

## Supplementary Information

### From Comparative and Statistical Assessments of Liveability and Health conditions of districts in Hong Kong towards Future City Development

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**Table S1.** Details of the 21 liveability indicators and 9 health indicators in the LHI-HK framework (for the Hong Kong context).

#### (a) 6 categories of liveability indicators

Categories	LHI-HK Indicators	Sources of Data
Education	Educational characteristics (Percentage of citizens having post-secondary education: degree-both sexes) (%) <i>((i) for both 2016 and 2019)</i>	Census and Statistics Department [1, 2]
Economy	Median monthly household income from all households (HK\$) <i>((i) for both 2016 and 2019)</i>	Census and Statistics Department [1, 2]
	Labor force participation rate (%) <i>((ii) for both 2016 and 2019)</i>	Census and Statistics Department [1, 2]
	Poverty rate (%) <i>((ii) for both 2016 and 2019)</i>	Census and Statistics Department [3, 4]
	Working hours (% of people with 45–54 hours, 55–64 hours, and over 65 hours of working hours) <i>((ii) for 2016; (iii) for 2019)</i>	Census and Statistics Department [5]
Housing	Median floor area of accommodation (m <sup>2</sup> ) <i>((ii) for 2016; (iii) for 2019)</i>	Census and Statistics Department [5]
	Median rent to income ratio (%) <i>((ii) for both 2016 and 2019)</i>	Census and Statistics Department [5, 6]
	Proportion of domestic households owning the quarters they occupy (%) <i>((i) for both 2016 and 2019)</i>	Census and Statistics Department [5, 6]

<b>Transport/ Walkability</b>	Proportion of working population with place of work in the same district of residence (%) <i>((i) for both 2016 and 2019)</i>	Census and Statistics Department [5, 6]
	Walking as main mode of transport to place of work (for working population with fixed place of work) (% of working population using walking as main mode of transport to place of work, given that their place of work is fixed) <i>((ii) for 2016; (iii) for 2019)</i>	Census and Statistics Department & Centamap [7]
<b>Environment</b>	Population density (people/km <sup>2</sup> ) <i>((ii) for both 2016 and 2019)</i>	Census and Statistics Department [5, 8]
	Number of old and valuable trees <i>((iii) for 2016; (i) for 2019)</i>	Development Bureau [9]
	Noise pollution (% of people exposed to traffic noise exceeding 70dB) <i>((iii) for 2016, (ii) for 2019)</i>	Environmental Protection Department [10]
	Number of greening and landscape assets <i>((iii) for 2016; (i) for 2019)</i>	Development Bureau [11]
	PM <sub>2.5</sub> concentration (µg/m <sup>3</sup> ) <i>((ii) for both 2016 and 2019)</i>	Environmental Protection Department & HKUST ENVF [12, 13]
	NO <sub>2</sub> concentration (µg/m <sup>3</sup> ) <i>((ii) for both 2016 and 2019)</i>	Environmental Protection Department & HKUST ENVF [12, 13]
	O <sub>3</sub> concentration (µg/m <sup>3</sup> ) <i>((ii) for both 2016 and 2019)</i>	Environmental Protection Department & HKUST ENVF [12, 13]
	Average temperature (°C) <i>((ii) for both 2016 and 2019)</i>	Environmental Protection Department & HKUST ENVF [13]

<b>Health Facilities</b>	Number of hospitals, specialist outpatient clinics, and general outpatient clinics under the Hospital Authority (HA) <i>((i) for both 2016 and 2019)</i>	Hospital Authority [14, 15]
	Total length of walking tracks (m) <i>((iii) for 2016; (i) for 2019)</i>	Leisure and Cultural Services Department [16]
	Total number of sports facilities (including badminton courts, basketball courts, fitness rooms, grass pitches, hard-surface pitches, swimming pools, and table tennis courts) <i>((iii) for 2016; (i) for 2019)</i>	Hong Kong Geodata Store, with reference to Leisure and Cultural Services Department [17-23]

*(i) Proportion to the Largest Value (P.L.V.) approach; (ii) Standard Score Approach (S.S.A.) approach; (iii) Standard Score Approach (S.S.A.), followed by either P.L.V. or S.S.A.*

#### **(b) 9 Official Health Indicators of Hong Kong**

<b>Categories</b>	<b>LHI-HK Indicators</b>	<b>Sources of Data</b>
<b>Physical Health</b> <i>(ii)</i>	Averaged death statistics from 2016 to 2018	Department of Health [24]
	Averaged death statistics (external causes) from 2016 to 2018	Department of Health [25]
	Number of specialist outpatient (clinical) attendances by major specialty and cluster/clinic	Hospital Authority [26]
	Number of general outpatient attendances by cluster/clinic	Hospital Authority [27]
	Family medicine specialist clinic attendance by cluster/clinic	Hospital Authority [27]
	Number of patient days by cluster/hospital during the 2019-2020 period	Hospital Authority [28]
<b>Mental Health</b> <i>(iv)</i>	Satisfaction with quantity of open space (by district)	Civic Exchange [29]
	Satisfaction with trees, plants and landscaping (by district)	
	Satisfaction with beauty of open space (by district)	

*(ii) Standard Score Approach (S.S.A.) approach; (iv) Directly from official documents available.*

**Table S2.** Determination of score range of Liveability and Health Indicators that adopted the Standard Score Approach (S.S.A.), based on previous literature and the consideration of local contexts in Hong Kong.

<u>Range of scores</u>	<u>Level of importance in connecting Liveability and Health</u>	<u>Indicators</u>
1 to 10	N/A (Due to the satisfactory performance of all 18 districts)	N/A
2 to 10	The indicator is the most significant within local context	<ul style="list-style-type: none"> <li>• Number of specialist outpatient (clinical) attendances by major specialty and cluster/clinic, 2019-20</li> <li>• Number of general outpatient attendances by cluster/clinic, 2019-20</li> <li>• Family medicine specialist clinic attendances by cluster/clinic, 2019-20</li> <li>• Number of patient days by cluster/hospital, 2019-20</li> </ul>
3 to 10	The indicator is highly important within local context	<ul style="list-style-type: none"> <li>• Median rent to income ratio (%)</li> <li>• Population density (people/ km<sup>2</sup>)</li> <li>• Working hours (% of people with 45-54 hours, 55-64 hours and over 65 hours of working hours)</li> <li>• Median floor area of accommodation (m<sup>2</sup>)</li> <li>• Death statistics (average figure in 2016, 2017, and 2018)</li> </ul>
4 to 10	The indicator is of medium importance within local context	<ul style="list-style-type: none"> <li>• Poverty rate (%)</li> <li>• Noise pollution (% of people exposed to traffic noise exceeding 70 dB)</li> <li>• PM<sub>2.5</sub> concentration (µg/m<sup>3</sup>)</li> <li>• NO<sub>2</sub> concentration (µg/m<sup>3</sup>)</li> <li>• O<sub>3</sub> concentration (µg/m<sup>3</sup>)</li> <li>• Average temperature (°C)</li> <li>• Walking as main mode of transport to place of work (for working population with fixed place of work) (% of working population)</li> </ul>

5 to 10	The indicator is of minimal significance within the local context	<ul style="list-style-type: none"> <li>• Labor force participation rate (%)</li> <li>• Death statistics (external causes) (average figure in 2016, 2017, and 2018)</li> </ul>
6 to 10	The indicator is the least significant/influential within the local context	N/A
7 to 10	N/A	N/A
8 to 10	(Failure to obtain a sharp distribution of scores)	
9 to 10		

**Table S3.** Statistical parameters obtained from the best-fit line between each LHI-HK Liveability Indicator versus Overall Health Score, and the respective multiplying factors imposed to each of these indicators in Case Study 3 (See Section 2.3.4 and Table 1), after local contexts are being considered.

<u>Categories</u>	<u>LHI-HK Liveability Indicator</u>	<u>Slope</u>	<u>R value</u>	<u>Multiplying Factor</u> <u>(Case Study 3)</u>
<i>Education</i>	Educational characteristics (percentage of post-secondary education: degree) (both sexes) (%)	0.65	0.378	<b>4</b>
<i>Economy</i>	Median monthly household income from all households (HK\$)	0.50	0.417	<b>5</b>
	Labor force participation rate (%)	0.48	0.353	<b>4</b>
	Poverty rate (%)	0.68	0.410	<b>5</b>
	Working hours (% of people with 45-54 hours, 55-64 hours and over 65 hours of working hours)	0.01	0.00002	<b>5</b>
<i>Housing</i>	Median floor area of accommodation (m <sup>2</sup> )	0.92	0.536	<b>6</b>
	Median rent to income ratio (%)	-0.55	-0.272	<b>5</b>
	Proportion of domestic households owning the quarters they occupy (%)	0.36	0.268	<b>3</b>
<i>Transport/ Walkability</i>	Proportion of working population with place of work in same district of residence (%)	-0.19	-0.116	<b>1</b>
	Walking as main mode of transport to place of work (for working population with fixed place of work) (% of working population using walking as main mode of transport to place of work given that their place of work is fixed)	0.17	0.114	<b>2</b>
<i>Environment</i>	Population density (people / km <sup>2</sup> )	0.93	0.461	<b>5</b>
	Number of old and valuable trees	0.28	0.113	<b>2</b>
	Noise pollution (% of people exposed to traffic noise exceeding 70 dB)	0.21	0.123	<b>2</b>
	Number of greening and landscape assets	0.21	0.136	<b>2</b>
	PM <sub>2.5</sub> concentration (µg/m <sup>3</sup> )	0.22	0.176	<b>2</b>
	NO <sub>2</sub> concentration (µg/m <sup>3</sup> )	0.57	0.384	<b>5</b>
	O <sub>3</sub> concentration (µg/m <sup>3</sup> )	-0.38	-0.253	<b>5</b>
	Average temperature (°C)	-0.04	-0.03	<b>1</b>
<i>Health Facilities</i>	Number of hospitals, specialist outpatient clinics, and general outpatient clinics under the Hospital Authority (HA)	-0.72	-0.410	<b>1</b>
	Total length of walking tracks (m)	0.05	0.0245	<b>1</b>
	Total number of sports facilities	-0.82	-0.461	<b>1</b>

**Table S4.** Overall normalized liveability scores of all 18 districts of Hong Kong in 2016 and 2019, together with the changes and percentage changes of scores, and changes in rankings from 2016 to 2019.

District	$L_{2016,N}$	$L_{2019,N}$	$\Delta L_N$	$\Delta PC_L$ (%)	$\Delta R_L$
<b><u>Hong Kong Island</u></b>					
Central and Western	73.64	72.62	-1.02	-1.39	-
Eastern	67.86	69.27	+1.41	+2.08	-
Southern	71.83	72.35	+0.52	+0.72	+1
Wan Chai	70.41	69.94	-0.47	-0.67	-
<b><u>Kowloon</u></b>					
Kowloon City	64.89	66.05	+1.16	+1.79	+2
Kwun Tong	52.84	52.49	-0.35	-0.66	-
Sham Shui Po	55.73	57.60	+1.87	+3.36	-
Wong Tai Sin	55.70	57.27	+1.57	+2.82	-
Yau Tsim Mong	61.34	62.04	+0.70	+1.14	-
<b><u>New Territories</u></b>					
Islands	77.40	75.57	-1.83	-2.36	-1
Kwai Tsing	60.16	60.70	+0.54	+0.90	-
North	65.77	66.63	+0.86	+1.31	+2
Sai Kung	74.03	76.08	+2.05	+2.77	+1
Sha Tin	71.73	70.96	-0.77	-1.07	-
Tai Po	65.88	65.01	-0.87	-1.32	-2
Tsuen Wan	72.01	72.06	+0.05	+0.07	-1
Tuen Mun	67.26	64.71	-2.55	-3.79	-4
Yuen Long	65.57	66.53	+0.96	+1.46	+2

$L_{2016,N}$ : Normalized Liveability score in 2016;  $L_{2019,N}$ : Normalized Liveability score in 2019;  $\Delta L_N$ : Change in Normalized Liveability score from 2016 to 2019;  $\Delta PC_L$ : Percentage change in scores from 2016 to 2019;  $\Delta R_L$ : Change in Ranking from 2016 to 2019

\*All numerical figures are corrected to 2 decimal places, and the normalized liveability scores in both 2016 and 2019 are out of 100.

**Table S5.** The categorization of 21 LHI-HK liveability indicators for the liveability assessment prescribed by The California Healthy Places Index (HPI) (i.e., with 8 action areas). Corresponding weighting scheme of HPI framework is as shown.

<b><u>The California Healthy Places Index (HPI)</u></b> <b><u>Action Areas</u></b>	<b><u>Indicators (based on LHI-HK framework)</u></b>	<b><u>Weighting (%)</u></b>
<i>Economic</i>	<ul style="list-style-type: none"> <li>• Median monthly household income from all households (HK\$)</li> <li>• Labor force participation rate (%)</li> <li>• Poverty rate (%)</li> </ul>	<b>32</b>
<i>Social</i>	<ul style="list-style-type: none"> <li>• Working hours (% of people with 45–54 hours, 55–64 hours and over 65 hours of working hours)</li> </ul>	<b>10</b>
<i>Education</i>	<ul style="list-style-type: none"> <li>• Educational characteristics (percentage of citizens having post-secondary education: degree) (both sexes) (%)</li> </ul>	<b>19</b>
<i>Transportation</i>	<ul style="list-style-type: none"> <li>• Walking as main mode of transport to place of work (for working population with fixed place of work) (% of working population using walking as main mode of transport to place of work, given that their place of work is fixed)</li> </ul>	<b>16</b>
<i>Neighborhood</i>	<ul style="list-style-type: none"> <li>• Proportion of working population with place of work in the same district of residence (%)</li> <li>• Total length of walking track (m)</li> <li>• Total number of sports facilities</li> <li>• Population density (people/km<sup>2</sup>)</li> </ul>	<b>8</b>
<i>Housing</i>	<ul style="list-style-type: none"> <li>• Median floor area of accommodation (m<sup>2</sup>)</li> <li>• Median rent to income ratio (%)</li> <li>• Proportion of domestic households owning the quarters they occupy (%)</li> </ul>	<b>5</b>
<i>Clean Environment</i>	<ul style="list-style-type: none"> <li>• Number of old and valuable trees</li> <li>• Noise pollution (% of people exposed to traffic noise exceeding 70dB)</li> <li>• Number of greening and landscape assets</li> <li>• PM<sub>2.5</sub> concentration (µg/m<sup>3</sup>)</li> <li>• NO<sub>2</sub> concentration (µg/m<sup>3</sup>)</li> <li>• O<sub>3</sub> concentration (µg/m<sup>3</sup>)</li> <li>• Average temperature (°C)</li> </ul>	<b>5</b>
<i>Healthcare</i>	<ul style="list-style-type: none"> <li>• Number of hospitals, specialist outpatient clinics, and general outpatient clinics under the Hospital Authority (HA)</li> </ul>	<b>5</b>



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