

MEASURING SOCIAL DIMENSION OF CITY PROSPERITY BY USING A COMPREHENSIVE METHOD: A CASE STUDY OF DA NANG CITY

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Abstract. UN-Habitat developed the City Prosperity Initiative (CPI) in 2012 as a method for quantifying urban prosperity and sustainable development. The research aims to use the indicators of CPI and adopted the Full Permutation Polygon Synthetic Indicator method to measure and evaluate the prosperity level of the social dimension in Da Nang City with data from 2004 to 2019. According to the findings of our study, the value of a synthetic indicator for social prosperity of Da Nang City was increasing gradually from 0.52 in 2004, 0.50 in 2009, 0.60 in 2014, and 0.60 in 2019, which indicates a good level of wealth. In general, Da Nang City has a high level of quality of life, equity and social inclusion, and urban governance and legislation. However, some indicators of social prosperity were unfavorable such as green area per capita, accessibility the open public spaces, women in local government, land use mix, civic participation, and local expenditure efficiency... The Full Permutation Polygon Synthetic Indicator approach offers a comprehensive solution that exemplifies the system integration concept of the whole being greater than the sum of its parts. As a result, the technique provides a possible platform for decision-making in order to promote sustainable urban development and evaluate the effectiveness of these measures.

Keywords: Prosperity; The Full Permutation Polygon Synthetic Indicator method; social dimension; a comprehensive index; Da Nang City; Vietnam.

1. Introduction

Cities have emerged as key drivers of productivity, technology, infrastructure development, and institutional institutions that aid in the improvement of equity, social inclusion, and general quality of life (UN Habitat, 2016). However, urban sprawl, pollution, and environmental degradation can be exacerbated by unplanned or poorly managed urban development, in combination with unsustainable production and consumption practices and a lack of capability of governmental institutions to manage urbanization (Feng Li et al., 2009). The State of the World's Cities Report, published in 2012, proposed a concept of prosperity beyond economic growth, which has dominated development strategy and agendas for many years. Prosperity looks at how cities may create and equitably divide the advantages and opportunities that come with wealth, assuring economic well-being, social cohesion, environmental sustainability, and a higher overall quality of life (UN Habitat, 2013). UN-Habitat also created a tool to measure the sustainability of cities. This tool is known as the City Prosperity Initiative (CPI), accompanied

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by a conceptual matrix of crucial components with 62 indicators (UN Habitat, 2016; Arbab, 2017).

Vietnam is undergoing rapid urbanization and industrialization accompanied by a swiftly rising GDP, rapidly developing urban infrastructures and significant changes in the quality of life in cities. Building an efficient, healthy, and civilized urban society, encompassing livable human settlements and regional ecological security, has become a global priority for governments and organizations and is gradually becoming a national goal in Vietnam. The Vietnamese government has already begun to propose people-oriented development strategies for constructing sustainable and harmonious cities (Socialist Republic of Vietnam, 2015; Socialist Republic of Vietnam, 2018). Measuring and managing the progress of cities toward prosperity and sustainability using a comprehensive index has become an urgent concern in Vietnam. The research aims to apply indicators of CPI and built a comprehensive index by using Full Permutation Polygon Synthetic Indicator method (FPPSI) to measure and evaluate the level of social prosperity of Da Nang with the temporal scope of data in period 2004-2019. The evaluation results are critical foundations for municipal officials to conduct a thorough examination of the urban development process and create suitable policies to support long-term growth.

2. Content

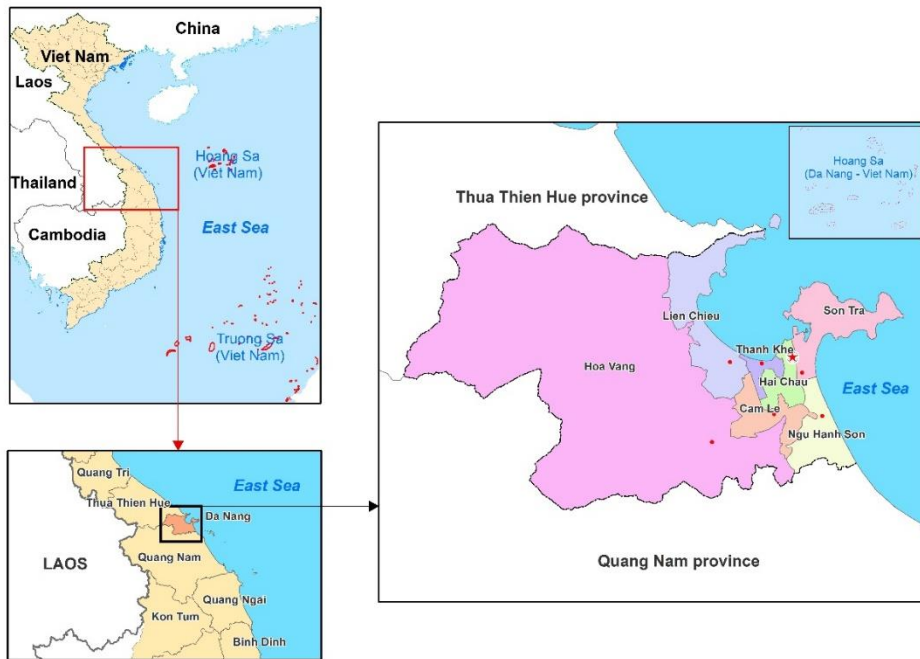
2.1. Study area

Da Nang is one of Vietnam's most important port cities, located on the coast of the East Sea near the mouth of the Han River, known as the most livable, dynamic, friendly, peaceful city. It is administered by the central government as one of the direct-controlled municipalities and the largest city in the Central area. Da Nang serves as the region's economic, commercial, and educational hub. It also serves as a transportation hub, thanks to its placement on National Route 1A, North-South Railway, and lies at one end of the East-West Economic Corridor, an economic corridor connecting Vietnam with Laos, Thailand, and Myanmar. Furthermore, Da Nang serves as the center for three UNESCO World Heritage Sites: the Hue Citadel in Thua Thien-Hue province, Hoi An historic town, and My Son Sanctuary in Quang Nam province.

Da Nang is bounded to the north by Thua Thien Hue province, west and south by Quang Nam province, and east by the East Sea. Before 1997, the city was the territory of the Quang Nam–Da Nang province. On January 1, 1997, it was withdrawn from Quang Nam Province and had become one of Vietnam's five autonomous (centrally-controlled) municipalities. With a population of 1,141 thousand people in 2019, the city covers an area of 1284.4 km². It comprises 06 urban districts (Hai Chau, Ngu Hanh Son, Thanh Khe, Son Tra, Lien Chieu, Cam Le) and Hoa Vang rural district, the Hoang Sa island district (see Fig.1). Currently, Da Nang City has the highest proportion of urban population among the provinces in Vietnam, with nearly 90 percent in 2020, while the average urban population rate of the whole country is only 37.3 percent (General Statistics Office, 2021).

The climate of Da Nang is characteristic of the tropical monsoon season. It maintains a generally constant temperature with little change. Its climate is divided into two seasons: a rainy season from August to December and a dry season from January to July, with rainfall concentrating mainly between September and December. Every year, 1-2 typhoons and 1-2 significant flooding spells hit this area directly or indirectly (Vu Tu Lap, 2012). The average humidity is 83.4 percent, and the average temperature is around 26 degrees Celsius. The highest temperatures are 28-30 degrees Celsius in June, July, and August, while the lowest temperatures are 18-23 degrees Celsius in December, January, and February. The average annual rainfall is 2,505 mm, with October and November being the wettest months. This area's geography ranges

from flat to hilly, with elevations ranging from 0 to 2,000 feet above mean sea level (Da Nang City Statistics Office, 2021).



Source: own elaboration

Figure 1. Location of the study area (Da Nang City – Vietnam)

Da Nang is Central Vietnam's most significant manufacturing city. Its GDP per capita in 2019 was 4171 USD, making it one of the wealthiest in Vietnam (after Ho Chi Minh City, Hanoi, Binh Duong Province, and Dong Nai Province) (Da Nang City Statistics Office, 2021; General Statistics Office, 2021). Da Nang is one of the municipalities that always lies on the top of the Provincial Competitiveness Index rankings for many years, mainly benefiting from good performance in labor training, transparency, proactive provincial leadership, and low entry costs (Malesky et al., 2020). The economic structure of the city is shifting to a “service-industry-agriculture” paradigm. The service sector, including tourism, still accounts for the highest proportion in the economic system of this coastal city. In 2020, the service sector was estimated to reach 64.56%; the industry-construction sector was 22.32%; the agricultural sector was estimated at 1.72% in the city's economic composition (Danang City Statistics Office, 2021).

Da Nang is one of the famous cities in Vietnam for its “the City of 5 No, 3 Yes, and 4 Security” program to develop a rich, beautiful, and civilized city. Da Nang launched the “City of 5 No” program in 2000, which included no hungry households, no illiterate people, no begging vagrants, no drug addiction, and no murder and robbery. In 2005, the city continued to promote the “City of 3 Yes” program, which included housing, jobs, and an urban cultural and civilized lifestyle. Da Nang began implementing the “4 Security” city program in 2016: security and order, traffic safety, food safety, hygiene, and social security (Da Nang People’s Committee, 2020).

2.2. The Indicators for Social Prosperity of Da Nang City

Prosperity is a social construct that manifests itself via human actions. That is a more significant, broader concept concerned with clear policies and well-balanced, harmonic growth in a fair and just environment (Jackson, 2009; UN Habitat, 2013). In 2012, UN-Habitat developed a technique to assess the sustainability of cities known as the City Prosperity Initiative (CPI) which

argues for the need to move towards measuring the broad conception of human and societal well-being in terms of sustainability (UN-Habitat, 2015; Wong, 2015). CPI was accompanied by 6 key dimensions including productivity, infrastructure development, quality of life, equity and social inclusion, environmental sustainability, and governance and legislation. In this paper, we only assess the level of social prosperity with 28 indicators belong to three sub-dimension: quality of life, equity and social inclusion, and governance and legislation.

- Quality of life (12 indicators): Life Expectancy at Birth (year), Under-Five Mortality Rate (%), Vaccination Coverage (%), Maternal Mortality (mother per 100,000 live births), Literacy Rate (%), Mean years of Schooling (year), Early Childhood Education (%), Net enrollment rate in higher education (%), Homicide rate (Homicides per 100,000 inhabitants), Theft rate (Thefts per 100,000 inhabitants), Accessibility to Open Public Areas (%), Green Area per Capita (m²/person).

- Equity and social inclusion (8 indicators): Gini Coefficient (constant), Poverty Rate (%), Slums Households (%), Youth Unemployment (%), Equitable Secondary School Enrollment (Dimensionless), Women in Local Government (%), Women in Local Work Force (%), Land Use Mix (Dimensionless).

- Governance and legislation (8 indicators): Voter Turnout (%), Access to Public Information (%), Civic Participation (%), Own Revenue Collection (%), Days to Start a Business (days), Subnational Debt (%), Local Expenditure Efficiency (%), Land Use Efficiency (Dimensionless).

2.3. A Full Permutation Polygon Synthetic Indicator (FPPSI) method for constructing a comprehensive index

On the basis of the selected indicator system, many ways may be employed to evaluate the city's prosperity. Typical approaches include the analytical hierarchy process (AHP), principal component analysis (PCA), entropy weight method, *etc.* In this paper, A Full Permutation Polygon Synthetic Indicator method (FPPSI) has been used to assess the level of the prosperity of Da Nang City. The benefit of using FPPSI is that it incorporates the target's multifactor and systematic features. While the evaluation procedure lessens the impact of subjective elements, the aggregated evaluation findings make analysis and comparison easier (Feng Li et al. 2009). Additionally, FPPSI is not required when establishing the weight by expert subjective judgment, which lowers subjective randomness compared to the conventional simple weighing technique. By employing a multi-dimensional method that more accurately captures the integrative system concept that the whole is greater than the sum of its parts, FPPSI can modify the conventional additive technique to combining indicators (Xu et al., 2016). For indicator i , the normalized value S_i is can be expressed as following equation:

$$S_i = \frac{(U_i - L_i)(X_i - T_i)}{(U_i + L_i - 2T_i)X_i + U_iT_i + L_iT_i - 2U_iL_i}$$

where S_i is the standardized value of indicator X_i ; U_i is the upper limit of X_i , which is usually the highest value of X_i ; L_i is the lower limit of X_i , which is commonly the lowest value of X_i ; and T_i is the threshold value of X_i , which is usually the average value of X_i . The lower limit, the upper limit are determined by looking for the best and worst performances of cities in the world (UN Habitat, 2016). With negative variables (e.g., Under-five mortality rate), the highest numerical value is the worst, and the lowest is the best. While for positive indicators, the highest numerical value is the best, and the lowest is the worst (e.g., City product per capita). To eliminate the effects of extreme values, the values at 5% of the best and the worst, and 95% of the rest are taken as the upper limit, the lower limit, and the threshold value respectively. The standardization interval is $[-1, +1]$. Notably, $S_i = -1$ when $X_i = L_i$; $S_i = 0$ when $X_i = T_i$; and $S_i = 1$ when $X_i = U_i$. The inner portion of the critical zone shows that the normalized value of each indicator is less than the critical value and so has a negative value. The exterior area shows that

the normalized value of each indicator is more than the critical threshold and positive, as illustrated in Figure 2.

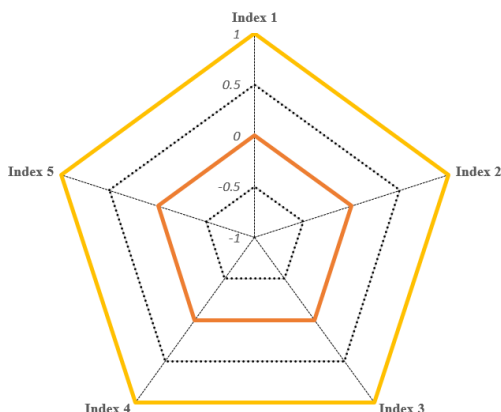


Figure 2. The schematic of Full Permutation Polygon Synthetic Indicator Method

The composite index of FPPSI is defined as the ratio of the mean of all the irregular polygon area to the central polygon area. The value of composite index of permutations polygons of each dimension can be obtained as follows:

$$S = \frac{\sum_{i \neq j}^{i,j} (S_i + 1)(S_j + 1)}{2n(n - 1)}$$

where S is the value of the synthetic indicator. The authors established a four-level classification system based on the value of S as shown in Table 1.

Table 1. Classification for City prosperity level

Level	Value of the synthetic indicator	Qualitative level
I	>0.75	Excellent
II	0.5 – <0.75	Good
III	0.25 – <0.5	Moderate
IV	<0.25	Bad

Source: (Feng Li et al. 2009)

Table 2. Indicator system used to evaluate social prosperity in Da Nang City

Dimension	Indicator	2004	2009	2014	2019	Upper limit	Lower limit
1. Quality of Life Index	Life Expectancy at Birth (year)	75.4	75.7	75.9	76.1	83.5	49.0
	Under-Five Mortality Rate (%)	14.3	13.7	13.3	12.6	2.2	181.6
	Vaccination Coverage (%)	98.7	99.5	98.5	97.04	100.0	0.0
	Maternal Mortality (mother per 100,000 live births)	0.00	0.00	0.00	0.02	1.0	1100.0
	Literacy Rate (%)	94.8	96.5	97.8	98.7	99.9	15.0
	Mean years of Schooling (year)	8	8.3	8.6	9.1	14.0	0.0

Measuring social dimension of city prosperity by using a comprehensive method: ...

Dimesion	Indicator	2004	2009	2014	2019	Upper limit	Lower limit
	Early Childhood Education (%)	100.0	98.5	99.4	96.5	100.0	0.0
	Net enrollment rate in higher education (%)	12.7	17.8	22.5	27.9	100.0	0.0
	Homicide rate (Homicides per 100,000 inhabitants)	0.91	0.85	0.76	0.71	1.0	1654.0
	Theft rate (Thefts per 100,000 inhabitants)	46.4	38.8	33.3	26.6	25.5	6159.1
	Accessibility to Open Public Areas (%)	4.3	8.2	33.2	58.7	100.0	0.0
	Green Area per Capita (m ² /person)	1.1	1.62	4.5	7.51	15.0	0.0
2. Equity and Social Inclusion Index	Gini Coefficient (constant)	0.314	0.356	0.344	0.334	0.2	0.6
	Poverty Rate (%)	4.05	5.13	1.00	0.69	0.0	81.3
	Slums Households (%)	3.9	2.6	0.2	0.5	0.0	80.0
	Youth Unemployment (%)	25.1	20.1	11.4	10.1	2.7	62.8
	Equitable Secondary School Enrollment (Dimensionless)	0.97	0.98	0.99	1.00	1.0	0.0
	Women in Local Government (%)	21.5	23.6	28	24	50.0	0.0
	Women in Local Work Force (%)	49.2	48.3	49.4	48.1	50.0	0.0
	Land Use Mix (Dimensionless)	0.34	0.42	0.49	0.48	1.6	0.0
3. Governance and Legislation Index	Voter Turnout (%)	95.0	99.5	99.6	99.9	100.0	0.0
	Access to Public Information (%)	54.0	65.0	73.0	82.0	100.0	0.0
	Civic Participation (%)	5.50	5.28	4.83	4.50	100.0	0.0
	Own Revenue Collection (%)	96.8	94.3	90.3	95.0	80.0	17.0
	Days to Start a Business (days)	12.0	12.0	9.0	6.0	2.0	208.0
	Subnational Debt (%)	77.3	72.8	68.1	61.7	60.0	120.0
	Local Expenditure Efficiency (%)	103.5	163.7	116.4	175.0	100.0	200.0
	Land Use Efficiency (Dimensionless)	0.63	0.70	0.83	0.86	0.0	3.0

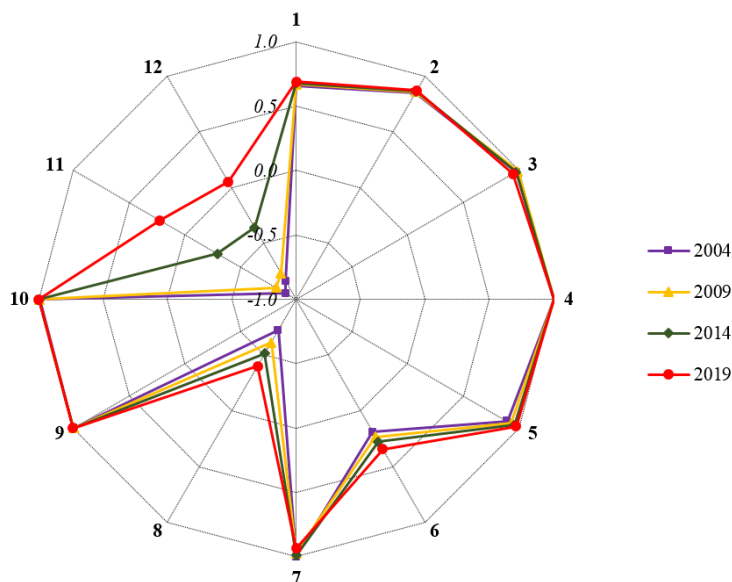
Source: own synthesis and calculation (The data for indicators to evaluate social prosperity in Da Nang City was synthesized and calculated by authors from sources of Vietnamese government, Local government of Da Nang City, map and remote sensing data...)

2.4. Results

Based on the data for Da Nang City in the period 2004 - 2019 described in Table 2, the authors evaluated the social prosperity of Da Nang city from three perspectives: quality of life; equity and social inclusion, and governance and legislation. The authors then synthesized the results to provide a single comprehensive indicator of social prosperity.

2.4.1 Quality of Life

Quality of life refers to happiness, good health, and the general well-being of individuals and society. The quality of life dimension measures the city's achievements in providing essential amenities that promote happiness and general well-being. They include basic services and amenities such as education, health, recreation, safety, security, etc. They are required to enable the population to maximize their individual potentials and to lead long, fulfilling lives (UN Habitat, 2013).



Source: own elaboration

Figure 3. Comprehensive evaluation of Quality of Life dimension in Da Nang

(1) Life Expectancy at Birth, (2) Under-Five Mortality Rate, (3) Vaccination Coverage, (4) Maternal Mortality, (5) Literacy Rate, (6) Mean years of Schooling, (7) Early Childhood Education, (8) Net enrollment rate in higher education, (9) Homicide rate, (10) Theft rate, (11) Accessibility to Open Public Areas, (12) Green Area per Capita.

The indicator for quality of life in Da Nang was good (0.67, level II in 2019) and improved from 0.5 in 2004, to 0.52 in 2009, 0.59 in 2014 and 0.67 in 2019 (Fig.3). The good quality of life in the city can be linked to the good healthcare system (low under-5 mortality rate, really high vaccination coverage, and low maternal mortality), safety and security (very low homicide rate and theft rate). Nevertheless, the education sector of Da Nang still suffers from a low enrollment rate in higher education. Besides that the mean years of schooling also need to be addressed. Moreover, the availability of adequate public spaces for recreation and socialization is a weak sub-dimension with low level of the green area per capita and the accessibility to the open public spaces.

2.4.2. Equity and Social Inclusion

The equity and social inclusion factors assess how cities distribute affluence among their residents. Cities that are inclusive ensure that no parts of the population are left behind in

poverty or deprivation as they grow. More socially inclusive and economically equitable cities are more productive and have a higher standard of living and quality of life (UN Habitat, 2013).

Based on the 2004 - 2019 data, the synthetic indicator for equity and social inclusion dimension in Da Nang was good (level II) with 0.54 in 2004, 0.55 in 2009, 0.63 in 2014, and 0.62. in 2019 (Fig.4).

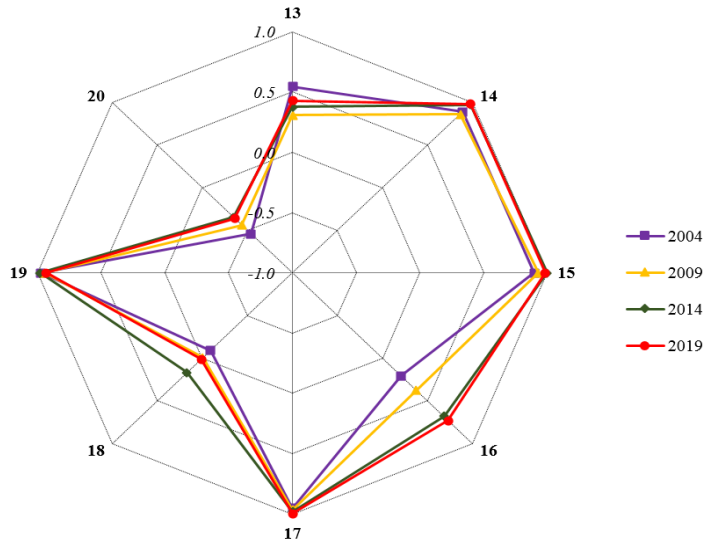


Figure 4. Comprehensive evaluation of Equity and Social Inclusion dimension in Da Nang

Source: own elaboration. (13) Gini Coefficient, (14) Poverty Rate, (15) Slums Households, (16) Youth Unemployment, (17) Equitable Secondary School Enrollment, (18) Women in Local Government, (19) Women in Local Work Force, (20) Land Use Mix.

The Gini coefficient, poverty rate, slums households, youth unemployment, equitable secondary school enrollment, women in local work force are all favorable factors that reflect the high level of economic equality, social inclusion, and gender inclusion in Da Nang. However, the number of women in the local government is still low, calling for the prioritization of policies that promote more women's participation in the local government. The city still has to strengthen its ability to provide jobs for young people in order to reduce youth unemployment. Furthermore, a thriving city strives to balance its systems and functions by distributing main urban activities (UN Habitat, 2016). However, most of Da Nang's economic activities and population are concentrated in the inner city (only about 20% of the territory). Hence, the very low level of land use mix (a mix of residences, workplaces, and local commerce) reflects the unbalanced situation of the city's spatial distribution of activities, structure, and organization.

2.4.3. Governance and Legislation

A decent society is not just financially prosperous but also socially inclusive, environmentally sustainable, and well-governed. Good governance and the rule of law foster a sense of security and well-being. On the other hand, corruption, lawlessness, dishonest politicians, uneven government services, massive discrimination, insider transactions, and other issues produce a lot of displeasure (Sachs, 2015). To provide a suitable environment for the city to appropriately manage other drivers of prosperity and attain sustainability, competent governance and appropriate laws are essential (UN-Habitat, 2019).

Based on the available information, Da Nang city's overall governance and legislation index was good (level II) in general with 0.53 in 2004, 0.45 in 2009, 0.57 in 2014, and 0.50 in 2019 (Fig.5). Da Nang gets a high level for voter turnout, access to public information, own

revenue collection, subnational debt, days to start a business, and land-use efficiency. In reality, Da Nang has consistently rated high in the list of provincial competitiveness in Vietnam due to significant advances in economic management mechanisms and policies (Malesky et al., 2020). However, citizen participation was very low and local expenditure efficiency was unstable.

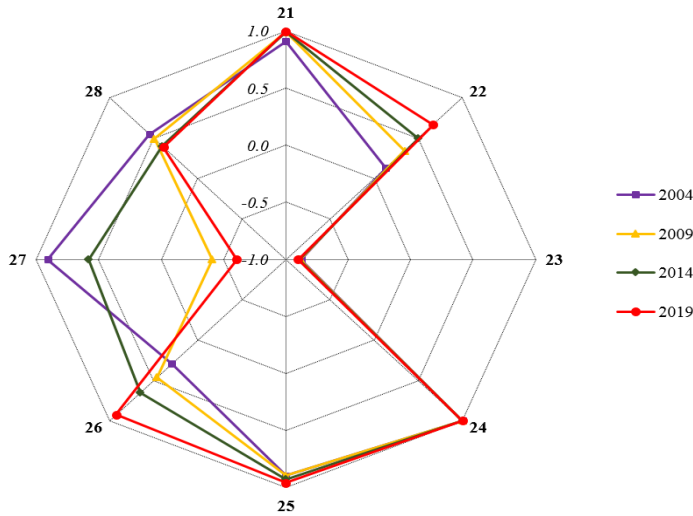


Figure 5. Comprehensive evaluation of Governance and Legislation dimension in Da Nang

Source: own elaboration. (21) Voter Turnout, (22) Access to Public Information, (23) Civic Participation, (24) Own Revenue Collection, (25) Days to Start a Business, (26) Subnational Debt, (27) Local Expenditure Efficiency, (28) Land Use Efficiency

2.4.4 Comprehensive evaluation of city prosperity in Da Nang

As in 2004 - 2019, the comprehensive indicator for social prosperity in Da Nang was at level II and progressively increased from 0.52 in 2004 to 0.60 in 2019 which represents a good status.

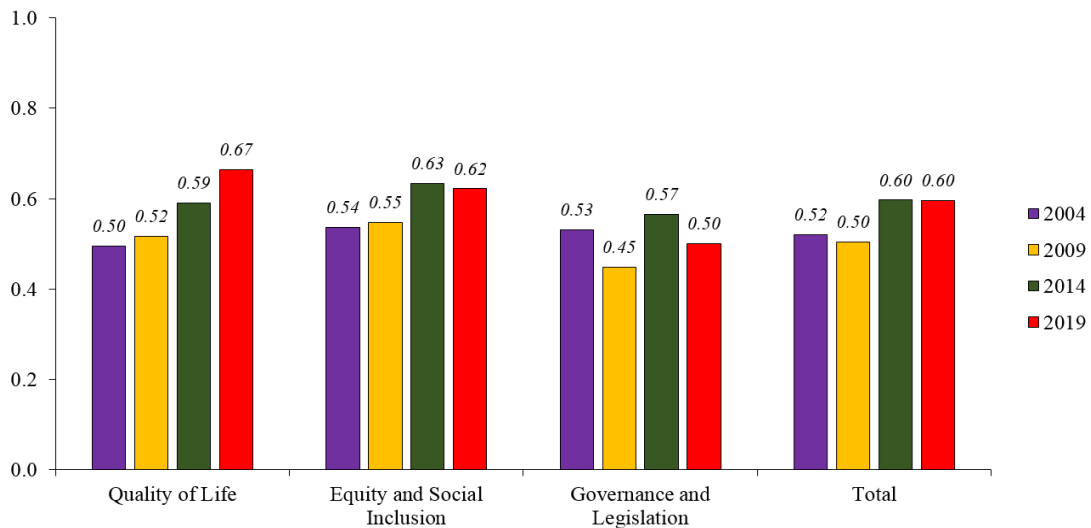


Figure 6. Comprehensive evaluation of Social Prosperity in Da Nang City

Source: own elaboration

Even though all of the sub-dimensions were evaluated as good status (≥ 0.5 , level II), the diagram still illustrates the lack of balance between social dimensions in Da Nang. Quality of life, and equity and social inclusion have better status. Especially, quality of life has been improved significantly. Meanwhile, governance and legislation had lower value and fluctuation over times (see Fig.6). A balanced city ensures that the citizens do not suffer extreme deprivations associated with a very low index. Hence, Da Nang should make progress and equilibrium between and within dimensions of the prosperity index to be sustainable and prosperous.

3. Conclusion

Urban sustainable development and prosperity is a long-term task that aims to develop a more vital synthesis of social, economic, environmental, and governance factors. The indicator system of CPI, developed by UN-Habitat, is a novel tool to evaluate urban prosperity that is comprehensive, integrated, and crucial for promoting and monitoring socio-economic development, inclusion, and progressive fulfillment of urban-related human rights for everyone. The authors have used this indicator system and applied the FPPSI method to assess social prosperity in the case study of Da Nang city of Viet Nam in the period 2004 - 2019. Instead of using subjective expert judgements on the values of coefficients, the FPPSI technique just asks analysts to specify upper and lower bounds and crucial values, which should lessen the amount of bias that may skew subjective evaluations. This approach is more accurate, measurable, and effective. The ability to measure the indicators and quantify progress towards a target is another benefit of the FPPSI approach. The FPPSI technique at least enables planners to select measurable indicators that are related to management goals, despite the fact that indicator selection is rather arbitrary. The FPPSI technique deviates from the usual approach to combining indicators by employing a multi-dimensional approach that more accurately reflects the integrative system concept that the whole is greater than the sum of its parts (Feng Li et al, 2009). The overall social prosperity index implies that the city has good level of prosperity with strong sub-dimensions such as quality of life, equity and social inclusion. However, the index also shows that Da Nang has some weak aspects of social prosperity related mainly to green area per capita, accessibility to the open public spaces, women in local government, land use mix, civic participation, and local expenditure efficiency. Nonetheless, the index is a tool that allows municipal officials and local and national stakeholders to identify possibilities and possible areas of action for their communities to become wealthier. Hence, the results of our analysis should thus support decisions made to promote sustainable development of the city and should permit tracking of the consequences of the decisions of local government.

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