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The Household-Based Socio-Economic Index for Every District in Peninsular Malaysia

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***Abstract*—**Deprivation indices are widely used in public health study. These indices are also referred as the index of inequalities or disadvantage. Even though, there are many indices that have been built before, it is believed to be less appropriate to use the existing indices to be applied in other countries or areas which had different socio-economic conditions and different geographical characteristics. The objective of this study is to construct the index based on the geographical and socio-economic factors in Peninsular Malaysia which is defined as the weighted household-based deprivation index. This study has employed the variables based on household items, household facilities, school attendance and education level obtained from Malaysia 2000 census report. The factor analysis is used to extract the latent variables from indicators, or reducing the observable variable into smaller amount of components or factor. Based on the factor analysis, two extracted factors were selected, known as Basic Household Amenities and Middle-Class Household Item factor. It is observed that the district with a lower index values are located in the less developed states like Kelantan, Terengganu and Kedah. Meanwhile, the areas with high index values are located in developed states such as Pulau Pinang, W.P. Kuala Lumpur and Selangor.

***Keywords*—**Factor Analysis, Basic Household Amenities, Middle-Class Household Item, Socio-economic Index

I. INTRODUCTION

DEPRIVATION indices are widely used in public health study. It can also be referred as the index of inequalities or disadvantage. When measuring the deprivation index based on the socio-economic factors, the index can be defined as the value of socio-economic inequalities for individual, households or areas. This index can act as a proxy for data on several factors that are believed to give an impact to certain independent variables such as public health, social problems, and etc.

Many previous studies has discussed about the deprivation index in terms of definition, deprivation types, their usage, the index construction, and the relationship of the index with public health outcomes and so forth. There are many types of index that have been constructed by previous studies such as Jarman Underprivileged Area Score (UPA 8), Townsend index of deprivation, Carstairs deprivation index, material deprivation index (MATDEP), social deprivation index (SOCDEP), index of multiple deprivation 2000 and so on [1].

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These indices can be divided into two types, a weighted index and unweighted index.

These existing indices have been applied by researchers either with or without some modifications, depending on the socio economic and geographical conditions of the study area. For example, the Index of Multiple Deprivation 2000 (IMD2000) was used in order to measure correlation between six domains and also IMD2000 access score [2]. Meanwhile, Carstairs scores were applied to measure the deprivation patterns across England and Wales based on data from the 2001 census [3]. Other study discussed about the application of Breadline Britain Index, as an indicator of poverty level [4]. They studied the relationship of risk of murder in Britain with this index and they found that rates of murder were increased in the poorest areas. Furthermore, a research was done by using the human development index (HDI) to measure the deprivation among urban households in Minna, Nigeria [5].

Apart from that, there are some researchers who build their own index for the purpose of their study [6]. They constructed the socioeconomic status index (SES) based on four variables such as poverty, homeownership, high school completion and unemployment by using factor analysis method. They used this index in order to measure the relationship with mortality rates in Atlanta metropolitan area. Reference [1] proposed to develop a material deprivation index for the area of Genoa based on four variables, namely unemployment, housing ownership, overcrowding and low education level based on 1991 census. They developed this index by given unweighted value to combine the four *z*-scores of variables. Other study was done to developed the deprivation index (Fdep99) by performing principal component analysis of four socioeconomic variables [7]. They evaluate the relationship of Fdep99 with mortality over the entire mainland France territory from 1997 – 2001.

The weighted index is built by combining the variables by taking into account the level or value of the contribution of each variable to the index. Normally, variables that have larger effect will be given a higher weightage. Otherwise, the unweighted index was constructed by giving the equal weight to the variables under study. The example of weighted index are Jarman Underpriviledged Area Score (UPA 8) and the examples of unweighted index are Townsend index of deprivation, Carstairs deprivation index, MATDEP and also SOCDEP index [1].

It was found that many deprivation indices were developed previously. These indices were constructed based on the economic and social conditions in the geographical situation of a country or specific area. However, it is less appropriate to use the indices that have been applied in other countries or areas due to different socio-economic conditions and geographical characteristics. The objective of this study is to construct the deprivation index based on the geographical and socio-economic factors in Peninsular Malaysia using the data obtained from the year 2000 census report. This index is defined as weighted household-based socio economic index. The factor analysis method will be used to analyze the data.

II. Data

Malaysia is divided into two parts which known as Peninsular Malaysia and East Malaysia. According to 2000 census, Malaysia consists of 14 states, 82 administrative districts in Peninsular Malaysia and 53 administrative in East Malaysia. In this study, administrative district is used as the unit of analysis. Due to data availability, only twelve states located in Peninsular Malaysia consist of 82 administrative districts will be considered in this study.

The data employed in this study were obtained from 2000 census report [8]-[9]. The variables accounted in order to construct the household-based deprivation index in this study are variables related to household items, household facilities, school attendance and education level in each district. The twelve variables are as follows:

- Percentage of households who have car (Car)
- Percentage of households who have motorcycle (Motor)
- Percentage of households who have air-conditioning (Aircond)
- Percentage of households who have washing machine (W/Machine)
- Percentage of households who have fixed line telephone (FixedTel)
- Percentage of households who have television (Tv)
- Percentage of households who have video / vcd / dvd. (Video)
- Percentage of households who are 24-hours connected to electricity (Electric)
- Percentage of households who use tap water (TapWater)
- Percentage of households who have proper toilet (Toilet)
- Percentage of school attendance (SchoolAtt)
- Percentage of person with a tertiary degree (TerEdu)

III. Methodology

A. Factor analysis

In this study, SPSS 16.0 will be used to perform factor analysis, using Principal Component extraction method for factor reduction and rotation method of Varimax with Kaizer Normalization. This analysis used to extract the latent variables from indicators, or reducing the observable variable into smaller amount of components or factor. As a result, the variables that have the strongest association with a given factor can be examined. Next, factor index are obtain which will be used as weights to construct the deprivation index for each district. Reference [10] indicated that these index coefficients W_{kf} are computed by multiplying the inverse matrix of original variables correlation, R_{kk}^{-1} with the rotated component matrix, S_{kf} (the correlation between factors and variables) which is defined as:

$$W_{kf} = R_{kk}^{-1} S_{kf} \quad (1)$$

where k is the number of variables and f is the number of extracted factors.

In order to calculate the factor index for each district i, F_{ik} (considered as index), all variables will be standardized using the following standardization:

$$Z_{ik} = \frac{x_{ik} - \breve{x}_{ik}}{\hat{x}_{ik} - \breve{x}_{ik}} \quad (2)$$

where x_{ik} is the actual observed value in district i for variable k, $\breve{x}_{ik}$ and $\hat{x}_{ik}$ are the minimum and maximum observed value in location i and variable type k respectively. The standardized value will range between zero to one. The standardized observed values will be multiplied by the matrix of factor index coefficients, W_{kf} to obtain the estimated factor indices for each unit of analysis (district), F_{if} :

$$F_{if} = Z_{ik} W_{kf} \,. \quad (3)$$

The estimated factor indices of factor f for district i can be represented as follows:

$$\begin{aligned} F_{if} &= z_{i1} w_{1f} + z_{i2} w_{2f} + \ldots + z_{ik} w_{kf} \\ &= \sum_{k=1}^{K} z_{ik} w_{kf} \end{aligned} \quad (4)$$

IV. Result and Discussion

The result of this analysis is given in Table I to Table IV. After performing the factor analysis, two extracted factors were selected with eigenvalues of 7.212 and 1.864 (greater than 1), which explained 75.633% of total variance. Table I shows the communalities values which represent the proportion of variance in the original variables that is accounted for by the factor solution after extraction process. For example, we can say that 58.2% of the variance for electricity variable can be explained by retained factors after extraction.

TABLE I
Communalities

Variables	Extraction
Electric	0.582
TapWater	0.485
Toilet	0.659
Car	0.925
Motor	0.794
Aircond	0.797
W/Machine	0.784
Fixedtel	0.828
Tv	0.911
Video	0.842
SchoolAtt	0.864
TerEdu	0.606

TABLE II
TOTAL VARIANCE EXPLAINED

Component	Initial			Rotation Sums of Squared Loadings		
	Eigen values	Variance (%)	Cumulative variance (%)	Eigen values	Variance (%)	Cumulative variance (%)
1	7.212	60.100	60.100	5.144	42.863	42.863
2	1.864	15.533	75.633	3.932	32.770	75.633

Table II presents the total variance explained by component before extraction (initial) and after rotation. In this analysis, two factors were extracted with eigenvalue greater than 1 after rotation where the number of factors is set as 2. The eigenvalues associated with these factors and the percentages of variance explained are displayed in the "Rotation Sums of Square Loadings". Column 6 showed how much of the total variability can be explained by each factors after rotation. For example, factor 1 (component 1) account for 42.863% of the variability in all 12 variables. The two factors explained 75.633% of the total variance in the variables which are included in the components. This means that these two factors could explained over 75% of the information contained in the original variables.

Table III showed the rotated component matrix known as factor loading that measure the correlation between variables and factors. The values range from -1 to 1. The higher the absolute value of the loading means that the factor contributes more to the variable. The bold value give an indication that variable belongs to which component / factor. Based on the factor loading, factor 1 (component 1) includes the variables electricity, tap water, toilet, washing machine, fixed line telephone, television, and school attendance, which can be defined as Basic Household Amenities factor. Whereas, factor 2 consist of car, motorcycle (negative sign), air-conditioning, video/ vcd/ dvd and tertiary education variables, which is classified as Middle-Class Household Item factor.

TABLE III
ROTATED COMPONENT MATRIX

Variables	Component	
	1	2
Electric	**0.706**	0.288
TapWater	**0.696**	-0.037
Toilet	**0.798**	0.149
Car	0.521	**0.808**
Motor	0.219	**-0.864**
Aircond	0.478	**0.754**
W/Machine	**0.772**	0.434
FixedTel	**0.786**	0.458
Tv	**0.951**	0.085
Video	0.560	**0.727**
SchoolAtt	**0.723**	0.583
TerEdu	0.145	**0.765**

Table IV is the inverse of correlation matrix and Table V showed the component index coefficient matrix. As discussed in methodology section, factor index can be obtained by multiplied the inverse matrix of coefficient correlation by factor loading matrix. These factor indices used as weights to calculate the indices of each district by combining the variables. For example, electricity's factor indices are:

Factor 1:

$$3.332(0.706)+(-0.136)(0.696)+(0.25)(0.798)+(1.577)(0.521)+$$
$$(-0.628)(0.219)+(-0.109)(0.478)+(-1.405)(0.772)+(-0.831)(0.786)+$$
$$(0.501)(0.951)+(-1.346)(0.560)+(-1.252)(0.723)+(-0.14)(0.145)$$
$$=0.148588\approx 0.150$$

Factor 2:

$$3.332(0.288)+(-0.136)(-0.037)+(0.25)(0.149)+(1.577)(0.808)+$$
$$(-0.628)(-0.864)+(-0.109)(0.754)+(-1.405)(0.434)+(-0.831)(0.458)+$$
$$(0.501)(0.085)+(-1.346)(0.727)+(-1.252)(0.583)+(-0.14)(0.765)$$
$$=-0.02682\approx -0.027$$

TABLE IV
INVERSE OF CORRELATION MATRIX

	Electric	Tap Water	Toilet	Car	Motor	Aircond	W/ Machine	Fixed Tel	Tv	Video	School Att	TerEdu
Electric	3.332	-0.136	0.250	1.577	-0.628	-0.109	-1.405	-0.831	0.501	-1.346	-1.252	-0.140
TapWater	-0.136	5.729	-3.685	0.960	0.921	-0.171	0.713	0.832	-3.879	0.683	1.233	-1.013
Toilet	0.250	-3.685	5.387	-2.433	-0.652	-0.220	0.012	-0.530	0.055	0.949	-0.601	0.462

Car	1.577	0.960	-2.433	16.296	2.627	-2.757	-4.673	0.461	-0.226	-8.706	1.363	-1.711
Motor	-0.628	0.921	-0.652	2.627	3.539	-1.159	-0.600	0.650	-2.260	0.833	0.579	1.252
Aircond	-0.109	-0.171	-0.220	-2.757	-1.159	4.982	0.755	0.210	0.721	-1.253	-1.152	-1.537
W/Machine	-1.405	0.713	0.012	-4.673	-0.600	0.755	5.669	-0.263	-1.803	2.237	-1.212	0.042
FixedTel	-0.831	0.832	-0.530	0.461	0.650	0.210	-0.263	7.377	-3.104	-2.534	-1.617	0.245
Tv	0.501	-3.879	0.055	-0.226	-2.260	0.721	-1.803	-3.104	8.881	-0.516	-2.149	0.414
Video	-1.346	0.683	0.949	-8.706	0.833	-1.253	2.237	-2.534	-0.516	12.705	-2.758	2.295
SchoolAtt	-1.252	1.233	-0.601	1.363	0.579	-1.152	-1.212	-1.617	-2.149	-2.758	8.647	-0.976
TerEdu	-0.140	-1.013	0.462	-1.711	1.252	-1.537	0.042	0.245	0.414	2.295	-0.976	3.343

TABLE V
COMPONENT INDEX COEFFICIENT MATRIX, W_{kf}

	Component	
	1	2
Electric	**0.151**	-0.027
TapWater	**0.211**	-0.149
Toilet	**0.205**	-0.098
Car	-0.004	**0.208**
Motorcycle	0.231	**-0.373**
Aircond	-0.006	**0.196**
W/Machine	**0.142**	0.017
FixedTel	**0.141**	0.023
Tv	**0.262**	-0.152
Video	0.023	**0.169**
SchoolAtt	**0.099**	0.083
TerEdu	-0.106	**0.265**

Finally, the estimated factor indices (index) for each district were obtained. Because the number of factors derived from this analysis is two, then the factor index calculation for each district will be separated into two parts. There are seven variables included in the first factor, while there are five variables in second factor. Index for the first, F_{i1} and second factor, F_{i2} can be calculated using the formula below:

$$F_{i1} = Z_{ik} W_{k1}, \quad \text{where} \quad k=1,2,...,7 \ ,$$

$$F_{i2} = Z_{ik} W_{k2}, \quad \text{where} \quad k=1,2,...,5 \ .$$

For example, the index for Basic Household Amenities factor in district of W.P. Kuala Lumpur and Gua Musang are:

$$\begin{aligned} F_{kl1} &= 0.98997(0.151) + 0.99714(0.211) + 0.99307(0.205) \\ &\quad + 0.78883(0.142) + 0.77634(0.141) \\ &\quad + 0.73588(0.262) + 0.93995(0.099) \\ &= 1.07079 \end{aligned}$$

$$\begin{aligned} F_{gm1} &= 0(0.151) + 0.59611(0.211) + 0(0.205) + 0(0.142) \\ &\quad + 0.08909(0.141) + 0(0.262) + 0(0.099) \\ &= 0.13834 \end{aligned}$$

The complete index can be referred in the Appendix A. The index can be either positive or negative values. The larger the index value means that the area has more complete basic amenities and vice versa. By comparing these two areas, it can be said that W.P. Kuala Lumpur have better basic needs compared to Gua Musang.

Meanwhile, the index for Middle-Class Household Item factor in district of Petaling and Sik are:

$$\begin{aligned} F_{pt2} &= 1(0.208) + 0.03218(-0.373) + 1(0.196) \\ &\quad + 0.85435(0.169) + 1(0.265) \\ &= 0.80138 \end{aligned}$$

$$\begin{aligned} F_{sik2} &= 0(0.208) + 0.88839(-0.373) + 0.09799(0.196) \\ &\quad + 0.06176(0.169) + 0.04457(0.265) \\ &= -0.28992 \end{aligned}$$

The larger the index in an area, will indicate that the facilities in a particular area is beyond the basic needs and vice versa. It can be said that the necessities of life in Petaling are more complete compare to the district of Sik. Table VI showed the five districts with the smallest index and Table VII showed the five districts with highest index for both two factors. Generally, based on both indices obtained, the districts with lower index values were located in the less developed states such as Kelantan, Terengganu and Kedah. Meanwhile, the areas with high index values were located in developed states such as Penang, W.P. Kuala Lumpur and Selangor.

TABLE VI
FIVE DISTRICTS WITH THE SMALLEST INDEX FOR TWO FACTORS

DISTRICTS	BASIC HOUSEHOLD AMENITIES	DISTRICTS	MIDDLE-CLASS HOUSEHOLD ITEM
Gua Musang	0.13834	Sik	-0.28992
Bachok	0.47169	Padang Terap	-0.28875
Kuala Krai	0.51599	Pendang	-0.28443
Jeli	0.52512	Setiu	-0.22027
Pasir Puteh	0.54414	Baling	-0.20069

TABLE VII
FIVE DISTRICTS WITH THE HIGHEST INDEX FOR TWO FACTORS

DISTRICTS	BASIC HOUSEHOLD AMENITIES	DISTRICTS	MIDDLE-CLASS HOUSEHOLD ITEM
S.P. Tengah	1.10583	Timur Laut	0.48359
Seremban	1.10589	Gombak	0.53617
Melaka Tengah	1.11854	Ulu Langat	0.55242
Barat Daya	1.14644	W.P. Kuala Lumpur	0.64045
Timur Laut	1.18888	Petaling	0.80138

V. CONCLUSION

Deprivation indices are widely used in public health study. It can also be referred as the index of inequalities. When measuring the deprivation index based on the socio-economic factors, the index can be defined as the value of socio-economic inequalities for individual, household or area.

There are many types of index that have been constructed by previous studies such as Jarman Underprivileged Area Score (UPA 8), Townsend index of deprivation, Carstairs deprivation index, material deprivation index (MATDEP), social deprivation index (SOCDEP), index of multiple deprivation 2000 and etc [1]. These indices were constructed based on the economic and social conditions in the geographical situation of a country or specific area.

This study has built the index based on the geographical and socio-economic factors in Peninsular Malaysia.

It was performed by using factor analysis to extract the latent variables from indicators, or reducing the observable variable into smaller amount of components or factor. Based on the result, the variables that have the strongest association with a given factor can be examined. Based on the twelve variables considered, the result from factor analysis has reduced these variables into two main factors by combining several variables in groups based on characteristics of specific factors.Two factors that were extracted known as Basic Household Amenities and Middle-Class Household Item index. The Basic Household Amenities index consisted of seven variables meanwhile the Middle-Class Household Item index consisted of five variables. Indices result obtained from this factor analysis were used to analyze the situation in a particular district based on the variables considered. Generally, it is observed that the district with lower index value was located in the less developed states. Meanwhile, the areas with high index values located in developed states.

The results obtained in this study are very useful and can be used by policy makers or the authority incharge in providing specific assistance to meet the needs in certain district. The more deprived areas will need more attention and a larger amount of resource allocation. In addition, the results obtained from the index construction can be used as input data for further study such as cluster analysis, spatial regression analysis and so on.

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APPENDIX

District	Basic Household Amenities
Gua Musang	0.13834
Bachok	0.47169
Kuala Krai	0.51599
Jeli	0.52512
Pasir Puteh	0.54414
Pasir Mas	0.57343
Lipis	0.57673
Ulu Perak	0.58392
Besut	0.61691
Sik	0.62441
Setiu	0.62446
Pekan	0.63508
Baling	0.65305
Cameron Highlands	0.66059
Rompin	0.66387
Machang	0.66855
Tanah Merah	0.67085
Tumpat	0.69308
Hulu Terengganu	0.73816
Padang Terap	0.73891
Batang Padang	0.81025
Ulu Selangor	0.82703
Bera	0.83634
Kota Bharu	0.84149
Jerantut	0.85087
Marang	0.86511
Pendang	0.87043
Langkawi	0.87935
Temerloh	0.90132
Kuala Kangsar	0.90295
Perak Tengah	0.90902
Bandar Baharu	0.93046
Yan	0.94574
Raub	0.95280
Sepang	0.95766
Jelebu	0.95931
Kerian	0.96222
Kemaman	0.96461
Hilir Perak	0.96936
Larut Dan Matang	0.98204
Bentong	0.98655
Kuala Selangor	0.98689

District	Middle-Class Household Item
Sik	-0.28992
Padang Terap	-0.28875
Pendang	-0.28443
Setiu	-0.22027
Baling	-0.20069
Hulu Terengganu	-0.19395
Bachok	-0.18658
Bandar Baharu	-0.17341
Kuala Krai	-0.16962
Ulu Perak	-0.16780
Gua Musang	-0.16482
Jeli	-0.16446
Bera	-0.16395
Yan	-0.15194
Pasir Puteh	-0.14728
Kerian	-0.14342
Marang	-0.13850
Tanah Merah	-0.13799
Sabak Bernam	-0.13455
Jempol	-0.13098
Pasir Mas	-0.12979
Tumpat	-0.12845
Perak Tengah	-0.12582
Rompin	-0.12258
Jelebu	-0.10984
Lipis	-0.09924
Besut	-0.09871
Mersing	-0.08902
Jerantut	-0.08128
Machang	-0.07790
Maran	-0.07467
Hilir Perak	-0.07227
Pekan	-0.06438
Perlis	-0.05498
Kota Tinggi	-0.04951
Jasin	-0.04481
Kuala Selangor	-0.04246
Kuala Kangsar	-0.03902
Batang Padang	-0.03216
Tampin	-0.02804
Raub	-0.02493
Kubang Pasu	-0.01364

Dungun	0.99039
Kubang Pasu	0.99054
Mersing	1.00507
Kuala Pilah	1.00703
Sabak Bernam	1.00775
Kuala Terengganu	1.01045
Rembau	1.01724
Jempol	1.01905
Kuala Langat	1.02149
Maran	1.02610
Perlis	1.02631
Kulim	1.04090
Manjung (Dinding)	1.04401
Kuala Muda	1.04708
S.P. Selatan	1.04976
Pontian	1.05058
Kluang	1.05117
Klang	1.05677
Port Dickson	1.06026
Kota Tinggi	1.06251
Alor Gajah	1.06800
Jasin	1.06837
W.P. Kuala Lumpur	1.07080
Kota Setar	1.07128
Segamat	1.07648
Kuantan	1.07661
Ulu Langat	1.07786
Johor Bahru	1.08057
Muar	1.08274
Kinta	1.08422
Petaling	1.08630
Tampin	1.09470
Gombak	1.09608
S.P. Utara	1.09782
Batu Pahat	1.09798
S.P. Tengah	1.10583
Seremban	1.10589
Melaka Tengah	1.11854
Barat Daya	1.14644
Timur Laut	1.18888

Larut Dan Matang	-0.01044
Muar	-0.00719
Rembau	-0.00322
Langkawi	-0.00292
Pontian	-0.00120
Kuala Terengganu	0.00827
Dungun	0.01390
Manjung (Dinding)	0.02375
Batu Pahat	0.03704
Kuala Pilah	0.04027
Segamat	0.04551
Kota Setar	0.04575
Kemaman	0.05996
Kuala Muda	0.07349
Kota Bharu	0.07369
Alor Gajah	0.07604
S.P. Selatan	0.07784
Kulim	0.08139
Bentong	0.08277
Kuala Langat	0.08304
Kluang	0.08877
Temerloh	0.09879
S.P. Utara	0.11017
Ulu Selangor	0.12656
Port Dickson	0.15032
Sepang	0.20384
S.P. Tengah	0.22883
Barat Daya	0.23495
Cameron Highlands	0.23687
Melaka Tengah	0.31233
Kuantan	0.31530
Kinta	0.31796
Johor Bahru	0.39065
Seremban	0.39279
Klang	0.43265
Timur Laut	0.48359
Gombak	0.53617
Ulu Langat	0.55242
W.P. Kuala Lumpur	0.64045
Petaling	0.80138