \left[\underline{z}_{ij}^*, \bar{z}_{ij}^* \right]}{n} \quad (5)$$

Step 4. Calculate the winterization of the grey weight by using equation (6) as follows:

$$M_i = (1 - \lambda) \underline{w}_i + \lambda \bar{w}_i \quad (6)$$

where λ is the whitening coefficient

Step 5. The calculation of the consistency ratio from experts is as follows [45]:

$$CR = \frac{CI}{RI} \quad (7)$$

where

CI is the consistency index, and

RI is the random index

4. Research Results and Discussion

The empirical model of quality of urban life in Ho Chi Minh city in Table 3 has demonstrated both subjective and objective criteria.

Table 3. The research results in model of quality of urban life

Criteria	Indicators
Health (0.2783)	Physical health (0.2955)
	Mental health (0.4106)
	Social health (0.2940)
Family happiness (0.1050)	Family sense (0.3236)
	Relationship with family (0.3360)
	Marital status (0.1686)
	Children's education (0.1719)
Employment (0.1872)	Teaching satisfaction (0.3166)
	Research evaluation (0.1766)
	Social needs (0.2229)
	On the job training (0.1693)
	Administrative system evaluation (0.1145)
Income (0.2063)	Wage (0.334)
	Welfare (0.666)
Socialization (0.1083)	Being supported upon adverse impacts (0.2186)
	Friendship needs (0.2415)
	Relationship with colleagues (0.2622)
	General trust (0.2777)
Self-esteem (0.1149)	Individual's views (0.4077)
	Individual's pleasure (0.2227)
	Individual belief (0.3696)

The ranking results emphasized the high shares of health, employment, and income compared to self-esteem, socialization, and family happiness. Further investigation has confirmed the superiority of non-material components in the life quality model of the city dwellers in Ho Chi Minh City, Vietnam. Health was ranked as the top criterium, followed by income, and employment of the life quality measurement model. These findings were similar to the results reported by Kwasniewska, Bielecki & Drygas [46] in the assessment of the life quality of Polish urban residents.

In terms of income, welfare contributed to life quality much more than the current wage. The result confirmed the superior role of permanent income and wealth to current income as satisfaction and happiness predictors as indicated by D'Ambrosio, et al. [35]. Moreover, the non-linear relationship between material factors and life quality has been evidenced by Robin and Dominguez [47] to confirm the diminishing marginal utility. An additional dollar to be spent shall bring less satisfaction and happiness than the prior one. Employment was the third priority in the life quality model. The level three ranking implicated the preference for stable employment as found in a seminal study by Taylor [48]. Robone, et al. [49] also distinguished informal and formal employment in driving life quality. This was empirically confirmed in several studies in both developed and developing countries [50-52].

Personal values, and social and family relationships are also the three subjective sources of life quality as implied [53]. The superior weight of personal values to the

other two subjective criteria complied with Maslow [30] because the former was the highest level in the needs pyramid to enjoy life. It regulated individual desires and hopes which were the foundation of life quality and consistent with theories of self-efficacy and self-determination [54]. Socialization shared the next important position in the group of subjective criteria, given its strong impact on social support perceptions, which also significantly improved well-being and decreased negative emotions, in line with attachment and social engagement theories [55], [56]. Finally, a family which is always considered a traditional factor in creating life quality was evaluated as the least priority in the life quality model. Vietnam is among the country of Confucian tradition with diversified family values such as harmony, duty, honor, respect, and children's education [57, [58]. Therefore, the family was seen as a source of basic needs for each individual, both material and spiritual. The economic reforms in the 80s global integration trend have, however, shifted the family roles in Vietnam and led to the preference of the extended network to the closed one in the family.

5. Conclusion

The employment of Grey-AHP in a hierarchical model to measure the quality of urban life in Ho Chi Minh City, Vietnam has concluded the criteria in the priority orders as follows: (1) health; (2) income; (3) employment; (4) self-esteem; (5) socialization; and (6) family happiness. Objective criteria of health, income and employment shared higher weight compared to subjective criteria of self-esteem, socialization, and family happiness. Further ranking of the model provided firm empirical evidence for the nudge in mindset changing to the pursuit of life quality with much emphasis on permanent aspects and non-material features due to the depreciation of material goods but an appreciation of experiences. This research has also provided a confident ranking choice of life quality criteria and sub-criteria based on the interval instead of concrete value thanks to the combination of grey theory and AHP . The indicative importance of criteria and sub-criteria in the measurement model of life quality implies the priority of proper policies to boost the quality of urban life in the context of Vietnam.

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