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Appraisal of China's Urban Underground Shopping Malls Based on Data Envelopment Analysis Model

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Abstract

Along with the process of large scale and fast urbanization in China, development and utilization underground shopping mall in China has become a hot issue. In the past 30 years, the development scale of China's urban underground shopping malls is very huge. Appraisal of China's urban underground shopping malls based on data envelopment analysis model, we found that the majority underground shopping mall which has opened were not ideal, and some are even to be closed or reorganized. China's underground shopping mall has gradually transformed from one with a very high degree of government intervention into a more market system. Lack of experience in underground shopping mall development and management has lead to high vacancy rate in many underground shopping centers.

Key words: Underground shopping malls; Data envelopment analysis; Present status; China

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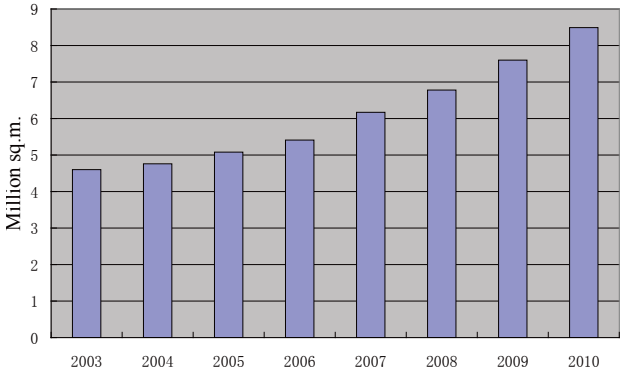
INTRODUCTION

Since the implementation of its "open-door" policy in 1978, the development and utilization of urban underground space resource in China experienced the process of focusing on construction of civil defense underground projects, and is gradually moving onto the track of combining urban redevelopment and construction.

Chinese Premier Wen Jiabao recently proposed to actively promote the joint development of civil air defense construction and economic development, and adhere to the combination of civil air defense construction and the urban construction. In Beijing, Shanghai, Guangzhou and other large cities, expansion of underground space has become a hot topic for the commercial real estate developers.

The underground shopping malls in China have undergone rapid evolution, development and growth. The total scale of China's underground shopping malls has increased from 4.6 million square meters in 2003 to 8.49 million square meters in 2010.the annual growth rate is about 7.5% (Figure 1).



Source: National Bureau of Civil Air Defense
Figure 1
Total Underground Shopping Mall Areas in China

China's underground shopping malls boom in the past years has led to growing vacancies. Take Guangzhou for example, based on historic statistic of Colliers International, under circumstances of large volume of supply in 1Q 2009, the vacancy of underground shopping mall locations in Guangzhou rose to 14.5%. In the last quarter of 2010, vacancy rate had decreased by 3.9 percentage points but remained high at 10.6 %. (Table1)

Table 1
Vacancy Rate in Selected Cities 4Q 2010

Region	City	Vacancy rate (%)
North	Beijing	12.0%
	Tianjin	16.1%
	Dalian	7.3%
	Shenyang	18.2%
	Qingdao	9.6%
East	Shanghai	6.1%
	Nanjing	3.5%
South	Guangzhou	10.6%
	Shenzhen	8.9%
Central and West	Chengdu	17.4%
	Chongqing	14.6%
	Wuhan	3.6%

Source: CBRE

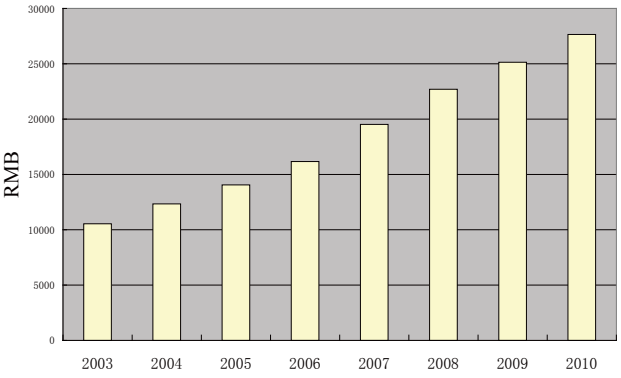
1. KEY DRIVERS IN DEVELOPMENT CHINA's UNDERGROUND SHOPPING MALLS

Economic development with GDP growth, continued urbanization and rapid development of transportation infrastructure will boost the demand for China's underground shopping malls.

1.1 Economic Development

The economic development level is a key element in deciding the potential of development and utilization of the underground space. An initial investment in an underground project can be 3-10 times the cost of equivalent development at ground level. According to the experience of developed countries, when GDP per capita income is between 500 and 1000 US dollar, underground space utilization tends to occur; when GDP per capita income is between 1000 and 2000 US dollar, urban underground spaces can become relatively common place in central urban areas; and when the annual per capita income exceeds 2000 US dollar, urban underground space utilization can reach a high level (Qian, 2001; Chen and Wang, 2005).

The Chinese economy has grown significantly since the Chinese government introduced economic reforms in the late 1970s. China's GDP per capita has increased to RMB27652 (approximately 4197 US dollar) in 2010. China has the economic strength to develop and use underground space on a large-scale. The following graph sets forth China's GDP per capita in each of the years from 2003 to 2010. (Figure 2).

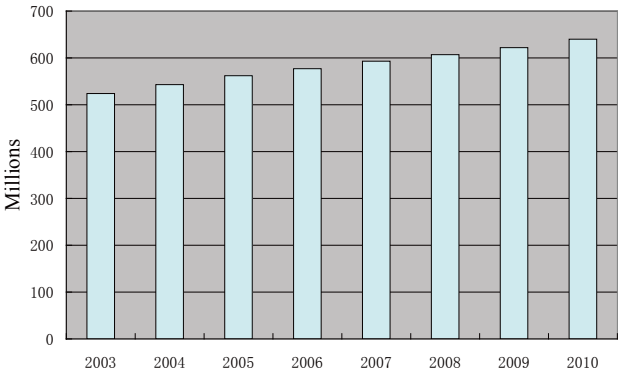


Source: National Bureau of Statistics of China
Figure 2
GDP Per Capita in China

1.2 Urbanization

For developed and developing countries, with the increasing urbanization levels and rapid growth of population, the problems of crowded city spaces, traffic jams, environmental pollutions, resources inadequacies come out. The problems can be released partly through placing facilities underground (Carmody and Sterling 1993).

China surpassed the United States in the mid-1970s to become the nation with the largest number of urban dwellers in the world. China's "opening up" and the introduction of market-oriented reforms in the early 1980s, accelerated urbanization across China such that, today, According to the National Bureau of Statistics of China, the total urban population in China increased to 640 million as of December 31, 2010. The urbanization rate (defined as the urban population as a percentage of the total population) increased from 36.2% in 2000 to 49.0% in 2010. By 2030, the urbanization rate in China would reach 61.9%. It is estimated that around 905 million Chinese citizens will live in the nation's cities by 2030. It should help unleash huge pent-up consumption demand and will stimulate investment in underground shopping malls (Figure 3).



Source: National Bureau of Statistics of China
Figure 3
Total Urban Population in China

1.3 Transport Infrastructure

Subways were regarded as the most vital contribution to underground space utilization (Barker 1986; Belanger 2007). The development of subways push the better development of land use and the compact land use support the underground space development. Large daily passenger flows will create new business opportunities in the stations or in nearby areas.

The development speed of urban rail transit in China is unprecedented and ranks first in the world. It is reported that there are 22 cities in which the urban rail transit planning have been approved and the fund invested on it will exceed 0.882trillion RMB before 2020.At present; there are 79 rail lines under construction in the country. According to plan, the number of rail lines will reach 158 and the total mileage will be more than 4189 km in 2015. By 2025, up to 170 new mass transit systems will be built in China, implying better connectivity to suburban areas. It is predicted that more shopping centers will be built to serve these new suburban communities.

2. THE APPRAISAL OF CHINA's URBAN UNDERGROUND SHOPPING MALLS

2.1 Evaluation Indicators of China's Urban Underground Shopping Malls

It is important to sum up representative comprehensive evaluation indicators of urban underground shopping malls. First, classify these comprehensive evaluation indicators, and then choose the representative or integrated indicators from each category.

Sustainable Development is a development that meets the needs of the present without compromising the capacity of the future generations to answer theirs (Environment and Development Commission of the United Nation, 1987). In the extensive discussion and use of the concept since then, there has generally been recognition of three aspects of sustainable development: an economically sustainable system, a socially sustainable system, and an environmentally sustainable system; Sustainable Development of underground shopping malls should consider these comprehensive evaluation indicators.

The assessment of economic aspect: underground shopping malls involve a large scale of investment in terms of financial expenditure, and then result is to achieve a satisfactory rate of returns on investment for the owners and investors.

The assessment of social aspect: Underground shopping malls create jobs opportunities during the construction phase and the management service jobs after open. The availability of retail spaces offers opportunities for people to try their hands in retail entrepreneurship. Underground shopping malls also combine shopping with entertainment by providing shoppers a place for shopping, socializing, walking, and eating. Some local groups or non-government organizations may be allowed to use underground shopping malls to distribute information on local activities and issues, such as project displays and fund-raising.

The assessment of environment aspect: A part of the improved visual appearance of areas with underground shopping malls is the increase in the space available for planting large trees. The space is increased by placing shopping space underground. Trees are known to have beneficial effects on mental health, stress reduction and people's moods. They improve the overall quality of life and increase people's enjoyment of their surroundings.

Upon the relevant information and historical experience reference, 3 categories 6 indices are selected as the comprehensive evaluation indicators of China's urban underground shopping malls. For underground applications, the sustainability can be realized by the assessments illustrated in Figure 4.

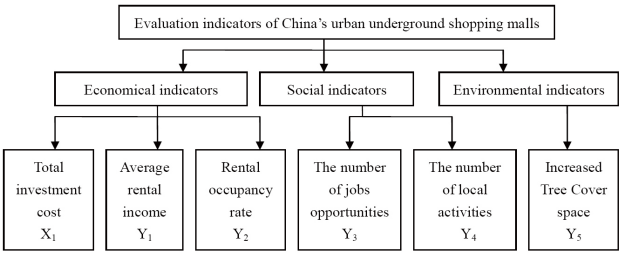


Figure 4
Evaluation Indicators of Urban Underground Shopping Malls

2.2 Data Envelopment Analysis Model

DEA is an effective non-parameter approach for the decision-making unit efficiency evaluation. Since the first DEA model—CCR model was established in 1978, it has been regarded as a new approach to efficiency evaluation and has been extensively investigated and utilized. One defect of the CCR model lies in its incapability in further evaluation of all the efficient units. Andersen and Petersen

(1993) later put forward super-efficiency evaluation model, which makes it possible to fully line up all the efficient units. In this section, we will introduce super-efficiency evaluation model that will be used to evaluate the efficiency of underground shopping malls in China.

Suppose there are n $DMU_j(1, 2, ..., j=n)$ and the input and output value of DMU_j are as follows:

$X_j=(x_{1j}, x_{2j}, ..., x_{mj})^T>0, j=1, 2, ..., n$

$Y_j=(y_{1j}, y_{2j}, ..., y_{sj})^T>0, j=1, 2, ..., n$

While the weights vector of input and output are $V=(v_1, v_2, ..., v_m)^T$ and $U=(u_1, u_2, ..., u_s)^T$, suppose h_j is the efficiency evaluation index of the DMU_j. we could get the improved DEA model—the super-efficiency DEA model. For schema (1),

$$\begin{cases} Max\, h_{j0} = \sum_{k=1}^{s} u_k y_{kj0} \\ s.t. \sum_{i=1}^{m} v_i x_{ij0} = 1 \\ \sum_{k=1}^{s} u_k y_{kj} - \sum_{i=1}^{m} v_i x_{ij} \le 1, j = 1, 2, ..., n;\ j \ne j0 \\ u_k \ge 0 \quad k = 1, 2, ..., s; v_i \ge 0 \quad i = 1, 2, ..., m \end{cases} \tag{1}$$

We can solve the linear programming (1), then get the each $DMU_j(1, 2, ..., j=n)$ efficiency value, $h_j \ge 1$ means the DMU_j works effectively; if $0 \le h_j < 1$, the DMU_j works ineffectively.

By making use of the crossed-evaluation approach, a total of 18 underground shopping canters are selected in this study, their efficiency could amply reflect the overall efficiency of China's underground shopping malls (Table 2).

Table 2
Indicator Data of China's Urban Underground Shopping Malls

Underground shopping mall	Total investment cost (million RMB)	Average rental income (RMB/ square meter month)	Rental occupancy rate	The number of jobs opportunities	The number of local activities	Increased Tree Cover space (thousand square meters)
Fashion Avenue Xuzhou center	80	400	0.83	390	9	13.6
Underground Fashion Street, Taiyuan	450	450	0.76	1400	24	50
Shanghai People's Square	460	750	0.98	1700	20	48.5
Shanghai Jungian Temple Square	75	450	0.95	250	16	8
Commercial Street, Wenzhou Xinxiang	149	140	0.87	700	13	17.7
Deduce District, Chongqing, nine temples underground commercial	83	120	0.69	390	10	11.5
Underground commercial Jiefangbei	158	400	0.79	780	13	20
Beijing Xian Cultural Square	102	600	0.86	500	8	12
Shun Chun under the commercial world	350	420	0.86	110015	40	
Shenyang popular front	408	290	0.91	1200	16	47
Shenyang fashion business	425	700	0.89	1500	20	50
Gogol Street in Harbin	167	600	0.65	670	15	20
Jiamusi in Heilongjiang Province, underground business street	100	240	0.79	450	10	13.3
Xining, Qinghai Province, Grand Cross Underground Shopping	167	230	0.65	940	21	22
First Avenue, Guangzhou	489	300	0.87	1900	24	60
Jinan, four air defense Mall	146	250	0.64	810	16	18
Jinan Hero Mountain air defense Mall	297	200	0.63	1400	19	35
Nanjing Fashion Lady	170	950	0.97	1000	12	20

According to Table 2 which lists out the input and output indicators of 18 China's urban underground shopping malls, By making use of MATLAB, there are five underground shopping malls of the DEA Efficiency is bigger than 1, such as Nanjing Fashion Lady. But more underground shopping malls in China of the DEA Efficiency is smaller than 1 (Table 3).

Table 3
The Result of China's Urban Underground Shopping Malls Based on DEA

Underground shopping mall	v_1	u_1	u_2	u_3	u_4	u_5	DEA Efficiency
Fashion Avenue Xuzhou center	0.125	0.0004	0	0	0	0.0858	1.331
Underground Fashion Street, Taiyuan	0.0022	0	0	0.00027	0	0.0053	0.644
Shanghai People's Square	0.0021	0	0	0.00023	0.0042	0.0017	0.610
Shanghai Jungian Temple Square	0.0133	0.00037	0	0	0.102	0	1.79
Commercial Street, Wenzhou Xinxiang	0.0067	0	0.124	0.00092	0.0083	0	0.860
Deduce District, Chongqing, nine temples underground commercial	0.012	0	0.220	0.0015	0.0189	0	0.951
Underground commercial Jiefangbei	0.0063	0	0.0044	0.00078	0	0.0146	0.903
Beijing Xian Cultural Square	0.0098	0.00126	0	0.00013	0	0.0167	1.0246
Shun Chun under the commercial world	0.00285	0	0	0.000347	0	0.0068	0.6559
Shenyang popular front	0.00245	0	0	00.000298	0	0.00587	0.6335
Shenyang fashion business	0.00235	0	0	0.000286	0	0.00563	0.7109
Gogol Street in Harbin	0.00598	0.00013	0	0.000659	0.0117	0.00472	0.7902
Jiamusi in Heilongjiang Province, underground business street	0.01	0	0.1848	0.00137	0.0123	0	0.887
Xining, Qinghai Province, Grand Cross Underground Shopping	0.00598	0	0	0.00617	0.0144	0.00798	1.0585
First Avenue, Guangzhou	0.00204	0	0.00143	0.000252	0	0.00471	0.7629
Jinan, four air defense Mall	0.00684	0	0.1266	0.00094	0.00848	0	0.9779
Jinan Hero Mountain air defense Mall	0.00336	0	0.00236	0.000415	0	0.00776	0.854
Nanjing Fashion Lady	0.00588	0.000162	0	0.001	0	0	1.159

The DEA Efficiency is bigger than 1 means the underground shopping mall works effectively, and the DEA Efficiency is smaller than 1 means the underground shopping mall works ineffectively. On the table, the majority underground shopping Mall which has opened were not ideal, and some are even to be closed or reorganized.

3. ANALYSIS THE REASON

Most domestic underground shopping mall developers lack the required capital and expertise in underground shopping centre development and management, and rely on bank loans to finance the development. In order to make a quick profit, some developers lease only the anchor retail spaces, and sell the smaller units to independent retailers or to individual investors, turning the underground shopping centre into a condominium complex. Consequently, the management's ability to control the desired tenant mix is therefore lost, which can lead to undue competition within the centre, poor performance, and high vacancy rates (Wang and Zhang, 2006).

For example, Renhe Commercial Holdings Company limited(1387.HK), established in 1992,it focuses on the development and operation of underground shopping centers for wholesale and retail apparel /accessories stores by building civil air defense shelters in China. The revenue generated from transfer of operation rights and lease income, In 2009, the average selling price from transfer of operation rights is about RMB 33000-38000/ square meter (Figure 5). The annual lease income is about RMB 900-1200/ square meter (Figure 6). The investors sell 47.5% of the operation rights of shopping center units for a one- time. (Source: Bloomberg, BOCI).

	Revenue from operation rights transfer		Transfer of gross floor area realized		Average transfer price realized	
	2009	2008	2009	2008	2009	2008
	(RMB'000)		(sq.m.)		(RMB per sq.m.)	
Project						
Phase I of Shenyang Project	**1,321,003**	–	**31,148**	–	**42,411**	–
Wuhan Project	**674,025**	–	**26,130**	–	**25,795**	–
Phase I of Guangzhou Project	**374,154**	1,344,129	**8,252**	28,729	**45,341**	46,786
Phase I of Harbin Project	**214,613**	80,224	**6,267**	2,101	**34,245**	38,184
Phase II of Harbin Project	**7,078**	39,308	**265**	1,922	**26,709**	20,452
Phase III of Harbin Project	–	408,672	–	18,433	–	22,171
Phase I of Zhengzhou Project	–	995,863	–	22,792	–	43,694
Phase VI of Harbin Project	**1,253,876**	–	**40,748**	–	**30,771**	–
Harbin Youyi Road Project	**188,825**	–	**6,448**	–	**29,284**	–
Total	**4,033,574**	2,868,196	**119,258**	73,977	**33,822**	38,772

Figure 5
Operation Rights Transfer (Renhe Commercial Holdings Company Limited, Annual Report 2009)

	Lease income in 2009		Lease income in 2008		Leaseable GFA at the end of year	
	2009				2009	2008
	(RMB' 000, except for percentage)				(sq.m.)	
Project						
Phase I of Harbin Project	**25,118**	**19.4%**	30,082	16.5%	**7,552**	13,819
Phase II of Harbin Project	**21,595**	**16.7%**	23,768	13.1%	**19,446**	19,711
Phase III of Harbin Project	**5,249**	**4.1%**	30,120	16.5%	**2,582**	2,582
Phase I of Guangzhou Project	**30,443**	**23.5%**	98,115	53.9%	**5,587**	13,839
Phase I of Zhengzhou Project	**13,001**	**10.0%**	–	0.0%	–	–
Harbin Spring	**18,077**	**14.0%**	–	0.0%	**16,800**	–
Phase I of Shenyang Project	**15,886**	**12.3%**	–	0.0%	**79,352**	–
Total	**129,369**	**100.0%**	182,085	100.0%	**131,319**	49,951

Figure 6
Lease income (Renhe Commercial Holdings Company Limited, Annual Report 2009)

CONCLUSION

The high-return of underground shopping mall projects had attracted a lot of investors, appraisal of China's urban underground shopping malls based on data envelopment analysis model, we found that the majority underground shopping mall which has opened were not ideal, and some are even to be closed or reorganized. Lack of experience in underground shopping mall development and management has lead to high vacancy rate in many underground shopping centers. In order to make better use of underground space of shopping, Investor should fully consider future changes in the basis of risk analysis and made risk response mechanisms so that to reduced future losses to the minimum.

REFERENCES

Charnes. A, Cooper W. W (1978). Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research,* (2), 429-444.

CHEN Zhilong, WANG Yubei, LIU Hong, XIAO Qiufeng (2007). Prediction of Underground Space Needs. *Planner, 23*(10), 9-13.

Cook, W.D. and Joe Zhu (2008). *Data Envelopment Analysis: Modeling Operational Processes and Measuring Productivity.* USA: CreateSpace.

D. Sherman and Joe Zhu (2006). *Service Productivity Management: Improving Service Performance Using Data Envelopment Analysis (DEA)*. Boston: Springer.

Joe Zhu (2003). *Quantitative Models for Performance Evaluation and Benchmarking: DEA with Spreadsheets and DEA Excel Solver.* Boston: Springer (Kluwer Academic Publishers).

LI, Y. (2009). *The Potentials for Integrated Underground Space Development in Urban Planning: A Case Study of Shanghai City.* The University of Hong Kong.

QIAN Qihu, CHEN Zhilong (1997). The Prospect of Development and Utilization of Underground Space in 21th Century. *Journal of Nanjing Engineering Institute, 12*(3), 1-8.

W.W. Cooper, L.M. Seiford and Joe Zhu (eds.) (2004). *Handbook on Data Envelopment Analysis*. Boston: Springer (Kluwer Academic Publishers).

ZHU Daming (2008). On the Development Degree of Urban Underground Space. *Chinese Journal of Underground Space and Engineering, 4*(5), 793 -797.

