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Research on the Evaluation Indexes of Walking Friendly Environment in Healthy Communities from the Perspective of Mass Transit Oriented Development - Taipei MRT as an Example

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Abstract: This study explores Transit-Oriented-Development (TOD), a healthy community formed by four stations of Taipei MRT Bannan Line: Jiangzicui Station, Xinpu Station, Banciao Station and Fuchu Station Environment as an example, we use Fuzzy Delphi Method (FDM) and Analytic Network Process (ANP), and import Gray System Theory to construct TOD healthy community by Gray-ANP analysis. In this study, based on literature review and evaluation by FDM experts, we completed the selection and establishment of indicator architecture, and set up a set of index system suitable for assessing TOD healthy walking friendly environment by using ANP Gray-ANP Calculated the weight of each index and the priority of the results of the case area to conduct an index system instance analysis and application. The analysis of the case area shows that the current conditions are reflected in the importance of the weight, The top three in sequence were Design (15.55%), Pedestrian streets (12.59%), pollution remediation (11.76%) and Public access to green spaces (10.92%). Subsequent studies suggest that a comprehensive assessment of Taipei MRT (114 stations) be conducted and a comprehensive questionnaire system should be added to further quantify the users feelings.

Keywords: *Transit-Oriented-Development, healthy community, walk friendly, evaluation indicators*

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INTRODUCTION

Since the industrial revolution, the advance of science and technology and civilization have enabled the previous life style to gradually move toward the trend of global urbanization. The world's urban population has increased by about 60 times so far. As the latest WHO Over 112 cities in more than one million people and about 60% of the world's population will live in cities by around 2025 and by 2050 (Ramaswami & Dhakal, 2011) more than 80% of the world's population will live in cities (The Times of India, 2015). As a result, people continue to develop various issues of urban development during the continuous improvement of their daily needs. For example, the rapid mobility of automobiles accelerates the phenomenon of suburbanization and the city spreads to the suburbs. Radical and leapfrog development has not only led to an increase in the cost of transportation and construction, the cost of construction and transportation, the increasing burden of public facilities and public expenditure, and the serious pollution of living and natural environment (Harvey & Clark, 1965; Johnson, 2001; Mitchell & Dorling, 2003; Osra, 2017). By then, the problems caused by the industrialized and urbanized society such as health, Dyeing, environmental protection and ecology will also be growing, but also greatly affect the daily life of healthy people.

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In response to the above global urbanization, the WHO started to promote the Healthy City vision in 1981. It is expected that densely populated cities will not only have the negative impact of tense life and environmental degradation, but should also make the overall city more healthy growth. However, looking at the development of a healthy city, it can be found that the current implementation of a healthy city is still under conceptual conceptualization because of the different local conditions, characteristics and culture (Petersen, 1996; Teng, Quoquab, Hussin, & Mohammad, 2016). Like Duhl (1986) The realization of Healthy City mainly lies in the process, which means that: (1) a healthy city not only realizes a specific health condition; (2) a healthy city is a continuous improvement of health awareness, and any city No matter what its current subjective and objective conditions, it can be a "healthy city". (3) What is needed in a healthy city is the process and structure of practicing this goal. (4) Healthy cities can continuously improve the natural and social environment and expand the society Resources enable residents to develop their full potential in life. As stated above, Healthy City has a relatively broader vision and is less able to implement and make strategic recommendations because of the changing environmental conditions and many factors that depend on the environment. Therefore, the WHO held its first International Conference on Health Promotion in 1986 in Ottawa, Canada and further proposed by the Ottawa Charter for Health Promotion a healthy communities. Concept has also become a concrete direction for governments and local communities (WHO, 1986). In the 1986 Lisbon conference, the health characteristics were more specifically described, which included the participation of community residents in public-private cooperation. In addition, many studies in recent years have also defined healthy communities as the purpose of protecting and improving the quality of life of their residents by promoting healthy behaviors and maximizing the protection of the natural environment in communities in order to reduce the impact of disasters (Dannenberg et al., 2003). Not only is it a generalized emphasis on directly influential elements and a greater emphasis on the health effects of the built environment, it can also be widely understood as elements of the environment in general life such as from a pluralistic community environment Its healthy elements include good pedestrian environment, sidewalks, vehicle speed, lighting, crime rates, mass transport traffic use, social connections and cultural diversity. Not only are they closely interdependent but also interdependent, creating the characteristics of the local community environment. Therefore, the comfortable walking environment and safety considerations are even more important (Srinivasan, Ofallon, & Dearry, 2003). Due to the unfriendly community environment, residents' willingness to go out is significantly reduced. The closed lifestyle will reduce the community cohesion and gradually Social isolation (Kawachi, Kennedy, & Glass, 1999) not only greatly affects the identity of residents in the area, but also gradually begins to care about the living environment of the community and finally leads to the indifference of residents to the community environment and their indifference to social relations (Van Lenthe et al., 2005). Therefore, in the process of urbanization, it has become the current world trend to improve the environmental factors through healthy communities and to make the community environment deviate from the vicious cycle toward healthy communities and the development of a low-carbon and friendly environment.

THE LINK BETWEEN TOD AND HEALTHY COMMUNITY ENVIRONMENT

Aristotle said 350 years ago BC: "We went to design a city where there are four places to think, and the first and most indispensable is the health topic." And Aristotle The so-called health topics include "good health" and "public health" Why urban design and health are closely related? Due to the urban design will affect the city's internal environment and facilities to shape the city's built environment (built environment), built environment, including land use patterns and density, construction of the nature and quantity, transportation systems and Public facilities and so on, will affect all kinds of human behavior, and then affect people's life, work and leisure and other physical activities (Calthorpe, 1993). The environment built under different urban design concepts will lead to a variety of substantive activities through different transport systems.

As from the 1960s onwards, cities have been expanding outward in an orderly manner, looking for a good environment, building a beautiful house to enjoy individualism and shaping a car-oriented city to spread. As a result, people Instead of living in a good environment and without giving expression to mind and body, it has led to various topics of "public health" and "good health". By 1993, modern urban designer Calthorpe (1993), in his book "The Next American Metropolis",pointed out that the orderly development of cities was based on a good transport design and urban design meaning while the urban development was healthy Whether or not it depends on the type of "transportation system" suggests that a concept of urban design that uses mass transit as a transportation system be called TOD. The structure of the TOD is node-like, with commercial centers, municipalities and potential public transport stations dominated by the retail space, the space requirements of public transport stations, and the characteristics of an easily identifiable social center in neighborhoods and jurisdictions Demand and other factors as a judge. Through comfortable walking, the development of mass transit can be coordinated with the municipal or public transport system integration and flexible planning of residential, work and public space around to form a core business district, showing that the TOD model places great emphasis on people's walking Environment, and the TOD spatial scale is mainly measured by walking distance. It is also a major trend of thinking of "health" to integrate the mass transit system in urban design. It has also become the major trend of urban design since the 2000's.

Table 1 *5D Connotation of TOD*

5D Element	5D Element Content		
Density	Public transport stations around the land high-intensity use		
Diversity	The land around the mass transit station is highly mixed, combining residential, work and leisure functions		
Design	People-oriented street design with a comfortable and smooth action line		
Distance	The mass transit station as the core, within walking distance as the main area of land development		
Destination	Trip starting date and trip times between the distance		
Feature	Empirical Issues	Empirical Researcher	Substantial Efficiency
Distance	Increase the number of TOD planning areas	Downs (1994); Iams and Kaplan (2006)	Promote economic development and local growth, improve financial returns
	To the station for the development of the core	Porter (1997)	Stimulate the redevelopment of central business district
	Distance from the station	Gray and Hoel (1979)	The closer the station, the higher the willingness to take public transport
Density	Increase housing and employment density	Cervero and Wu (1997)	
		Moudon et al. (2005)	Stimulate pedestrian trips,reduce the number of car trips
		Nelson and Niles (1999)	Improve joint development opportunities and promote the development benefits of both public and private sectors
		Porter (1998)	Increase private development willingness and promote development value
		Parsons Brinckerhoff Quade & Douglas, Inc (1996)	Increase the willingness to take the mass transit system
	Increase employment intensity	Thompson and Audirac (1999)	Increase public transport boarding trips
Diversity	Mixed residential and commercial	Handy (1996); Porter (1997)	Increase pedestrian trips, attract business gatherings & promote local economic development
		Nelson and Niles (1999)	Attract pedestrians to walk & increase the number of boarding trips for mass transit
		Parsons Brinckerhoff Quade & Douglas, Inc (1996)	Increase the number of public transportation system commuter brigades
		McGuckin and Murakami (1999)	The increase in the number of female mass transit trips is higher than that of male mass transit trips
Design	Urban Structure Development Design	Belzer and Autler (2002)	Protect environmental resources and create environmental quality within the city
	Lattice street type	Crane (1996, 1998) & Crane and Crepeau (1998) Boarnet and Sarmiento (1998)	Stimulate the will of pedestrians to walk, increase accessibility and reduce the use of private cars
	Downtown parking restrictions	Steiner (1998); Thompson and Audirac (1999)	Reduce the use of private cars and increase the number of boarding buses for mass transit
	Pedestrian guidance	Corbett and Zykofsky (1999)	Attracting business to gather and develop, increasing the number of public transport boarding

Source: (Belzer & Autler, 2002)

Therefore, the walking environment must be people-oriented, giving people a friendly, comfortable, safe and convenient walking space. argues that a good walking environment is the most important part of the TOD and should create a comfortable walking environment at the beginning and the end of all traffic trips. In addition, planting sidewalk trees and building entrances and exits on both sides of the street, Pedestrian-friendly pedestrian environment is also conducive to the development of public transportation. In addition, conducted a TOD empirical study in the United States and found that TOD can reduce the total number of trips and the total mileage of vehicles by 3-5%. This shows that TOD can greatly reduce the use of private junk carriers and enhance the health of walking. In recent years, Belzer and Autler (2002) extended the 3D element to 5D, which further illustrates the internal structure of the TOD urban pattern. This research further expands the 5D element to summarize the empirical issues and the actual benefits of the healthy environment. The basis for establishing the assessment indicators is shown in Table 1.

In order to assist countries to establish a quantifiable health city index, WHO has initially developed 53 health indicators in 47 European cities, further discussed the feasibility and then revised it to 32 indicators that can be quantified in detail as cities for the establishment of Your City Health Profile, or as a reference for reviewing the effectiveness of your efforts. Therefore, based on the WHO's 32 indicators, this study selected the environmental indicators (a total of 14 indicators) that are more consistent with the theme of this study and the status of Taiwan's urban development as the basis for establishing a friendly environmental assessment of walking environment in healthy communities.

Table 2 *WHO Healthy City Indicators*

Category	Index
C1 Atmospheric pollution	C2 Water quality
	C3 Percentage of water pollutants removed from total sewage produced
	C4 Household waste collection quality index
	C5 Household waste treatment quality index
	C6 Relative surface area of green spaces in the city
Environmental indicators	C7 Public access to green spaces
	C8 Derelict industrial sites
	C9 Sport and leisure
	C10 Pedestrian streets
	C11 Cycling in city
	C12 Public transport
	C13 Public transport network cover
	C14 Living space

Source: (WHO, 1998)

TOD HEALTHY COMMUNITY WALKING FRIENDLY ENVIRONMENT ASSESSMENT INDEX SCREENING

Based on the above literature review, this paper uses 5D elements of TOD planning (5 indicators) and WHO health indicators (14 indicators) as the basis for assessment. The first use of FDM index screening, in order to establish TOD healthy community walking friendly environment assessment architecture. The following are the FDM analysis methods and screening results are described.

FDM Analysis Instructions

FDM is based on the Delphi method combined with fuzzy theory. The Delphi Technique is an expert evaluation method proposed by Dalkey and Helmer (1963). Its purpose is to provide expert prediction and group decision-making in two aspects Opinion integration, convergence method. The characteristics of the operation include Anonymous response, repeated questionnaires to obtain Iteration and controlled feedback, and the statistical group response to exclude face to face Desktop pressure and not affected by others, and the use of repeated questionnaires on the divergence of views on the experts to achieve convergence effect, and through the statistical approach to consolidate the views of experts in science, it is experts predict the integration of group comments on a good system integration.

The following FDM analysis steps are described:

1. First of all, need to investigate the evaluation of the project design a fuzzy expert questionnaire, select the appropriate candidate group of experts, each expert for each evaluation project, give a possible range of values. The minimum value of this interval represents the "most conservative cognitive value" of the expert's quantized score for the assessment item, and the "maximum value" of the range value indicates that the expert's "most optimistic cognitive value".

2. Then, for each assessment item *(i)*, we calculate the "most conservative cognitive value" and "the most optimistic cognitive value" given by all the experts. After calculating the average and standard deviation of the two, we will fall into the double standard (C_L^i), the geometric mean (C_M^i), the maximum value (C_U^i), and the "most optimistic cognitive value" among the "most conservative cognitive values" that have not been removed, respectively, from the extreme values other than "poor" In the minimum (O_L^i), the geometric mean (O_M^i) and the maximum (O_U^i).

3. And then establish triangular fuzzy numbers $C^i = C_L^i, C_M^i, C_U^i$ "the most optimistic cognitive value" of the "most conservative cognitive value" of each evaluation item i calculated in step two, The triangular fuzzy number $O^i = O_L^i, O_M^i, O_U^i$ the double triangular fuzzy number diagram, as shown in Figure 1 below.

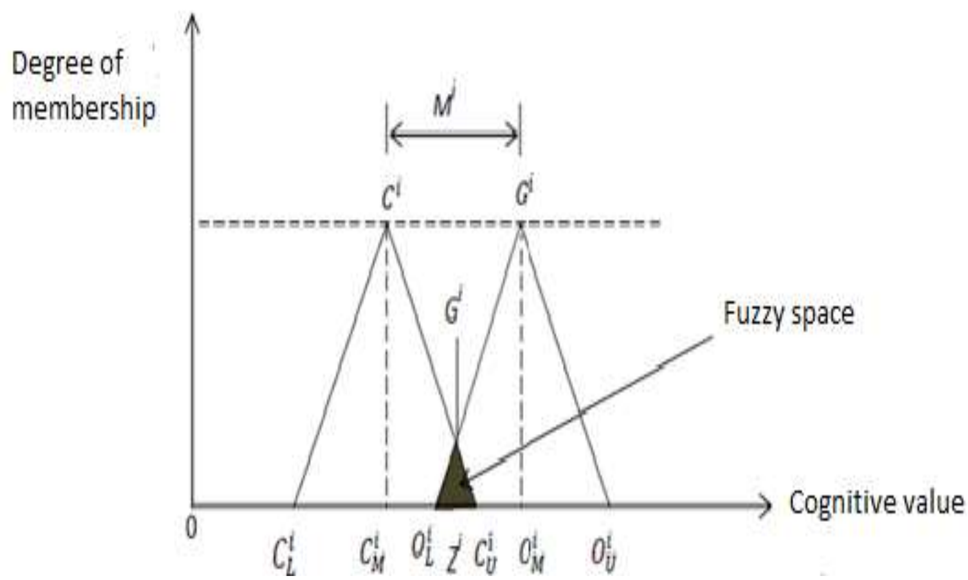

Figure 1 *Double Triangular Fuzzy Number*

4. Finally, whether there is a consensus reached through the "gray zone test" to test the opinions of experts is as follows:

If the gray zone ($C_U^i O_U^i$) with no fuzzy relation between the two trigonometric fuzzy numbers calculated by the most optimistic value and the most conservative value indicates that there is a consensus section in each expert opinion interval value, and the opinion tends to this consensus Within range. In this case, the "consensus importance value (G^i)" of the evaluation item *i* is equal to the arithmetic mean of C_M^i and O_M^i, and the calculation formula is $G^i = C_M^i + O_M^i/2$.

If the fuzzy numbers of the two triangles overlap each other to produce a fuzzy gray zone $C_U^i > O_U^i$, and the fuzzy gray zone $Z^iZ^i = C_U^i - O_L^i$ The evaluation item "the geometric mean of the most optimistic cognitive value O_M^i" and the range of the $M^iM^i = O_M^i - C_M^i$ indicates that although there is no consensus section for the range of opinions of experts, the two experts who give extreme opinions (the most optimistic value of optimistic cognitive value and the most conservative value of the most conservative cognitive value) have no relationship with other Differences in opinions of experts lead to divergence of opinions. Therefore, we make the "consensus importance value (G^i)" of this evaluation item *i* equal to the fuzzy set of the intersection of the fuzzy relations of the two-triangle fuzzy numbers and then obtain the quantized score of the maximum membership value of the fuzzy set.

If the two triangular fuzzy numbers overlap each other to produce a gray area $C_U^i > O^i$), and the fuzzy gray zone $Z^iZ^i = C_U^i - O_L^i$ The range of $M^iM^i = O_M^i - C_M^i$ between the geometric mean O_M^i of the most optimistic cognitive value and the geometric mean value of the most conservative cognitive C_M^i It means that there is no consensus section in each expert's opinion interval value and the two experts who give extreme opinions (the most optimistic value in optimistic cognitive value and the most conservative value in the most conservative cognitive value) have a big difference with other experts Divergence of opinions. Therefore, the "unconstrained geometric mean of the most optimistic cognitive values" and the "geometric mean of the most conservative cognitive values" for those opinions that have not converged should be referred to the expert and the steps 1 to 4 should be repeated for the next questionnaire until all assessments Projects have reached convergence, find the "consensus importance value (G^i)" so far.

FDM Expert Consensus Analysis and Screening Results

Through the questionnaire design and investigation of FDM experts, we invited Taiwan experts and scholars to fill in the questionnaires, respectively, to evaluate the importance of 19 index factors and get the consensus value of 19 experts (G^i) Filter as a threshold (6.59). According to the results of the analysis, a total of six indicators without expert consensus were deleted, which is of less importance to the friendly environment of TOD healthy walking. Therefore, 13 index factors that passed the threshold test were retained as the system for walking friendly environment assessment of TOD healthy community. The FDM expert consensus analysis evaluated the screening results (Table 3).

Table 3 *FDM Expert Consensus Analysis Results*

Evaluation Factor	Ci		Oi		ai		Geometric Mean			Zi	Gi
	Min	Max	Min	Max	Min	Max	Ci	Oi	ai		
Density	5	6	8	9	7	8	5.65	8.32	7.32	4.67	7.05
Diversity	6	7	9	10	8	8	6.65	9.32	8.00	4.67	8.04
Design	7	9	9	10	9	9	7.96	9.65	9.00	1.70	9.00
Distance	6	7	8	9	7	8	6.32	8.65	7.65	3.34	7.51
Destination	5	7	8	9	6	8	5.94	8.65	6.95	3.71	7.62
Atomspheric Pollution	3	4	5	6	4	5	3.63	5.31	4.64	2.68	4.54
Water quality	3	4	5	6	4	4	3.30	5.31	4	3.01	4.69
Percentage of water pollutant removed from total sewage produced	2	3	5	6	3	4	2.62	5.31	3.30	4.69	4.10
Household waste collection quality index	2	3	4	4	3	4	2.62	4.00	3.30	2.38	4.00
Household waste treatment quality index	2	3	4	5	3	4	2.29	4.64	3.63	3.35	3.53
Relative surface area in the green spaces	5	6	8	9	6	7	5.31	8.32	6.32	5.01	7.36
Public access to green spaces	6	7	8	9	7	8	6.32	8.32	7.32	3.00	7.68
Derelict industrial sites	2	3	4	5	3	4	2.29	4.64	3.63	3.35	3.53
Sports and leisure	5	6	8	9	6	8	5.31	8.32	6.95	5.01	7.36
Pedestrian streets	6	8	9	10	8	9	6.95	9.65	8.32	3.70	8.62
Cycling in city	6	8	8	10	7	9	6.95	9.28	8.28	2.33	8.00
Public transport	4	7	9	10	7	9	5.52	9.32	7.96	5.8	8.64
Public transport network cover	6	7	8	9	7	8	6.65	8.65	7.65	3.00	7.35
Living space	4	6	7	8	6	7	4.93	7.65	6.65	3.72	6.62
Threshold											6.59
Total											19
Pass the test											13

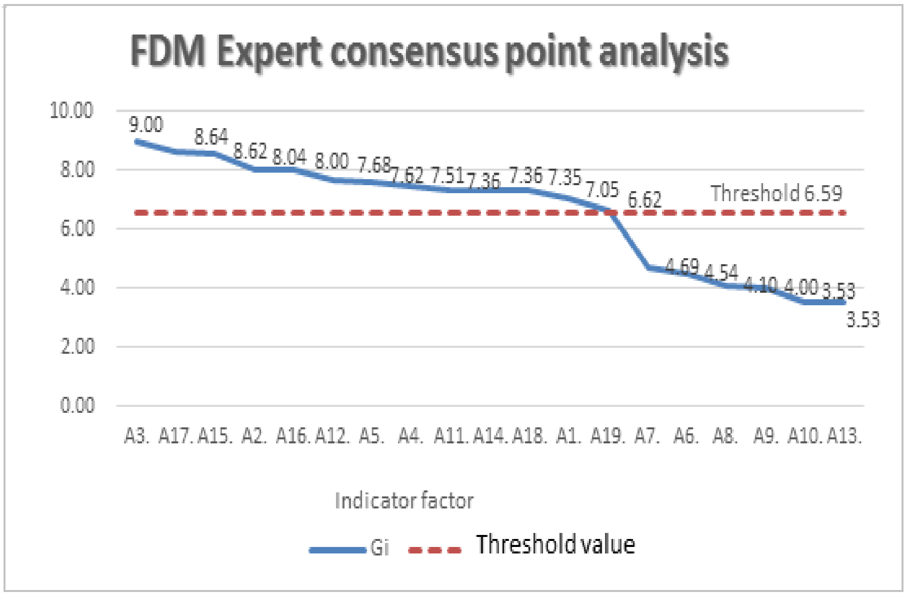

Figure 2 *FDM Expert Consensus Analysis*

CONSTRUCTION OF TOD FRIENDLY WALKING ENVIRONMENT ASSESSMENT INDEX

Based on the interdependencies (as shown in Figure 3 below) of the walking friendly environment assessment indicators of healthy communities established in TOD, this paper further inputs the three facets and 13 assessment indicators into Super Decisions Ver. 2.4.0 analysis software) and imported into a self-contained Gray-Analytic Network Process (Gray-ANP) analysis method for gray-weight calculations.

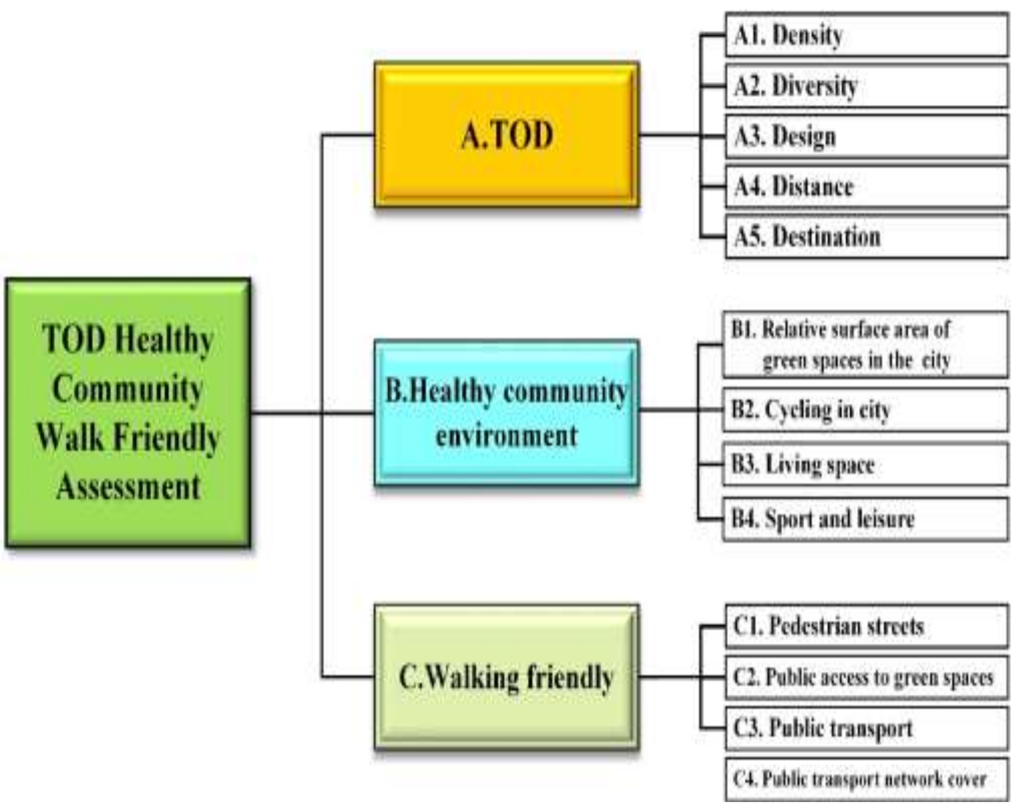

Figure 3 *TOD Healthy Community walking Friendly Environment Assessment system*

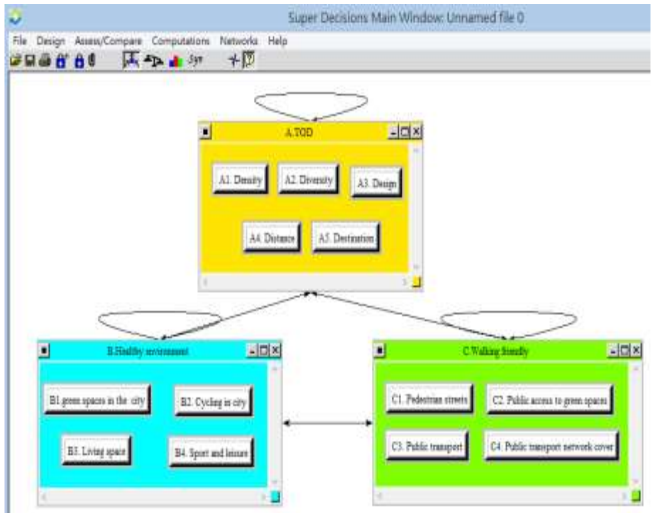

Figure 4 *S. D. Assess the Relationship between Tier and Indicators*

Analyzes of "Gray Weights" and "White Values" and "Priorities" of Metrics

Gray-ANP questionnaire method was used to evaluate the gray-level intervals. After compiling the relative significance of each of the five evaluation criteria, the Super Decision analysis software was used to obtain the upper and lower limit values of the relative weights of the five evaluation criteria. In this paper, the relative weights of the final upper bound and the lower bound are calculated by the arithmetic mean $\frac{(A+B+C+\ldots)}{n}$ respectively according to the weight of the facets evaluated by the Limit Matrix. Finally, The gray weight values of the five evaluation criteria are obtained from the percentages (%), and then the weighted white values calculated using the arithmetic mean and weighted prioritized, and the weight calculation results of each evaluation aspect (as shown in the following (Table 4)

Table 4 *Gray Weight and White Value and Sorting Results Table*

	Indicator Level	Gray Weight Value %	White Value %	Sort
TOD Healthy Community Walk Friendly Assessment	A.TOD	[33.42∼28.49]	30.95	3
	B. Healthy environment	[39.13∼31.85]	35.49	1
	C. Walking friendly	[36.52∼30.59]	33.55	2

Note: The white value is the median of the gray weight value. The white number calculation can be used as a reference for weight ranking and decision.

Analysis and mathematical operation described below:

1. Upper limits of the construct relative weights

$$\left\{ \text{upper boundary weight was} \begin{bmatrix} 0.325563 \\ 0.396475 \\ 0.358462 \end{bmatrix} + \begin{bmatrix} 0.331903 \\ 0.363045 \\ 0.385052 \end{bmatrix} + \begin{bmatrix} 0.345262 \\ 0.414336 \\ 0.352105 \end{bmatrix} \div 3 = \begin{bmatrix} TOD \\ Healthyenvironment \\ Walkingfriendly \end{bmatrix} = \begin{bmatrix} 0.334243 \\ 0.391285 \\ 0.365206 \end{bmatrix} \right.$$

(1)

2. Lower limits of the construct relative weights

$$\left\{ \text{lower boundary weight was} \begin{bmatrix} 0.283722 \\ 0.322607 \\ 0.313171 \end{bmatrix} + \begin{bmatrix} 0.280412 \\ 0.316283 \\ 0.323305 \end{bmatrix} + \begin{bmatrix} 0.290434 \\ 0.316717 \\ 0.281146 \end{bmatrix} \div 3 = \begin{bmatrix} TOD \\ Healthyenvironment \\ Walkingfriendly \end{bmatrix} = \begin{bmatrix} 0.284856 \\ 0.318536 \\ 0.305874 \end{bmatrix} \right.$$

(2)

Analysis of "Gray Weights" and "White Values" and "Priorities" of the Assessment Indicators

After Grey-ANP questionnaire was used to fill in the importance of two or more gray intervals, the Super Decision software was used to get the upper and lower bounds of the relative weight of 13 experts respectively. In this study, the calculation of the Limit Matrix is performed using the original weight of each indicator. Based on the result of the analysis, the final upper limit is further calculated by the arithmetic average $\frac{(A+B+C+\ldots)}{n}$ and the lower limit of the relative weight, and finally the weight according to the percentage (%) conversion, get the gray value of the 13 evaluation indicators of the weight; followed by gray weight value $\frac{(\otimes(x)+\otimes(x)+\otimes(x))}{2}$ weight white value, and weight priority Sort, the results of the collection as shown in Table 5 below, the indicator weight calculation simple process is as follows:

Table 5 *Comparison of Grey Weights and White Values of Assessment Constructs on Remediation Subsidy Prioritization*

Indicating construct	Indicating	Grey weight (%)	White value (%)	Priority
TOD [33.42∼28.49]	Density	[5.20∼4.07]	4.63	11
	Diversity	[7.83∼6.36]	7.10	7
	Design	[15.87∼15.23]	15.55	1
	Distance	[6.75∼5.48]	6.12	9
	Destination	[7.33∼5.60]	6.47	8
Healthy environment [39.13∼31.85]	Relative surface area of green spaces in the city	[11.04∼9.50]	10.27	4
	Cycling in city	[8.83∼6.79]	7.81	5
Walking friendly [36.52∼30.59]	Pedestrian streets	[13.26∼11.91]	12.59	2
	Public access to green spaces	[11.59∼0.26]	10.92	3
	Public transport	[4.44∼3.49]	3.97	12
	Public transport network cover	[2.20∼1.83]	2.01	13

1. Upper limits of the construct relative weights

$$\left\{\text{upper boundary weight was} \begin{bmatrix}0.034041\\0.063183\\0.161575\\0.070764\\0.082237\\0.106404\\0.057071\\0.062213\\0.095041\\0.172066\\0.116511\\0.037005\\0.022354\end{bmatrix} + \begin{bmatrix}0.050251\\0.078375\\0.151159\\0.091618\\0.075616\\0.132417\\0.077658\\0.051412\\0.080012\\0.134274\\0.101142\\0.045643\\0.010402\end{bmatrix} + \begin{bmatrix}0.071715\\0.093401\\0.163336\\0.040154\\0.062161\\0.092401\\0.130125\\0.074615\\0.078512\\0.091526\\0.130015\\0.050601\\0.033141\end{bmatrix} \div 3 = + \begin{bmatrix}A1\\A2\\A3\\A4\\A5\\B1\\B2\\B3\\B4\\C1\\C2\\C3\\C4\end{bmatrix} = \begin{bmatrix}0.052002\\0.07832\\0.15869\\0.067512\\0.073338\\0.110407\\0.088285\\0.062747\\0.084522\\0.132622\\0.115889\\0.044416\\0.021966\end{bmatrix}\right. \quad (3)$$

2. Lower limits of the construct relative weights

$$\left\{ \text{upper boundary weight was} \begin{bmatrix} 0.027669 \\ 0.047764 \\ 0.159855 \\ 0.058852 \\ 0.066657 \\ 0.086637 \\ 0.036025 \\ 0.048672 \\ 0.077379 \\ 0.167755 \\ 0.097956 \\ 0.028563 \\ 0.015764 \end{bmatrix} + \begin{bmatrix} 0.039412 \\ 0.064969 \\ 0.147883 \\ 0.079394 \\ 0.058543 \\ 0.119879 \\ 0.058583 \\ 0.035675 \\ 0.056723 \\ 0.114973 \\ 0.096454 \\ 0.037998 \\ 0.009465 \end{bmatrix} + \begin{bmatrix} 0.054884 \\ 0.078106 \\ 0.149203 \\ 0.026128 \\ 0.042724 \\ 0.078632 \\ 0.109138 \\ 0.037254 \\ 0.056341 \\ 0.074514 \\ 0.113368 \\ 0.038264 \\ 0.029741 \end{bmatrix} \div 3 = + \begin{bmatrix} A1 \\ A2 \\ A3 \\ A4 \\ A5 \\ B1 \\ B2 \\ B3 \\ B4 \\ C1 \\ C2 \\ C3 \\ C4 \end{bmatrix} = \begin{bmatrix} 0.040655 \\ 0.063613 \\ 0.152314 \\ 0.054791 \\ 0.055975 \\ 0.095049 \\ 0.067915 \\ 0.040534 \\ 0.063481 \\ 0.119081 \\ 0.102593 \\ 0.034942 \\ 0.018323 \end{bmatrix} \right. \quad (4)$$

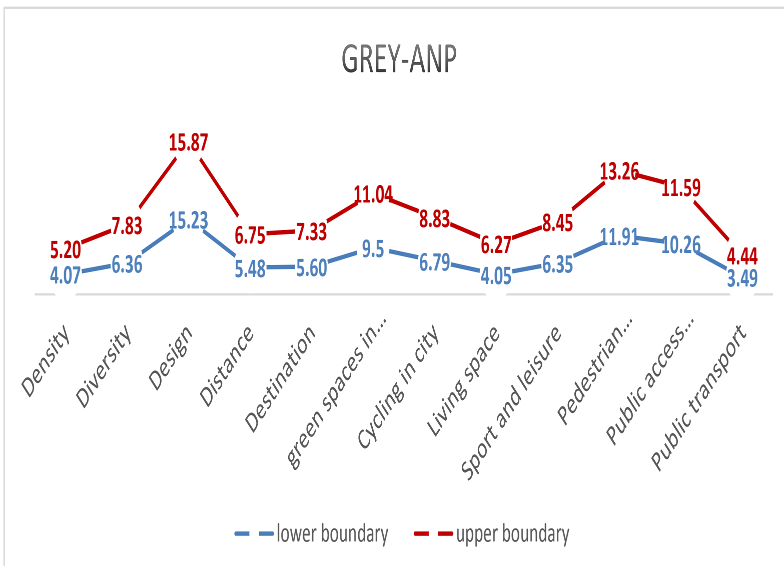

Figure 5 *GREY ANP*

CASE STUDY: TAIPEI MRT TOD HEALTHY COMMUNITY ENVIRONMENTAL ASSESSMENT

In this study, four stations of Taipei MRT - Banlan Line (Banciao Station, Fuzhong Station, Xinpu Station and Jiangzicui Station) were selected as examples to introduce the evaluation index of walking friendly environment for TOD healthy community established. 500 meters for the range (Figure 6), collect the surrounding environmental data, weight calculation of the index weight to calculate the four station environment TOD healthy community friendliness, and prioritized for the government or relevant units to develop environmental improvements Strategy reference.

The basic information collected through the above 13 indicators is used as input for the data analysis of this study. However, due to the different units of information, this study further standardized the data by converting the data into Average of 0, standard deviation of 1 new data; In other words, the information can be reconverted to only the relative merits or differences of data distribution, is conducive to data calculation and analysis, and then multiplied by the corresponding weight value Before being able to assess the performance of the case site weights.

The current environment 0-1 new data distribution is obtained through normalization, and the current environment weighted operation is performed by using the super-matrix, all sub-matrices formed by the eigenvectors are merged into a super-matrix (as shown in Figure 6), and the matrix If there is a blank space or 0, it indicates that the decision-making groups or guidelines are independent and independent of each other. Unweighted Supermatrix, Weighted Supermatrix and Limit Supermatrix are obtained in turn, and the data of the environment around the four stations are correlated with After weighting each item by weight, the final result of the limit-based super-matrix will be listed below. The results are summarized in Table 6 below.

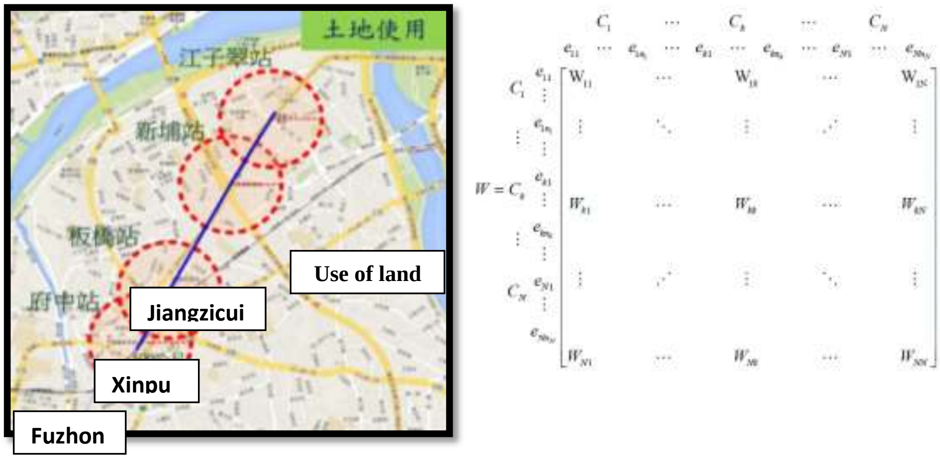

Figure 6 *Case Study Region and Indicator Weight Calculation Super Matrix*

Table 6 *TOD Healthy Community Walk Friendly Environment Assessment Results*

Index / Case Station	White Value (%)	Jiangzicui	Xinpu	Banciao	Fuzhong
A1. Density	4.63	0.0073	0.0062	0.0093	0.0015
A2. Diversity	7.10	0.0076	0.0078	0.0095	0.0032
A3. Design	15.55	0.1087	0.0842	0.1562	0.0608
A4. Distance	6.12	0.0723	0.0464	0.1044	0.0484
A5. Destination	6.47	0.0035	0.0051	0.0061	0.0027
B1. Relative surface area of green spaces in the city	10.27	0.0130	0.0067	0.0132	0.0046
B2. Cycling in city	7.81	0.0218	0.0028	0.0332	0.0020
B3. Living space	5.16	0.0096	0.0082	0.0051	0.0024
B4. Sport and leisure	7.40	0.0047	0.0008	0.0061	0.0008
C1. Pedestrian streets	12.59	0.0106	0.0070	0.0115	0.0053
C2. Public access to green spaces	10.92	0.0050	0.0011	0.0071	0.0018
C3. Public transport	3.97	0.0044	0.0090	0.0127	0.0076
C4. Public transport network cover	2.01	0.0093	0.0108	0.0061	0.0047
Total	100/1	0.28	0.20	0.38	0.15
	Prioritize	2	3	1	4

After collecting the environmental data of each index and carrying out the index weighted calculation, the friendly development environment of walking in TOD healthy communities of four case stations was obtained. According to the data, "Itabashi Station (0.38)" received the highest weight with the healthiest and healthy walking environment around it, followed by "Jiangzicui Station (0.28)" with the second highest weight, and the healthy walking environment score was significantly different from that of Itabashi Station , Followed by "Xin Pu Station (0.20)" for the third ranking weight. The healthy walking environment score is similar to that of Jiang Tsz Tsui Station and finally to "Fuchu Station (0.15)". From the data, there is a clear gap with the environment of Banciao Station. Weighted rank score the worst. In addition, the results showed that the Itabashi Station received a high weight score in the "Design (0.1562)" indicator, which also proves that "new board SAR" belonging to the emerging urban planning has achieved good results in a healthy and friendly environment. Observing from "New Banciao sar", due to the large residential area, the highest score was found in "Living space (0.0096)" for the four districts. However, "Xin Po Station" MRT can serve more residents, so "Public transport network cover (0.108)" scored highest among the four stations.

CONCLUSION AND IMPLICATIONS

In this study, based on literature review and evaluation by FDM experts, we completed the selection and establishment of indicator architecture, and set up a set of index system suitable for assessing TOD healthy walking friendly environment by using ANP Gray-ANP Calculated the weight of each index and the priority of the results of the case area to conduct an index system instance analysis and application. Relevant health improvement strategies can be based on the value of the weight of the results of the research, the reverse friendly environment arrangement of key projects, can be used as the basis for the allocation of urban planning to effectively provide the public transport environment toward healthy walking friendly development. Based on the research results, the following conclusions are suggested.

1. According to the analysis of the case study, the stations of Taipei MRT Bannan Line (Jiangzicui Station, Xinpu Station, Banciao Station and Fuzhong Station) are analyzed. The analysis of the case area shows that the current conditions are reflected in the importance of the weight, The top three in sequence were Design (15.55%), Pedestrian streets (12.59%), pollution remediation (11.76%) and Public access to green spaces (10.92%). According to the results and current environmental data analysis, The TOD Healthy Walk Friendly Environment Rating received the first priority, and the Design was well developed and in line with the current status. The prioritized scores of the scores of attainment scores were higher than those of the remaining indicators. It is also noteworthy that the weight of the Living Space indicator at Banciao Station is 0.00051%, which is also quite low. It also reflects the prosperous commercial development and high housing prices in the local area, which have already squeezed out living space for local residents to a certain extent.

2. According to the TOD Healthy Walk Friendly Environment Index, it shows that "Fuchu Station (0.15)" received the lowest weight for the four stations and the locality of its locality lacks the segments of its lanes. As a result, people and vehicles usually compete for each other, and the overall environment Less relevant health factors, so for residents and pedestrians less friendly. It is proposed that 13 indicators should be examined one by one and improved according to the connotation of various factors such as enhancing pedestrian lanes continuity (building overpasses and underpasses), improving access to green spaces (idle lands and deserted land) As well as enhancing public transport services (such as buses and bicycles) to enhance the overall weight score and achieve the TOD healthy walking environment.

3. Subsequent studies suggest that a comprehensive assessment of Taipei MRT (114 stations) be conducted and a comprehensive questionnaire system should be added to further quantify the user's feelings. The follow-up study should be comprehensively considered to analyze the actual perceptions and feelings of residents and pedestrians in order to This cross-examination gives you a better understanding of the true nature of the walking friendly environment in the TOD Healthy Community.

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