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Research on a Vertical Space System of the Mixed-use Complex¹

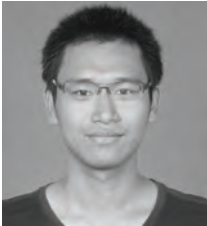
城市建筑综合体垂直空间体系研究¹



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Abstract

As the key method and important way to realize the vertical urban development in China, the mixed-use complex becomes the real case for the research of sustainable and vertical urbanism. Based on synergy perspectives, this paper reviews three typical mixed-use complexes with various vertical space systems in Shanghai via the combination of field observation, questionnaire inquiries and software analysis. It then proceeds to discuss which vertical space system in favor of encouraging sustainable vertical urban development from perspective of spatial efficiency. Finally it concludes the relative design features of mixed-use complex: to create external dimensional-connections, to create internal multi-connections, to organize overall composite functions.

Keywords: Sustainable Vertical Urbanism, Vertical Circulation, Synergy Effect, Spatial Efficiency, Spatial Attraction, Shanghai

摘要

摘要文本: 在中国城市发展过程中, 城市建筑综合体应运而生, 它是城市立体化发展的实现手段, 也是可持续垂直城市研究的现实案例。本文基于协同效应视角, 以上海的三个典型城市建筑综合体为例, 通过软件模拟分析、实地观测和问卷调查相互印证的方式, 对城市建筑综合体的三类垂直空间体系进行比较研究, 并从空间效率入手讨论何种体系更利于促进城市的可持续垂直发展。最终总结出城市建筑综合体的相应设计要点: 创造外部立体接口, 建立内部多重联系, 组织整体复合业态。

关键词: 可持续垂直城市, 立体交通, 协同效应, 空间效率, 空间吸引力, 上海

Introduction

Nowadays, the mixed-use complex is becoming the key method and important way to realize the vertical urban development under dense habitat in China. Compared with the single-function buildings, it is helpful for mixed-use complexes with synergy effect to bring better benefits for all functional subsystems (financial value), to create higher spatial efficiency for the entirety building (spatial value), and to promote not only the surrounding communities but also the whole city by attracting more peoples to visit (urban value). Among them, spatial value and urban value, which produce the efficiency and the attraction are the important characteristics of mixed-use complex. These characteristics are distinct from those of other building types, as well as important to realize the sustainable vertical urbanism in China in future.

This paper reviews three typical mixed-use complexes in Shanghai with three different types of vertical space systems via the

引言

当下, 城市建筑综合体已经成为中国高密度人居环境下城市立体化发展的重要契机和实现手段。相较单一功能建筑, 城市建筑综合体中各功能子系统因能产生协同效应而为整体带来更高收益(经济价值), 创造更高的空间效率(空间价值), 甚至吸引更多人流访问促进周边社区乃至整个城市的发展(城市价值)。其中, “空间价值”“城市价值”是城市建筑综合体区别于其他建筑类型的重要特征, 也是中国未来实现可持续垂直城市开发的关注重点。

本文通过软件模拟分析、实地观测和问卷调查相互印证的方式, 对城市建筑综合体的三类垂直空间体系进行比较研究, 并从空间效率入手讨论何种体系更利于促进城市的可持续垂直发展。

城市建筑综合体的空间体系类型

克里斯托弗·亚历山大²在《城市并非树形》一文中, 通过数学集合论的两个重要概念——树形结构和半网络型结构(请见图

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² 国家自然科学基金资助(项目批准号: 51008213), 上海市浦江人才计划资助(项目编号: 13PJC105), 高密度人居环境生态与节能教育部重点实验室自主课题资助

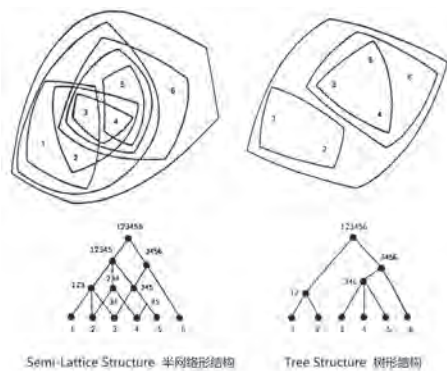


Figure 1. Tree Structure and Semi-lattice Structure (Source C·Alexander)
图1. 树形结构和半网络型结构 (出自: 克里斯托弗·亚历山大)

combination of field observation, questionnaire inquiries and software analysis. It then proceeds to discuss which vertical space system in favor of encouraging sustainable vertical urban development from perspective of spatial efficiency.

Space Systems Type of Mixed-Use Complex

In the essay A city is not a tree, Cristopher Alexander² analyzed and compared different urban structures via Tree Structure and Semi-lattice Structure, which are two important concepts in Mathematical Set Theory (see Figure 1). Based on this classic research, this paper considered the entrances (interfaces between mixed-use complex and the city) as the starting points, the public spaces internalizes as well as functions of each layer in buildings as the joint points (connections), and explains space systems of mixed-use complex to Tree Structure and Net Structure.

Tree Structure's features of vertical space system are as followings: spaces at the end of branches are isolated. To reach one end of the branches from another, it has to go back through the "branch" or "trunk" spaces which are interconnected. (see Figure 2) This kind of structure has weak connection among each part, and the accessibility of the terminal is worse.

The terminals of Net Structure are interconnected, and the connections of its joint points are even closer. When mixed-use complexes are connected with city only through the ground and underground levels, their space systems are relatively close, a visitor has to move upward to reach the terminals; while if they are connected with the city on multi-levels, a visitor can get in from different levels and move to different directions, the space system is relatively open. This paper defines the former type as "Close Net Structure" (abbr. C-Net), while the latter type as "Open Net Structure" (abbr. O-Net) (see Figure 2).

1) 来分析比较不同的城市结构。基于这一经典研究, 本文将城市建筑综合体与城市的接口 (即人流来向) 看作起点, 建筑中向内部深入的公共空间和各层功能看作节点, 将其空间体系转译为树形和网络型结构。

树形结构具有以下垂直空间体系特征: 位于树枝端部的空间彼此并不相连, 若需从其中一个树枝端部到达另外一个端部, 则必须经过联系彼此的“树杈”或“树干”空间。(请见图2) 此类结构各部分联系较弱, 其端部空间的可达性也较差。

网络型结构各个端部之间存在联系, 各结点之间的联系更加紧密。当城市建筑综合体仅通过地面及地下与城市相接, 空间体系相对封闭, 人流必须向上运动才能到达端部空间; 而如果其与城市在更多层面相连, 人流可在不同层面进入并选择不同方向流动, 空间体系相对开放。本文将前者定义为“封闭型网络型结构” (简称“封闭网络型”), 后者定义为“开放型网络型结构” (简称“开放网络型”)。(请见图2)

案例比较研究

本文选取位于上海的三座城市建筑综合体作为不同空间体系的研究案例, 分别是树形的五角场万达广场 (后简称“万达广场”)、封闭网络型的五角场百联又一城 (后简称“又一城”) 和开放网络型的虹口凯德龙之梦 (后简称“龙之梦”)。(请见表1) 它们都位于高密度城市环境中, 包含相似功能, 与城市地铁系统密切联系, 交通便利, 人流量大。

空间可达性

J-graph软件模拟

首先, 根据案例的功能和空间布局, 对案例垂直空间体系进行提取和归纳, 抽象成空间结构分析图 (请见图3)。图中主要关注的是空间的划分和连接关系, 包含以下要点: (1) 建筑整体空间布局和轮廓, (2) 建筑与城市接口, (3) 建筑各层平面, (4) 各层主要流线组织方式, (5) 中庭及扶梯等垂直交通联系。

随后, 将上图为底图, 通过J—graph软件³描点连线, 生成空间关系图 (请见图4)。由空间关系图可以看出, 龙之梦的空间深度 (Space Depth) 等级明显低于其他两个案例, 这说明从城市到达其离入口最远的空间, 开放网络型结构所需步数 (即空间转换次数) 最少, 初步反映其空间可达性更好。

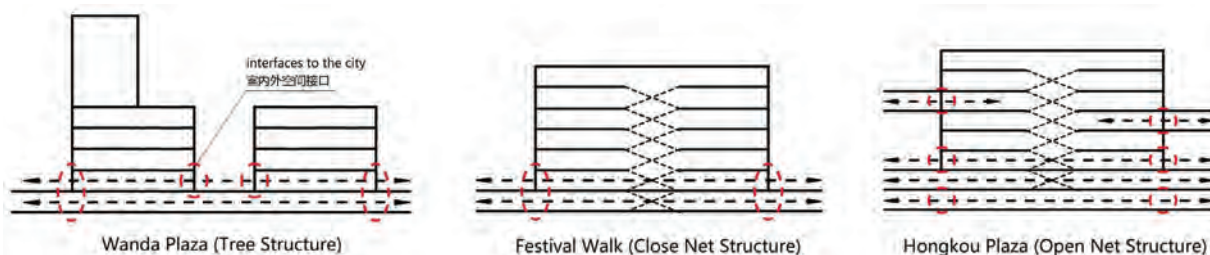


Figure 2. Diagram of three different types of vertical space system (Source: Yinpu WANG)
图2. 三类不同垂直空间体系图解 (出自: 王寅璞)

²Christopher Alexander is an Austrian-born, British-trained, U.S.-based architect/planner. In the essay A city is not a tree, he argued that a city should not be designed with a neatly branching treelike organization dividing functions from each other, but should be complex and overlapping.

³克里斯托弗·亚历山大是一位在奥地利出生, 英国长大, 并扎根于美国的建筑师和规划师。他在《城市不是一棵树》这篇论文中, 清晰地指出了城市不应该被设计为像树干分支一样的将各个功能孤立划分的系统, 而应该是复杂并具有重叠性的。




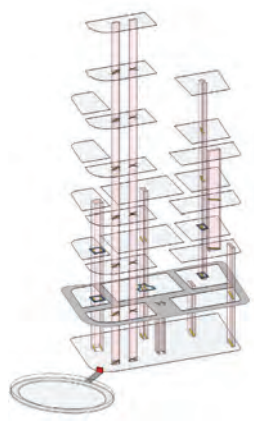
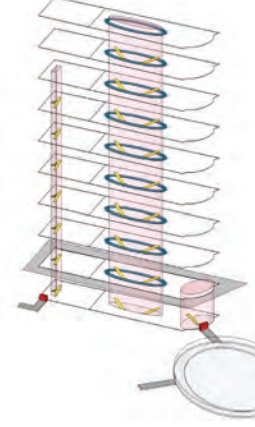
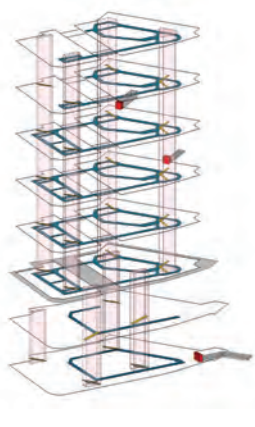
项目名称 Project Name	上海五角场万达广场 Wanda Plaza	上海五角场百联又一城 Festival Walk	上海虹口凯德龙之梦 Hongkou Plaza
项目外观 Project Image			
区位 Location	五角场商业区中心地段 Center of Wujiaochang Commercial Area	五角场商业区中心地段 Center of Wujiaochang Commercial Area	虹口区核心地段 Core area in Hongkou District
建成时间 Completed Time	2006年12月 December, 2006	2007年1月 January, 2007	2011年12月 December, 2011
总建筑面积 Gross Floor Area	33.4万平方米 334,000m ²	12.6万平方米 126,000m ²	28.0万平方米 280,000m ²
商业面积 Commercial Area	25.3万平方米 253,000m ²	12.6万平方米 126,000m ²	17.3万平方米 173,000m ²
功能组成 Functions	零售、餐饮、娱乐、办公、公寓 Retail, Catering, Recreation, Office, Apartment	零售、餐饮、娱乐、办公 Retail, Catering, Recreation, Office	零售、餐饮、娱乐、办公 Retail, Catering, Recreation, Office
城市接口 Interfaces with City	地面出入口，与地铁10号线和五角场中心广场在地下相接。 Ground Level Entrance, connects to Metro Line 10 and Wujiaochang Central Plaza in underground	地面出入口，与地铁10号线和五角场中心广场在地下相接。 Ground Level Entrance, connects to Metro Line 10 and Wujiaochang Central Plaza in underground	地面出入口，与地铁8号线地下相接，与3号线在3、4层相接。 Ground Level Entrance, connects to Metro Line 8 in underground, connects to Metro Line 3 on the 3rd and 4th floor
空间体系 Space System			
结构类型 Structure Type	树形结构 Tree Structure	封闭网络形结构 Close Net Structure	开放网络形结构 Open Net Structure

Table 1. Basic Information Comparison of Cases (Source: Yinpu WANG, Zhendong WANG)
表1. 研究案例基本情况对比 (出自: 王寅璞, 王桢栋)

calculated the ratio of each floor, then has got the following chart via VFR statistics (see Table 2):

The comparison of the distribution of VFR in different space systems reflects the difference in accessibility: according to the evenness degree, the O-Net has obvious advantage. It is worth mentioning that Hongkou Plaza has the most even distribution at weekday night after compared with other two cases; Moreover, the evenness degree at weekday night are quite different from that at daytime in Wanda Plaza, while which in Hongkou Plaza are similar. It demonstrates that O-Net mixed-use complex is easier to be integrated into the everyday lives of the surrounded communities.

最后，将分析数值可视化。结合之前绘制的案例结构分析图，将RN值⁴呈现在图示当中，设定随着RN值从低到高，彩色图由冷色到暖色，可以得到每个案例的整合度图示。因为RN值不受系统大小影响，进一步统一标准，将三个案例作为一个整体，按照其整合度值，赋予相对应的冷暖度色彩。(请见图5) 经过比较，整合度最高的区域出现在龙之梦中间层面，整合度最低的区域出现在万达广场的最高层面，整体看来，龙之梦空间整合度最高。

实地观测数据分析

通过对三个案例各层人流量的实地观测，获得人流量分布情况⁵。为进一步减少误差，每个时段采样3次，每次采样时间为5分钟，

Comparative Case Study

This paper selected three mixed-use complexes in Shanghai as the cases of different space systems, Wanda Plaza in Wujiaochang (abbr. Wanda Plaza) which is a Tree Type, Festival Walk of Bailian Group in Wujiaochang (abbr. Festival Walk) which is a C-Net and Hongkou Plaza of Capitalmall (abbr. Hongkou Plaza) which is an O-Net. (see Table 1) These three mixed-use complexes are all located in high-density urban environment with similar functions, close connection with urban metro system, convenient communication and high VFR (visitor flow rate).

Spatial Accessibility

J-Graph Simulation

First of all, according to the functional and spatial distribution of the case, the research group has extracted and induced its vertical space system, then they has abstracted the system into diagram of space structure (see Figure 3). The focus points of the diagram are the spatial distribution and connected relation, which containing main aspects: (1) overall spatial distribution and contour of the building, (2) interfaces to the city, (3) each floor layout of the building, (4) main organization form of circulation in each floor, (5) vertical circulation, for example, atrium and escalator.

Secondly, the research group has taken the diagram as the underlying graph, anchor has pointed and drew lines on it via J-graph³, then generated the spatial relation diagram (see Figure 4). According to the spatial relation diagram, it results that the space depth in Hongkou Plaza is obviously lower levels than the other two cases. This illustrates the number of steps, (the times of spatial switching) which are needed to get to the farthest terminal space away from the entrance, is relatively least in O-Net. And it also means the spatial accessibility of this kind of structure is better.

Finally, the research group has visualized the analysis of data. Combined with previously structure analysis diagram, they has visualized the RN value⁴, has defined the color would be warmer while the RN value is getting higher, then they has get the integrated diagram of each case. As the RN value is not affected by the size of systems, the research group has made the three cases into an entity by unifying the standards. The color of each part was influenced by its integration level (see Figure 5). After comparison, the part with highest integration level is on the intermediate floors in Hongkou Plaza, while the part with lowest integration levels is on the highest floors in Wanda Plaza. Generally speaking, Hongkou Plaza has the highest level of Spatial Integration.

Field Observation Data Analysis

The research group has obtained the distributions of the VFR via field observations on each floor of three cases⁵. To reduce deviation, each period of time has taken 3 samples and each sampling time is 5 minutes, thus has got the average number. The research group has defined the VFR on the ground floors in each case as 100%, has

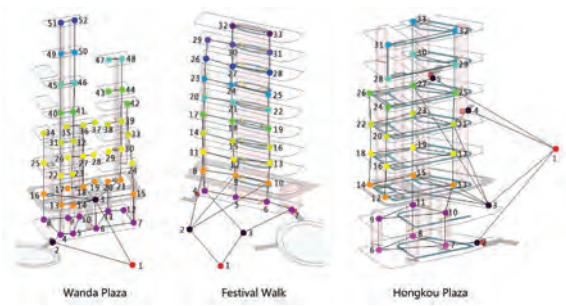


Figure 3. Diagram of space structure of three cases (Source: Yinpu WANG)
图3. 三个案例的空间结构图解 (出自: 王寅璞)

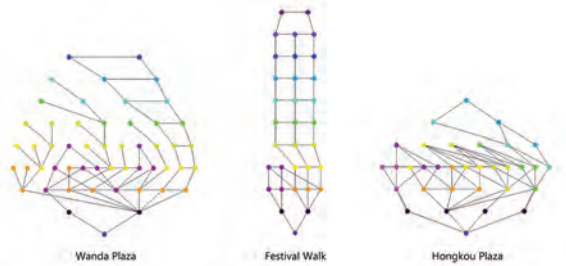


Figure 4. Spatial Relation diagram of three cases (Source: Yinpu WANG)
图4. 三个案例的空间关系图解 (出自: 王寅璞)

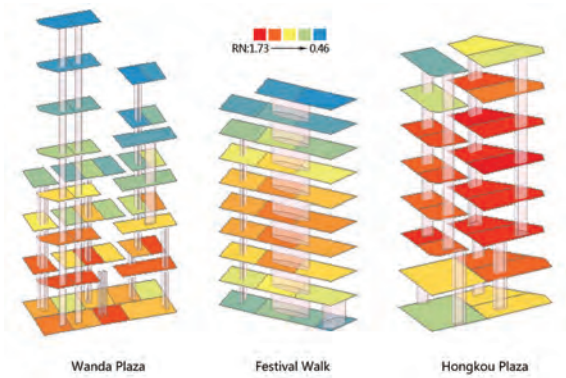


Figure 5. RN value visualization diagram of three cases (Source: Yinpu WANG)
图5. 三个案例的空间整合度形象化图解 (出自: 王寅璞)

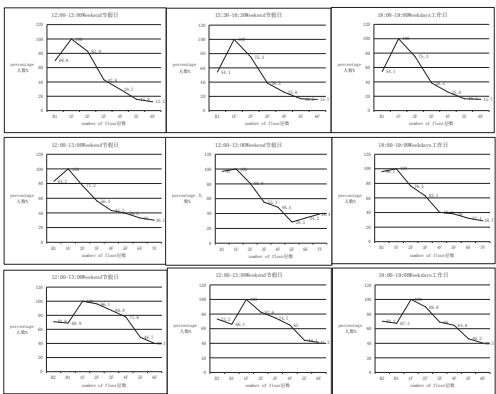


Table 2. VFR Statistics of Cases (Source Yinpu WANG)
表2. 案例人流量统计表 (出自: 王寅璞)

³J-Graph is a graph drawing open source software component written in the Java programming language; started by Gaudenz Alder as a University project in 2000 at ETH Zurich, Switzerland. The original design for J-Graph was to make it an architectural extension of J-Tree.
⁴J-Graph是一款基于Java编程语言的开放图形绘制软件;最早起源于2000年瑞士苏黎世高等工业学院的Gaudenz Alder教授主持的学校科研项目。这款软件的原始设计目标即为将建筑空间构架抽象化。
⁵RN value means integration, the integration level of each part reflects the average linear topological steps away from all the other parts in the system.
⁶RN即整合度, 每个部分的整合度值反映了它到系统中所有其他部分的平均线性拓扑步数。
⁷The sampling positions are near the escalators which have largest flows in vertical space systems. We set an observation position beside every escalator, then plus the flows of all the positions on each floor to get the data. The sampling periods are chosen at noon and afternoon in weekends and off-duty time in weekdays, for at this time there is largest flow and, therefore, small deviation.
⁸采样地点选取垂直空间体系人流量较大的自动扶梯附近, 每一部扶梯旁设置一个观察点, 然后将建筑内每层多个观察点的人流相加得到数据。采样时段为节假日中午、下午及工作日下班后时间, 此时人流量较大, 所得数据误差较小。

Summary

Based on the research of field observation and software analysis, O-Net has more even distribution of VFR in actual operation, in addition to better spatial integration and accessibility in theory. This will bring the merchants on each floor more business opportunities and profits. Moreover, as the place for leisure, recreation and consumption which is accessible for urban inhabitants, the mixed-use complex creating more and more urban value, via attracting more and more visitors.

Spatial Attraction

SPSS Simulation

Based on the data attained during the former observation, via the correlation analysis offered by SPSS software⁶, the research group has taken VFR on each floor which were measured in three cases as dependent variables, while the factors like floors, size etc. as independent variables. Then the research group has analyzed the correlation between VFR with factors as level of floor, relationship with entrance and position of escalator etc. to find out the influence of the independent variables on VFR, therefore, to generate the diagram which could reflect the importance of each influencing factors of VFR (see Figure 6).

Results of analysis shows: “whether there is entrance connected directly to the outside” is the most important factor in attracting visitors, “distance away from the entrances” is also quite important, then comes “the number of entrances” and “the level of floor”. Moreover, factors like the “gross floor area”, “functional component”, “the number of escalators” and “the period of statistics” also have certain influence, while the “number of elevators” and “the size of atrium” have less influence.

Data Analysis of the Questionnaire Inquiries

Selecting three periods of time in a day (12:00-13:00, 15:00-16:00, 19:00-20:00) during the weekdays and weekends, the research group gave out 230 questionnaires respectively in three cases while required 200 valid questionnaires. After analysis, they have found out the difference of spatial accessibility among the three cases.

Question 1: Which is the highest floor you would reach in commercial area in Wanda Plaza (Festival Walk or Hongkou Plaza) ?

- Underground
- 1st to 2nd floor
- 3rd to 4th floor
- 5th floor or higher

The statistics of question 1 is as following: (see Figure 7)

The results show that the accessibility of higher floors in Net Structure is better than that in Tree Structure, and the accessibility in Hongkou Plaza (O-Net) is the best. This again demonstrates that the overall spatial accessibility of O-Net is the best and its distribution of VFR is the most even one.

Question 2: When shopping in Wanda Plaza (Festival Walk or Hongkou Plaza), the reason you reach the 2nd floor or upper ones from the ground floor is?

取平均值。将三个案例建筑首层人流量计为100%，计算各层人流量比例，通过人流量统计得到下表 (请见表2)：

通过比较不同空间体系的人流量分布，反映出可达性的区别：从人流分布均匀度来看，开放网络型结构优势明显。值得一提的是，对不同案例中工作日晚间人流分布情况对比发现，龙之梦在此时段人流分布最为均匀；另外，万达广场工作日晚间人流分布均匀程度与白天有明显区别，而在龙之梦两个时段人流分布曲线相近。这说明开放网络型结构更易融入城市居民的日常生活。

小结

通过软件模拟与实地观测的相互印证，开放网络型结构的空间体系除了在理论上具有更好的空间整合度和可达性，在实际运营中，也可实现更加均匀的人流分布。这为各个层面的商家带来更多的商机和效益。另外，其作为城市居民便于到达的休闲、娱乐和消费场所，吸引大量人流，逐渐体现出越来越高的城市价值。

空间吸引力

SPSS软件模拟

基于前期调研获得的数据，借助SPSS软件⁶相关性分析功能，以不同案例中测得的每层人流数量为因变量，层面高低、规模大小等因素为自变量，分析人流分布情况与层面高低、入口关系、扶梯设置等因素之间的相关性，以此判断各变量对人流分布情况的影响，进而生成人流分布情况影响因子重要性图示。(请见图6)

分析结果表明：该层“是否有与外界直接联系的出入口”是吸引人流最重要的因素，出入口距离对于人流分布影响较大，出入口数量和楼层其次，另外面积、功能、扶梯数量和统计时段等因素也有一定影响，而电梯数量和中庭大小的影响程度很小。

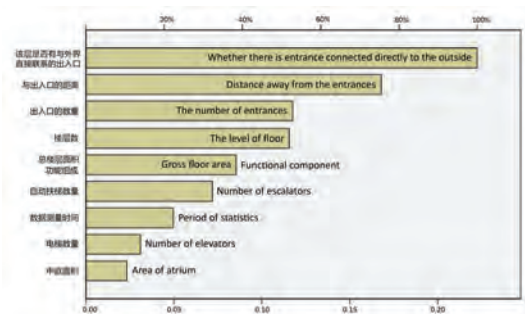


Figure 6. The result of SPSS Simulation (Source: Yinpu WANG)
图6. SPSS软件模拟结果 (出自: 王寅璞)

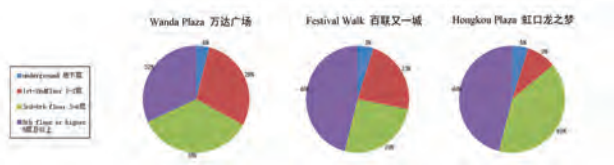


Figure 7. The statistics of question 1 (Source: Yinpu WANG)
图7. 问题1统计结果 (出自: 王寅璞)

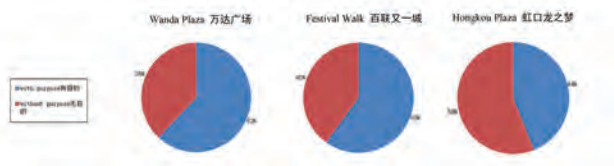


Figure 8. The statistics of question 2 (Source: Yinpu WANG)
图8. 问题2统计结果 (出自: 王寅璞)

⁶SPSS (Statistical Product and Service Solutions) for short, is IBM's launch of a series support software products for statistical analysis algorithms, data mining, predictive analysis and decision.
⁶SPSS是统计产品与服务解决方案 (Statistical Product and Service Solutions) 的简称，为IBM公司推出的用于统计学分析运算、数据挖掘、预测分析和决策支持任务的软件产品。

	Wanda Plaza 万达广场	Festival Walk 又一城	Hongkou Plaza 龙之梦	Total 总计
shopping 购物	76	84	78	238
catering 餐饮	88	102	104	294
recreation 娱乐	88	100	100	288
sales promotion 促销	76	70	32	178

Table 3. The statistics of question 3 (Source: Yinpu WANG)

表3. 问题3统计结果 (出自: 王寅璞)

- Visiting with purpose
- Wandering without purpose

The statistics of question 2 is as following: (see Figure 8)

The result show that the lowest ratio of the consumers who reach the higher floors with purpose happened in Wanda Plaza, while the highest happened in Hongkou Plaza. Tree Structure is relative closure, most visitors who go upward are purposive; while O-Net features multi-base-levels and high-accessibility, the ratio of the visitors who reach higher floors without purpose increases, which is good for the distribution of VFR.

Question 3: Which of the following functions would attract you to get to the upper floors from the ground floor? (multiple choice)

- Shopping
- Catering
- Recreation (cinema, ktv etc.)
- Activities like sales promotion
- Others

The statistics of question 3 is as following: (see Table 3)

In different functions, catering and recreation have largest influence on attracting visitors toward higher floors purposively, then comes shopping, while sales promotion has least influence. Special functions can attract consumers to reach the higher floors purposively, which is good for the overall spatial distribution of VFR.

Question 4: Which of the following factors would attract you to get to the upper floors from ground floor? (multiple choice)

- Open space through the atrium
- Sight line (such as shops, signboards, advertisements upstairs)
- Escalators
- Elevators

The statistics of question 4 is as following: (see Table 4)

From the results, it could find out that in the design of Mixed-use complexes, the arrangement of escalators should be paid more attention; Furthermore, establishing sight communication when connecting each floors via setting atrium would create possibility for attracting consumers to reach higher floors purposelessly.

Summary

Via the combination of questionnaire inquiries and software analysis, the research group has found out that the main features of O-Net – the interfaces between inner public space and the outside urban environment (namely entrances) – play decisive role in attracting visitors, while O-Net has the strongest potential to promoting the visitors to reach the higher floors. Among the functional factors, catering and recreation has strongest attraction; while among spatial factors, escalator has strongest guide ability.

	Wanda Plaza 万达广场	Festival Walk 又一城	Hongkou Plaza 龙之梦	Total 总计
Atrium 贯穿中庭	69	78	84	231
Sight line 视线吸引	60	69	66	195
Escalators 自动扶梯	102	114	129	345
Elevators 电梯	54	24	6	84

Table 4. The statistics of question 4 (Source: Yinpu WANG)

表4. 问题4统计结果 (出自: 王寅璞)

问卷调研数据分析

选取工作日和节假日12:00-13:00, 15:00-16:00, 19:00-20:00三个时间段在三个案例内各发放230份问卷, 选取其中有效问卷200份。通过分析, 得出三个案例空间可达性的差异。

问题1: 您平时在万达广场(又一城、龙之梦)消费最高会逛到商场的几层?

- 地下层
- 1-2层
- 3-4层
- 5层及以上

问题1结果统计如下: (请见图7)

从统计结果可以发现, 较高层面的可达性网络型结构优于树形结构, 而开放网络型结构的龙之梦可达性最强。再次证明开放网络型整体空间可达性最好, 人流分布最为均匀的观点。

问题2: 在万达广场(又一城、龙之梦)消费时, 您通常从地面层到二层以上的楼层是?

- 有目的性的购物娱乐
- 有目的性的购物娱乐

问题2结果统计如下: (请见图8)

从统计结果可以发现, 万达广场中无目的向高层运动的消费者比例最少, 而龙之梦最多。树形结构较为封闭, 消费者向高层空间运动多数是出于目的性的; 而开放网络型结构多基面及可达性高的特点, 消费者向高层空间的无目的运动比例增加, 利于人流均匀分布。

问题3: 您会被以下哪种功能所吸引, 而从地面层走向二层以上的楼层? (可多选)

- 购物
- 餐饮
- 娱乐 (电影院、KTV等)
- 促销等活动
- 其他

问题3结果统计如下: (请见表3)

不同功能业态中, 餐饮和娱乐对人流向高层有目的运动影响力最大, 购物其次, 促销活动的吸引力较弱。特殊业态可吸引消费者向建筑较高层面有目的性的运动, 有利于整体空间人流均匀分布。

问题4: 您会被以下哪种因素所吸引, 而从地面层走向二层以上的楼层: (可多选)

- 受中庭上下贯通的开敞空间吸引
- 受视线的影响 (如楼上的店铺、招牌、广告等)

Promote Sustainable Vertical Urbanism via Mixed-Use Complex

Through research, the research group has found out that vertical space systems play important roles in promoting synergy effect of mixed-use complexes. Net Structure (especially O-Net) has better overall accessibility and higher spatial efficiency than Tree Structure, which brings more visitors and generates more even distribution of VFR (spatial values), therefore, encourages place effect (urban values) when bringing more opportunities of making profits (financial values). This means O-Net could create more values for mixed-use complex and even vertical city. According to the above results, the research group has concluded the design principles of vertical space systems of mixed-use complex which could become the implementation approaches of sustainable vertical urbanism for China in future.

Create External Dimensional Connections

From urban planning perspective, planners could increase vertical development of cities to create conditions for developing O-Net mixed-use complex. From urban design perspective, mixed-use complex should establish tight dimensional connections with their neighboring urban environment and set up more even external interfaces. Via taking full advantage of topography, developers could establish connections between the neighboring underground space and vertical public space, and finally create O-Net structure.

Create Internal Multi-Connections

From the urban design perspective, developers could combine urban public space (such as the transferring space for buses or metros) into mixed-use complex to enhance internal vitality and VFR. From the architectural design perspective, it is benefiting to increase the sight line communication between different floors by adding atrium or escalators, in order to increase the spatial integrity and accessibility. As for group type mixed-use complex, it should create connections and increase the accessibility of the terminal space as far as possible when maintaining the mutual independence of different functions.

Organize Overall Composite Functions

During the design of the circulation of mixed-use complex, architects could organize functions like hotel, office and apartment into the overall spatial structure as far as possible, to encourage synergy by increasing the internal circulation. As for the arrangement of commercial sectors, architects could distribute functions like retail, catering and recreation systematically, and put high-attraction functions (cinema, anchor store and famous restaurant) and non-profit-oriented functions (arts and cultural facilities, roof greening parks) on the higher floors in order to enhance its attraction.

As a micro city, mixed-use complex becomes the main driving force of vertical urbanism in China and Asia under dense habitat. Via mixed-use complex, the developer could construct vertical urban public space, organize tridimensional urban function to attract more people to move higher, and finally create sustainable vertical urban life.

- 受自动扶梯影响
- 受电梯影响

问题4结果统计如下: (请见表4)

从统计结果可以看出, 在城市建筑综合体的设计中, 应重点考虑自动扶梯的设置; 另外, 通过设置中庭, 在联系各层空间的同时建立视线交流, 为吸引消费者向更高楼层的无目的运动创造可能性。

小结

通过软件模拟与问卷调研相互印证, 开放网络型结构空间体系的主要特征, 即建筑内部与外界城市环境的接口 (即出入口) 对人流的吸引具有决定性作用, 而开放网络结构最有利于引导消费者向更高层面空间运动。功能因素中, 餐饮娱乐功能的吸引力最大; 空间因素中, 自动扶梯的引导性最强。

以城市建筑综合体为契机促进可持续垂直城市

通过研究发现: 垂直空间体系对于促进城市建筑综合体的协同效应发生具有重要作用, 网络型结构 (尤其是开放型) 相较树形结构往往具有更好的整体可达性和更高的空间效率, 从而带来更大的人流量和形成更为均匀的人流分布 (空间价值), 在为整体创造更多盈利机遇 (经济价值) 的同时, 进而促生场所效应 (城市价值)。可以说, 开放网络型结构能为城市建筑综合体乃至立体城市创造更多价值。基于研究成果, 研究团队进一步总结出城市建筑综合体的垂直空间体系设计要点, 作为促进未来中国可持续垂直城市发展的实现手段。

创造外部立体接口

从城市规划角度, 加强城市立体化建设, 为建设开放网络型结构城市建筑综合体创造条件。从城市设计角度, 城市建筑综合体应与周边城市环境建立紧密的立体联系, 设置更加均匀的外部接口; 充分利用地形, 与周边地下空间和空中公共空间等建立联系, 形成开放网络型结构。

建立内部多重联系

从城市设计角度, 开发商可将城市公共空间 (如公交、地铁换乘空间等) 融入城市建筑综合体以增加其内部的人气与活力。而从建筑设计角度, 建筑内部宜通过中庭、单层及多层扶梯, 加强上下层视线和流线联系, 提升空间整合度和可达性。对于群体型城市建筑综合体, 在保持各功能相互独立的同时, 尽可能在空中创造联系, 增加端部空间的可达性。

组织整体复合业态

在城市建筑综合体的流线设计中, 应尽可能考虑将酒店、办公、居住等功能流线组织到整体空间结构之中, 利用内部通勤增加商业空间人气, 激发协同效应。而对商业部分的功能设置, 可将零售、餐饮、娱乐等业态复合布置, 在较高楼层设置高吸引力功能 (电影院、主力店、知名餐饮等) 和非盈利性功能 (如文化艺术设施、屋顶绿化公园等), 提升高层空间的吸引力。

城市建筑综合体作为微缩的城市, 已经成为中国乃至亚洲高密度地区城市垂直化的主要推动力量, 通过其创造的立体城市公共空间, 在空中组织城市功能从而将越来越多的人吸引往城市高处, 进而营造可持续立体化的城市生活。

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