工业化转型发展下城市工业景观的环境再生策略——上海典型案例调研与比较

STRATEGIC ANALYSIS OF URBAN INDUSTRIAL LANDSCAPE REGENERATION UNDER POST-INDUSTRIALIZATION: A SURVEY AND COMPARISON STUDY OF SAMPLES IN SHANGHAI

摘要
中国正处于由工业化向后工业化阶段转换的时期，而上海已率先进入后工业化阶段，历史遗留的大量工业景观面临遗产保护、转型升级和环境治理等发展需求。鉴于上海工业发展历史悠久、园区数量巨大且类型多样，本文通过梳理近现代工业发展历史，将工业景观再生归纳为遗产类、转型类和优化类三种类型；通过解析相关规范标准设定的建设要求，就基建控制、服务配套与产业升级这三大重点对上海的典型工业景观分类样区进行调研，并讨论各自的环境再生策略。研究结果表明，遗产类样区需重点应对遗产利用和生态恢复问题；转型类样区应同时关注服务设施的完善、公共空间的塑造，以及循环产业链的构建；优化类样区应通过节能减排、立体绿化来提升绿地的生态效益，改善环境品质。不同的工业景观应针对相应的再生类型和具体问题，选取适用的再生策略，以优化环境品质，达成环境、社会和经济相协同的可持续发展。

关键词
工业景观；后工业化；再生策略；城市更新

ABSTRACT
With the nationwide trend of shifting from industrialization to post-industrialization, Shanghai is one of the first cities stepping into the post-industrialization stage. The large amount of industrial landscapes left over from this transition requires heritage preservation, industrial transformation, and environmental conservation. This paper reviewed the long-term modern industry development of Shanghai and divided its various industrial landscapes into three categories of regeneration: heritage revitalization, site transformation, and environmental optimization. After summarizing the existing constructive guidelines and standards, five sample areas of typical industrial landscapes in Shanghai were surveyed in terms of construction control, supporting service improvement, and industrial structure upgrading, with regeneration strategies suggested for each of them. The results show that the sample area for heritage revitalization needs to prioritize heritage reuse and ecological restoration; sample areas for site transformation should reinforce the improvement of service facilities and public spaces together with establishing the recycling industry chain; and sample areas for environmental optimization have to enhance the ecological performance of green spaces by introducing vertical greening along with energy saving and emission reduction for an environmental quality improvement. In conclusion, strategies for each type of regeneration should vary on a case-by-case basis so as to improve its environment and achieve sustainable development with a synergy in environment, society, and economy.

KEYWORDS
Industrial Landscape; Post-industrialization; Regeneration Strategy; Urban Renewal

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1 引言

随着经济的发展，中国正处于由工业化向后工业化阶段转换的时期，服务业比重持续上升，制造业比重持续下降，产业结构面临深刻转型[1]。这一变化正同步引发城市工业景观的闲置和污染修复等问题，以及转型升级的需求。随着生产技术的进步和可持续发展理念的不断深入，循环产业链、产城融合、工业遗产地保护与利用等手段也逐渐兴起[2]~[4]。城市工业景观的设计应借助各种环境再生策略——即可使环境适应新的发展需求以达到动态平衡机能的策略[5]——针对性地解决与具体环境相关的历史遗留问题，适应不断提升的建设规范与标准，优化环境品质。

上海是中国最早开埠发展现代工业的城市之一，目前已进入以现代服务业为主、以高端制造业为辅的后工业时代，既有工业区数量巨大、类型全面。在后续规划建设用地零增长的背景下，这些工业区普遍需要进行转产、升级，但因各自的历史与未来发展方向不同，其具体的再生策略也大不相同。本文首先梳理了上海的工业发展历史与当地工业景观的再生类型；而后回顾了相关的建设规范、标准，结合当前的建设要求，选取分属不同再生类别的典型样区进行调研；最后针对再生区的建设问题，讨论适用的景观环境再生策略，以期为面临后工业化转型的城市提供工业景观再生发展的借鉴。

2 研究背景

2.1 上海工业发展历史与工业景观再生类型

上海是中国近代史上最早开放的5个通商口岸之一，自1843年起，华商与外商开始沿码头自由建厂发展轻工业，形成沪东、沪西、沪南三大工业聚集区；新中国成立后，为恢复经济、引导并发展重工业，工业用地呈圈层式向外扩展，8个近郊工业区①和7个卫星城②为重点建设对象；1990年后，浦东新区开发计划启动，同时中心城区外围工

1 Introduction

With the growth of economy, China is entering its era of post-industrialization with a significant reform of industrial structure, seeing a boom of the service industry and a decline of the manufacturing[1]. Urban industrial landscapes are in an urgent and increasing need of transformation and regeneration of idle or polluted sites. Meanwhile, concepts such as recycling industry chain, city-industry integration, and protection and reuse of industrial heritage emerge with technological advance and sustainable development[2]~[4]. The design of urban industrial landscapes should employ appropriate environmental regeneration strategies, which could help the environmental improvement adapt to new development needs to achieve a balanced functional upgrading[5]，to address longstanding problems, to meet the updated constructive standards, and to improve the environmental qualities.

The post-industry of Shanghai, a metropolitan benefiting from almost the earliest development of modern industry in China, is pillared by modern service sector, seconded by high-end manufacturing. The existing multi-typed, large-amount industrial parks, however, are necessary to be transformed or updated under Shanghai’s inventory land planning control. With different historical backgrounds and future visions, such sites require diverse regeneration strategies suitable to specific conditions. This paper, thus, expects to provide regenerative references for cities confronting post-industrial transformation problems by reviewing the industrial development of Shanghai and identifying its varied regeneration types of industrial landscapes; investigating typical sample areas of each type after analyzing relevant construction standards and examining current construction requirements; and finally exploring appropriate regeneration strategies for each type of regeneration.

2 Research Background

2.1 Shanghai’s Industrial Development History and Regeneration Types of Industrial Landscapes

Shanghai was one of the five earliest trading ports in China’s modern history. Since 1843, both local and foreign businessmen were allowed to build factories of light industry along the docks, forming three core industrial clusters locating in eastern, western, and southern Shanghai. After 1949, more and more suburbs were included into industrial land, and eight major suburban industrial parks① and seven satellite towns② were created to revitalize the economy and develop heavy industry. In the 1990s, together with the establishment of Pudong New Area,
业区增加较多，形成“1+3+9”③的集约化产业布局。随着城市土地资源日渐紧缺，自2006年“十一五”规划开始，工业向园区集中，重点发展新兴产业，全面推进产业转型升级。目前，上海共整合形成104个产业园区，形成了由战略性新兴产业引领、先进制造业支撑和生产性服务业协同的新型工业体系。⑥⑦⑧⑨

如若以历史的时空视角审视现在或曾经开展生产活动的工业景观，在上海从工业化向后工业化转型的过程中，部分工业景观围绕生产功能展开，形成园区景观；另部分转型功能，成为公园、博物馆等遗产景观；还有部分既包含工业遗产，又具有生产功能，可视为混合型景观，如上海M50创意园等。

这些不同类型的工业景观体现出了三种再生发展方向：1）遗产类再生，即由工业生产景观向观赏游憩和展示类景观转变。这类工业景观主要包括沿黄浦江、苏州河岸分布的早期工业废弃地，它们转换功能，成为公园、博物馆等遗产景观；2）转型类再生，即工业景观为顺应时代发展而进行产业升级和改造更新，多是位于因城市扩张而成为新的城市中心的近郊工业区，依据转型进程还可细分为转型中和转型完成两类；3）优化类再生，主要涉及远郊及浦东的新型工业区，它们在建设之初已受到循环经济、生态工业园和绿色工业发展理念的影响，但因高品质工业园区建设要求的不断提升，需要纳入新的再生策略，进一步优化环境品质。

在各类城市工业景观中，每个景观一般都自成管理单元；而工业景观的再生分类则面向环境再生策略。在同一景观类型的管理单元中可同时并存多种再生分类，例如，一些旧工业区的再生发展既包含对工业遗产景观的保护，也涉及基于工业区更新的新产业的植入。

2.2 城市工业区建设要求

自1949年以来，中国针对城市工业区的建设出台了一系列规范和标准。首先是对工业区建设进行底线控制的标准，如国家级的《工业项目用地控制指标》⑩⑪和市级的《上海产业用地指南》⑫⑬⑭，工业区外围的工业景点也增加较多，形成“1+3+9”③的集约化产业布局。随着城市土地资源日渐紧缺，自2006年“十一五”规划开始，工业向园区集中，重点发展新兴产业，全面推进产业转型升级。目前，上海共整合形成104个产业园区，形成了由战略性新兴产业引领、先进制造业支撑和生产性服务业协同的新型工业体系。⑥⑦⑧⑨

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2.2 Construction Requirements for Urban Industrial Zones

Since 1949, China has issued a series of regulations and standards to guide urban industrial zone construction. The early ones were the baseline standards, such as the national-level
### Table 1: Baseline indicators for urban industrial zone construction

| 文件名称（颁布年份） | 《工业项目用地控制指标（试行）》 (2004) | 《上海工业用地指标》 (2008) | 《上海工业用地指标》 (2008) | 《上海工业用地指标》 (2012) | 《上海工业用地指标》 (2019) |
|-----------------------|----------------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Documents (issued year) | Construction Land Regulatory Indicators for Industrial Projects (Trial) (2004) | Shanghai Industrial Land Use Guide (2004) | Shanghai Industrial Land Use Guide (2008) | Shanghai Industrial Land Use Guide (2012) | Shanghai Industrial Land Use Guide (2019) |
| 等级 Level | 国家级 National | 市级 Municipal | 市级 Municipal | 市级 Municipal | 市级 Municipal |
| 基建指标 Construction indicators | 容积率 FAR | 建筑系数 Building coverage ratio | 容积率 FAR | 建筑系数 Building coverage ratio | 容积率 FAR |
| 服务配套指标 Supporting service indicators | 行政办公及生活服务设施用地面积所占比重 Land ratio for administrative and service facilities | 行政办公及生活服务设施用地面积所占比重 Land ratio for administrative and service facilities | 行政办公及生活服务设施用地面积所占比重 Land ratio for administrative and service facilities | 行政办公及生活服务设施用地面积所占比重 Land ratio for administrative and service facilities | 行政办公及生活服务设施用地面积所占比重 Land ratio for administrative and service facilities |
| 投资回报指标 ROI indicators | 投资强度 Investment intensity of fixed assets | 投资强度 Investment intensity of fixed assets | 投资强度 Investment intensity of fixed assets | 投资强度 Investment intensity of fixed assets | 投资强度 Investment intensity of fixed assets |

### NOTE

All the listed documents are sourced from Ref. [10] ~ [15].

这类标准的控制指标可分为基建指标、服务配套指标和投资回报指标（表1），其中基建的基本指标为建设强度（以建筑系数与容积率为代表），服务配套的基本指标为服务设施用地面积所占比重，之后逐步增加了控制环境品质的绿地率和土地产出率，完善了基建和投资回报方面的要求。其次是引导工业区建设向高品质环境方向发展的规范标准，主要包括颁布于2015年的国家级的《国家生态工业示范园区标准 (HJ 274-2015)》[16]及颁布于2017年的市级的《上海市工业园区循环化改造实施方案编制指南（试行）》[17]，关注于园区内产业结构和企业生产方式。
式的转型升级，在保障资源产出的同时，通过多个指标控制园区内的资源消耗及废弃物排放，促进企业生产资料的减少与资源的循环利用（表2）。

综合而言，对以生产功能为核心的转型类和优化类再生实践来说，基建控制、服务配套与产业升级是目前政策层面所重点关注的。就遗产类再生而言，这类工业景观的改造涉及用地性质的改变，相应的基建控制和服务配套的具体要求会发生较大的改变。例如，历史风貌建筑会加以保留但转变使用功能，并应公共性使用而增加更多的服务内容和面积；同时绿地率指标会应新的用地要求有所提高18-20（表3）。

3 上海工业景观再生现状分类调研

3.1 工业景观再生分类典型案例及样区选择

研究团队针对遗产类、转型类和优化类这三种再生类型的工业景观，选择了5处较为典型的案例，即杨浦滨江工业带、漕河泾新兴科技开发园区、市北高新技术服务业园区、上海外高桥保税区和上海国际汽车城零部件配套工业园区，针对其中遗产类再生方向中既往工业用地

| 文档名称 | 总体要求 | 指标分类 |
|---------|---------|---------|
| 文件名称 | Documents | 总体要求 | General requirements | 指标分类 | Category indicators |
| 国家生态工业示范园标准（HJ274-2015） | Standard of National Demonstration Eco-Industrial Parks (HJ 274-2015) | 经济发展 | Economic growth | 资源节约 | Resource conservation |
|   |   | 产业共生 | Industrial symbiosis | 环境保护 | Environmental protection |
|   |   | 资源产出 | Resource productivity and consumption | 信息透明 | Information transparency |
|   |   | 信息透明 | Information transparency | 资源产出 | Resource productivity and consumption |
| 上海市工业园区循环化改造实施方案编制指南（试行） | Implementation Planning Guide for the Recycling Reform of Industrial Parks in Shanghai (Trial) | 经济持续发展、资源集约利用、环境优美清洁、生态良性循环、统筹规划园区创建 | Economic sustainable development, efficient utilization of resources, beautiful and clean environment, ecological recycle, systematical industrial park planning | 资源产出 | Resource productivity and consumption |

注：表中文件请参见参考文献[16]、[17]。

NOTE: The listed documents are sourced from Ref. [16] and [17].

Table 2: Main construction standards for high-quality industrial parks

| 文件名称 | 总体要求 | 指标分类 |
|---------|---------|---------|
| Documents | General requirements | Category indicators |
| 国家生态工业示范园标准（HJ274-2015） | Economic development | Resource productivity and consumption |
| 上海市工业园区循环化改造实施方案编制指南（试行） | Economic development | Resource productivity and consumption |

3 Survey of the Regeneration of Industrial Landscapes in Shanghai

3.1 Typical Cases and Sample Area Selection of Industrial Landscape Regeneration

This study selected 5 typical cases of the 3 types for further regeneration of industrial landscapes in Shanghai—Yangpu Riverside Industrial Belt, Caohaijing Emerging Technology Development Zone, Shibei High-Tec Park, Shanghai Waigaoqiao Free Trade Zone, and Automotive Components Supporting Park of Shanghai International Automobile City—which vary from 3 to 10 square kilometers in area. Then the study identified 5 sample zones (2 square kilometers on average)—for the heritage revitalization type, this study focused on the areas with a great number of industrial features; for the transformation- and optimization-oriented cases, this study selected the areas dominated by the
### 表3: 转型后的工业用地与部分其他用地的附属绿地占比对比

| 规划要求 | Planning standards | 等级 | Level | 绿地类别 | Green space category | 附属绿地占比 | Subsidiary green space ratio | 绿地类别 | Green space category | 附属绿地占比 | Subsidiary green space ratio |
|----------|-------------------|------|------|----------|---------------------|------------|-----------------|----------|---------------------|------------|-------------------|
|          |                   | 国家级 | National | 工业企业单位附属绿地 | Subsidiary green space to industrial enterprises | ≥20% | 产生有害气体及污染的工厂≥30% | ≥20% | 新建工业项目及工业项目外新建工业项目的附属绿地 | Subsidiary green space to newly-built industrial parks and to scattered newly-built industrial projects outside the parks | ≥20% | 新建产生有毒有害气体的项目≥30% |
|          |                   | 市级  | Municipal | 存储单位附属绿地 | Subsidiary green space to storage land | ≥20% | 存储项目的附属绿地 | Subsidiary green space to storage projects | ≥20% | 物流仓储用地的规划绿地率 | Planned green space ratio for logistics and storage land | ≥20% |
|          |                   |       |       | 学校、医院、疗休养院所、机关团体、公共设施、部队等单位附属绿地 | Subsidiary green space to schools, hospitals, nursing homes, government organizations, public cultural facilities, military units, etc. | ≥35% | | ≥35% | 公共管理与公共服务设施用地的规划绿地率 | Planned green space ratio for public management and public facility land | ≥35% |
|          |                   |       |       | 商业单位附属绿地 | Subsidiary green space to commercial places | ≥20% | | | 商业服务业设施用地的规划绿地率 | Planned green space ratio for commercial and service facility land | ≥20% | (宜大于35%) |
|          |                   |       |       | 新建居住区绿地 | Green space in new residential areas | ≥30% | | ≥35% | 规划新建居住区的绿地率 | Green space ratio for the planned newly-built residential areas | ≥30% |
|          |                   |       |       | 成片改建、扩建居住区的绿地 | Green space in large-scale reconstructed or extended residential areas | ≥25% | | | 旧城居住区的绿地率 | Green space ratio for built residential area | ≥20% |

注/NOTES:
1. 表中各类文件请参见文献[18]~[20]。
2. 《城市绿地规划标准（征求意见稿）（2018）》已正式变更为《城市绿地规划标准（GB/T51346-2019）》，于2019年12月1日生效（参见参考文献[21]）。但因本文撰写时正式稿尚未发布，且正式稿中缺少量化指标参照，故仍参考征求意见稿中的指标要求。

NOTES:
1. All the listed documents are sourced from Ref. [18] ~ [20].
2. The Urban Green Space Planning Standard (Exposure Draft) (2018) was further revised and officially adopted as the Urban Green Space Planning Standard (GB / T51346-2019) on December 1, 2019 (Source: Ref. [21]). But considering that the latter version was not released during the writing of this paper and it does not include relative quantitative indicators, this study adopted the standards from the 2018 draft as quantitative references.
3.2 Field Survey and Data Sources

In view of that regulating construction, improving supporting service, and upgrading industrial structure are the major concerns in the regeneration of industrial landscapes, this study surveyed 3 aspects of the sample areas as follows, taking the feasibility, replicability, and originality into account:

1) The ratio of subsidiary green space: The ratio can reflect the construction intensity of the sample areas. Though the building coverage rate—the ratio of the area covered by buildings and structures to the total land area—is a main
用地范围内各种建、构筑物占地面积总和占总用地面积的比例。对于总面积一定的用地，建筑系数与附属绿地占总用地面积的比例存在较为明确的数量关系，故可利用附属绿地占比代替各类标准中的建筑系数指标来进行讨论。在本研究中，各样区的附属绿地占总用地面积的比例根据上海市测绘院的测绘图测算获得。

2) 服务设施密度：该调查项目用于考察三类样区的配套服务情况，主要通过统计各类服务设施数量并根据样区面积转换为设施密度进行比较。依据《上海市控制性详细规划技术准则（2016年修订版）》(22)，公共设施用地按中类分为行政、商业服务业、文化、体育、医疗卫生、教育科研设计、文物古迹、商务办公和其他公共设施9类；考虑到研发类企业往往集中进驻园区的商务办公用地，因此在统计服务设施类别时未纳入商务办公用地，仅参照其余8类设施用地，分为行政、商业、文化、体育、医疗、教育、文物和其他用地。各样区产业用地上的设施数量分别根据各区政府网站公开的用地性质及借助20m精度的百度地图搜索各服务设施点获得。

3) 产业类型及是否具有构建循环经济链潜力：该调查项目用于考察转型类和优化类样区的产业升级状况，其中循环经济链是针对产业转型升级后生产过程会产生废弃物的样区专设的考察项目。因各个样区内涉及的单位较多，难以一一获得其投资强度、土地产出率和具体生产方式的准确信息，故借助产业门类考察高新产业的引入情况。

Table 4: Selected cases of industrial landscape types for further regeneration

| 工业景观类型 | 工业景观（及所选样区） | 典型性说明 |
|--------------|----------------------|------------|
| 遗产类      | 杨浦滨江工业带（样区一） | 位于上海工业最早起源地之一的沪东工业区，多数重工业区现已转型，主要发挥商务办公和旅游休闲功能 |
| 转型完成    | 虹桥经济技术开发区（样区二） | 为20世纪50年代所建的远郊工业区之一，自20世纪80年代以来，逐渐由重工业区转型为以生物医药为主的高新技术产业开发区 |
| 现代化园区  | 位于上海国际汽车城零部件配套工业园区（样区五） | 创建于20世纪90年代的以汽车零部件产业为特色的现代化工业园区 |

index in various standards, the ratio of subsidiary green space can be a substitute since it often has certain proportions with the building coverage rate. In this study, the ratio was sourced from the maps by the Shanghai Surveying and Mapping Institute.

2) The density of service facility: This indicator examines the supporting services in the sample areas in the amount and density of varied service facilities. According to the Technical Guidelines for Regulatory Planning in Shanghai (2016 Revision)\(^{(22)}\), the land use for public facilities can be classified into the administrative, commercial service, cultural, sporting, medical and healthcare, educational / research / design, cultural relics, business and office, and other typologies. This research adopted 8 of these typologies except the business and office since such places often accommodate R & D enterprises. The facility number of varied land use typologies in each sample area was accessed from the government’s data release and with Baidu maps of a 20-meter accuracy.

3) The industry type and the potential for establishing recycling industry chain: These factors were used to examine the sample areas’ upgrading capability in transformation- and optimization-oriented regeneration, and whether the upgraded industry satisfy recycling requirements (waste discharge or not in this study). Considering the large amount of enterprises located in each sample area, it is hard to collect detailed information on their
各样区的产业门类主要通过查阅企业查询网站中的园区信息，并根据《国民经济行业分类（GB/T 4754—2017）》[23]将各企业归入对应大类获得。

构建循环产业链可通过园区整体工业共生及基础设施的共享，实现能源的梯级利用、废弃物及副产品的循环利用，并通过企业内部的生产管控从源头减少资源能源消耗量，提高资源转化效率，最终在产业聚集、资源能源消耗和环境污染排放最集中的区域实现绿色发展[24]。一条完整的循环产业链应当包括生产者企业、消费者企业和分解者企业，分别负责研发设计、生产、销售，以及资源的回收和再利用[3]。中间由物流、商贸、信息服务业者进行沟通（图2）。表5中根据以上三者的定义，结合《国民经济行业分类（GB/T4754-2017）》列出了常见的生产者、消费者、分解者和中间者企业门类，据此可推断各样区的产业类型是否能构建循环产业链。

3.3 调研结果

各样区的调研结果如表6所示。

4 分类样区再生策略分析

4.1 遗产类再生策略

样区一再生后的用地类型为公共绿地、公共文化设施用地、商业用地、行政办公用地、教育科研用地等[26]，各类附属绿地占比要求较再生前有所提高；同时，当工业用地转变为具有公共性的用地时，除保护工业建筑遗产为文物类设施外，还需要配置更为完善的文化、运动、商业等服务设施，并对工业建筑的拆除和改造、工业污染治理等问题。

浦江两岸具有大量工业区遗存，对于工业区的普查与评估不应仅仅关注工业建筑实体，也需重视建筑以外的工业设备与构筑物所形成的独特景观环境。此外，工业用地所承载的生产历史、技术管理、生产投资规模，GDP每单位面积，和生产模式。这项研究调查了高科技产业的库存信息，并通过匹配到的行业分类，即《国民经济行业分类（GB/T 4754-2017）》[23]。

The recycling industry chain of an industrial park could be established through the industrial symbiosis and infrastructure sharing for the cascade use of energy and the recycle of wastes and by-products. Meanwhile, to address the current dilemmas of resource shortage and environmental deterioration, a source control of the energy consumption and productive efficiency during the production of enterprises within the industrial areas of intensive-layout, high-energy-consumption, and heavy-pollution would greatly contribute to the regional green development[24]. A complete recycling industry chain should include “producer” enterprises for research, design, and production, “consumer” enterprises to take charge of sale, and “decomposer” enterprises to help with resource recycling and reusing[3]; the material and information flows are supported by logistics, commercial, and information service enterprises, as intermediaries (Fig. 2). Accordingly, Table 5 lists the enterprise categories as common producer, consumer, decomposer, and intermediary servers, referring to the National Industries Classification (GB/T4754-2017), to help evaluate the industry’s potential for establishing recycling chain in the sample areas.

3.3 Survey Results

The survey results of each sample area are shown in Table 6.

4 Regenerative Strategies for Sample Areas of Varied Types

4.1 Strategies for Heritage-Revitalization Regeneration

After its regeneration, the land typologies in Sample Area 1 now are public green space, public cultural facility, commercial, administrative, and education and research land, etc.[26], each requiring a larger ratio of subsidiary green space than before. When industrial lands are transformed for public uses, more cultural, sporting, commercial service facilities should be introduced to protect industrial heritage as cultural relics, and address problems such as building demolition and reconstruction and industrial pollution remediation.

Considering the large amount of industrial heritages along the waterfront of the Huangpu River, a sweeping survey and assessment is required on both the industrial structures and the unique landscapes what they have shaped. For this type of regeneration, design strategies for the site’s commercial, cultural, and tourist places should be integrated with its intangible cultural
### Table 5: Industry categories suitable for establishing a recycling industry chain

|                      | 产业门类 | 产业大类                                                                 |
|----------------------|----------|--------------------------------------------------------------------------|
| 生产者 Producer      | C. 制造业（必须包括废弃资源综合利用业） | 汽车制造业、通用设备制造业、废弃资源综合利用业                      |
|                      | C. Manufacturing (must including comprehensive reuse of wastes)         | Automobile manufacturing, general equipment manufacturing, comprehensive reuse of wastes |
|                      | M. 科学研究和技术服务业                                           | 研究和试验发展、科技推广和应用服务业                               |
|                      | M. Research and technical services                                    | Research and experimental development, technique promotion, and application services |
| 消费者 Consumer      | F. 批发和零售业                                                   | 批发业和零售业                                                    |
|                      | F. Wholesale and retail                                             | Wholesale and retail                                                |
| 分解者 Decomposer    | N. 水利、环境和公共设施管理业                                       | 生态保护和环境治理业、公共设施管理业                             |
|                      | N. Water conservancy, environmental and public facility management    | Ecological and environmental protection, and public facility management |
|                      | O. 居民服务、修理和其他服务业                                      | 机动车、电子产品和日用产品修理业                                 |
|                      | O. Neighborhood services, repair services, and other services         | Vehicle, electronic product, and daily necessity repair services       |
| 中间者 Intermediary server | G. 交通运输、仓储和邮政业                                 | 装卸搬运和仓储业                                                 |
|                      | G. Transportation, storage, and postal services                       | Handling and storage                                                |
|                      | I. 信息传输、软件和信息技术服务业                                 | 互联网和相关服务、软件和信息技术服务业                          |
|                      | I. Information transmission, software, and information technology services | Internet and related services, software, and information technology services |
|                      | L. 租赁和商务服务业                                               | 租赁业和商务服务业                                               |
|                      | L. Leasing and business services                                     | Leasing and business services                                       |

When dealing with common soil and water pollution problems, physical, chemical, biological, and phytoremediation techniques can be employed according to specific pollution reasons and levels. When dealing with common soil and water pollution problems, physical, chemical, biological, and phytoremediation techniques can be employed according to specific pollution reasons and levels. When dealing with common soil and water pollution problems, physical, chemical, biological, and phytoremediation techniques can be employed according to specific pollution reasons and levels.

In Sample Area 1, the South Demonstration Section of the Yangpu Riverside Public Space which has finished industrial transformation may especially inspire other similar cases. The created 9 sections recall people's memory about the site's history with scattered bollards, concrete cleats, and a sculpture of stevedores, showing respect to its tangible and intangible cultural heritages preserved from the previous "eight factories and one bridge," namely Shanghai Shipyard, Shanghai Yangshupu Waterworks, Shanghai No. 1 Wool Factory, Shanghai Tobacco Factory, Shanghai Power Station Auxiliary Machine Design and Manufacturing Factory, Shanghai Yangshupu Gasworks, Shanghai Yangshupu Power Plant, Shanghai No. 17 Cotton Textile Main Factory, and Dinghai Bridge. Meanwhile, practices of vertical greening, rain gardens, heritage parks, etc. further improve the ecology of the site, forming an integrated system of the nature and culture.
| Sample Area | Sample area location | Green space in the industrial land | Administrative and public facilities |
|-------------|----------------------|-----------------------------------|------------------------------------|
| Sample Area 1 | ![Map of Sample Area 1](map1.png) | ![Map of Green space in Sample Area 1](green1.png) | ![Map of Administrative and public facilities in Sample Area 1](admin1.png) |
| Sample Area 2 | ![Map of Sample Area 2](map2.png) | ![Map of Green space in Sample Area 2](green2.png) | ![Map of Administrative and public facilities in Sample Area 2](admin2.png) |
| Sample Area 3 | ![Map of Sample Area 3](map3.png) | ![Map of Green space in Sample Area 3](green3.png) | ![Map of Administrative and public facilities in Sample Area 3](admin3.png) |
| Sample Area 4 | ![Map of Sample Area 4](map4.png) | ![Map of Green space in Sample Area 4](green4.png) | ![Map of Administrative and public facilities in Sample Area 4](admin4.png) |
| Sample Area 5 | ![Map of Sample Area 5](map5.png) | ![Map of Green space in Sample Area 5](green5.png) | ![Map of Administrative and public facilities in Sample Area 5](admin5.png) |

续表见下页 / Continued
### 4.2 Strategies for Site-Transformation Regeneration

Sample Areas 2 and 3 are cases aiming at transforming and updating the overall environment, where the ratio of subsidiary green space reaches 24% and 22.3% respectively, both meeting the official requirement. However, these two sites are facing the shortage and low-diversity of service facilities. The survey results show that most of the commercial facilities are convenience stores and restaurants, while the educational, cultural, and 

| 研究区域 | 面积 (km²) | 产业用地中附属绿地的占比 | 行政办公及生活服务设施 | 文物 | 其他 |
|----------|-----------|-----------------|-----------------|-----|-----|
| 样区一 | 1.44 (完成改造部分：0.43) | 21.3% | 2 | 0 | 15 | 0 |
| 样区二 | 1.95 | 24.0% | 14 | 2 | 0 | 0 |
| 样区三 | 2.24 (完成改造部分：1.27) | 22.3% | 4 | 0 | 1 | 0 |
| 样区四 | 2.96 | 17.1% | 1 | 0 | 0 | 0 |
| 样区五 | 1.60 | 18.2% | 2 | 0 | 0 | 2 |

**NOTES**

1. The boundary line of Sample Area 1 was referred to its previous industrial land boundary, sourced from Ref. [25]; the updated land use of Sample Area 2 was sourced from Ref. [26]; the land use of Sample Area 3 was sourced from Ref. [27]; the land use of Sample Area 4 was sourced from Ref. [28] and Baidu map; the land use of Sample Area 5 was sourced from Ref. [29]; and the land use of Sample Area 5 was sourced from Ref. [30].

2. Letters in the industry categories under the industry upgrading indicators represent respectively C for Manufacturing (excluding comprehensive reuse of wastes), M for Research and technical services, F for Wholesale and retail, N for Water conservancy, environment, and public facility management, I for Information transmission, software, and information technology services, L for Leasing and business services, O for Neighborhood services, repair services, and other services, and G for Transportation, storage, and postal services.

### 表6: 各样区调研结果汇总表

Table 6: Research results of each sample area

| 研究区域 | 面积 (km²) | 产业用地中附属绿地的占比 | 行政办公及生活服务设施 | 文物 | 其他 |
|----------|-----------|-----------------|-----------------|-----|-----|
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置更为全面，其改造部分的服务设施密度（0.72个/hm²）比样区二（0.34个/hm²）高出近一倍。此外，原污染性工业用地使用致使场地存在污染遗留问题。从产业结构来看，两个案例都剥离了污染较大的产业，向研发类高新技术产业转型，但并未向循环经济的领域探索。

根据针对样区三内改造完成地块上的产业门类统计可知，租赁与商务服务业占比33.0%，信息技术服务业占比19.8%，相加超过半数；制造业仅占14.0%（图3）。虽然仍保留制造业，但并无处理废弃物的废弃资源综合利用户，水利、环境和公共设施管理业也未有配套。因此，其产业转型和升级实质上是污染的外输转移，并未真正做到生产物质的闭环，难以达成环境再生目标。

随着研发类高新技术产业的引入以及与城市功能的融合，劳动人群由单一的劳动密集型人口变为包含了知识型、技术型在内的多层次人口，二者间的活动需求存在较大的差异[34]，因而需构建符合其需求的服务设施及公共空间。例如，在文化教育设施方面，可构建行业协会、信息交流中心、以及书店、培训机构等技术交流场所；在商业设施方面可配套商业综合体、餐厅会所与精品主题商店等，满足园区内

**图3：工业类型占比**

- A. 房地产业 0.2%
- B. 公共管理、社会保障和社会组织 0.2%
- C. 制造业 14.0%
- D. 电力、热力、燃气及水生产和供应业 0.8%
- E. 建筑业 3.3%
- F. 批发和零售业 12.7%
- G. 交通运输、仓储和邮政业 1.2%
- H. 住宿和餐饮业 0.8%
- I. 信息传输、软件和信息技术服务业 19.8%
- J. 科学研究和技术服务业 13.3%
- K. 租赁和商务服务业 33.0%
- L. 综合类 0.2%
- M. 公共管理、社会保障和社会组织 0.2%
- N. 公共管理、社会保障和社会组织 0.2%

**注**

由于少数企业没有识别出行业属性，行业统计的企业数量略少于实际查询出的企业总数。

**NOTE**

The total number of enterprises analyzed here is slightly less than the actual quantity of enterprises that have been searched as some of the industry attributes were hard to identify.
like basketball courts could encourage workers to take physical exercise and have a healthier lifestyle.

For a higher accessibility, a clear identity, and great attractions, all these service facilities can be distributed within working spaces and along with auxiliary facilities such as reference rooms, meeting rooms, and exhibition spaces to provide workers with opportunities for leisure, recreation, entertainment, and communication. For these purposes, design measures like integrating recreational atriums, ground greening, and roof gardens into public spaces can be employed. Considering the possible loss of green space caused by being occupied by diverse public spaces, strategies such as vertical greening could be introduced to realize an optimal use of space and broader ecological benefits.

Together with environmental remediation techniques to polluted lands, the recycling industry chain should be established to promote the industrialization of high-tech resource recycling enterprises. Such an industry chain can form a virtuous cycle of resource and energy reuse that the production waste from the upstream industries could become the raw materials for the downstream industries, helping achieve the goal of low input, high output, low pollution, and zero discharge.

4.3 Strategies for Environmental-Optimization Regeneration

Compared with other cases, Sample Area 4 and 5 have a higher construction density, whose subsidiary green space accounts only for 17.1% and 18.2% respectively, both below the official standard. Dilemmas for these two sample areas lie in that they are both newly-built parks and planned to undertake certain production functions, making it unlikely to take another industrial transformation or upgrading for site regeneration; also, the area of green space would be little increased as the existing plant layout and working field can be hardly adjusted, to which vertical greening might become a solution.

The mechanized production of enterprises in Sample Areas 4 and 5 requires fewer workers than others, which means less demands for daily service facilities. At present, the service facilities within the productive construction land (e.g. industrial, logistics, and warehouse land) are mainly retail outlets, and most restaurants, markets, and kiosks are located on the commercial land, which are sufficient for workers’ daily life.

The industrial categories in these optimization-oriented cases are less diverse than those in site-transformation cases. For instance, Sample Area 4 accommodates an industrial cluster dominated by trading services, which supports trade logistics in a wider-range industry chain; Sample Area 5, a cluster of automobile enterprises, accommodates fewer R & D and recycling industries.
研发和回收利用为主导的产业，亟需向循环产业链方向进行探索。用于单一产业集中建设和生产的场地亦需要通过绿地生态效益的提升来改善环境问题。样区四的物流职能致使区域内库房和堆场集中分布，硬质下垫面多，雨洪问题突出，可结合屋顶绿化、植草沟、滞留沟和雨水花园等低影响开发设计，减少径流污染，促进雨水的滞蓄和回收；样区五存在较多容易产生污染的汽车生产企业和部门，在小区域生态系统不足以消除场地污染的情况下，可与区域背景相结合，将场地的生态需求融入到区域生态服务中解决。

从长远来看，拓展单一产业的上下游生产环节、构建循环产业链是工业景观优化和环境再生的根本策略。此类策略已在国际上有较多先例，例如，日本北九州生态工业园由综合环境联合体、试验研究区和循环区三部分组成，其中综合环境联合体由大企业参股设立资源再生企业，对来自全国各地的报废汽车、废旧家电及建筑垃圾等废弃物进行规模化收集和再生处理，最大限度地降低循环成本，最终构建了互补的生态工业链。样区五可借鉴北九州生态工业园的经验，一方面引进汽车研发设计类企业，提高自主创新能力；另一方面引进废弃物回收利用等资源再生企业，与生产研发共同组成完整的产业链。

5 结论与展望

处于工业化转型发展时期的上海工业景观可通过遗产类、转型类和优化类三种环境再生策略进行改造升级。由相应的典型案例分析可知，不同再生类型的工业景观所面临的具体问题存在差别，应采取不同的针对性策略：遗产类的样区一需重点关注遗产利用和生态恢复问题；转型类的样区二和样区三除考虑既往工业用地的污染治理问题外，还需关注服务设施的完善和公共空间的塑造；优化类的样区四和样区五需借助立体绿化提升绿地生态效益，进而改善环境品质。对于具有生产功能、产业转型升级后生产工艺仍会产生废弃物的转型类与优化类案例，均需推进循环产业链的构建，从根本上减少污染，实现节能减排，达成环境、社会和经济的协同发展。

从长远来看，拓展单一产业的上下游生产环节，构建循环产业链是工业景观优化和环境再生的根本策略。此类策略已在国际上有较多先例，例如，日本北九州生态工业园由综合环境联合体、试验研究区和循环区三部分组成，其中综合环境联合体由大企业参股设立资源再生企业，对来自全国各地的报废汽车、废旧家电及建筑垃圾等废弃物进行规模化收集和再生处理，最大限度地降低循环成本，最终构建了互补的生态工业链。样区五可借鉴北九州生态工业园的经验，一方面引进汽车研发设计类企业，提高自主创新能力；另一方面引进废弃物回收利用等资源再生企业，与生产研发共同组成完整的产业链。

Both of them need to develop their own recycling industry chain. The construction and production of such single-industry clusters may also lead to severe environmental problems which can be coped with by the improvement of green spaces’ ecological performances. Specifically, the concentration of warehouses and storage yards in Sample Area 4 brings about the prevailing use of impervious pavements that has caused more frequent flooding events, which could be resolved by Low Impact Development measures, e.g. roof gardens, grass swales, water retention ditches, and rain gardens, to reduce runoff pollution and recycle the stormwater. Sample Area 5 is challenged with pollution caused by automobile manufacturing that is hard to be removed by the onsite ecosystem, which thus should be dealt with by ecological planning means at a larger regional scale.

In the long run, a single industry’s landscape optimization and environmental regeneration would greatly rely on the collaboration between up- and down-stream enterprises and the establishment of recycling industry chain. One of the successful international precedents is the Kitakyushu Eco-Town in Japan, which is composed of an environmental protection joint venture, a pilot R & D area, and a recycling area. The joint venture includes resource recycling enterprises invested by large enterprises and conducts mass collection and reuse of scrap automobiles, home appliances, and construction waste from the whole nation, ultimately helping build an industry chain of symbiotic enterprises with a sound cost-effectiveness. This experience may provide reference for Sample Area 5 to introduce more R & D and resource recycling enterprises dedicated to innovative automobile design and resource recycling business.

5 Conclusion and Prospects

In conclusion, the industrial landscapes of Shanghai in this post-industrial era can be regenerated via heritage revitalization, site transformation, or environmental optimization. Strategies for each type of regeneration should vary on a case-by-case basis: Sample Area 1 needs to prioritize heritage reuse and ecological restoration; Sample Areas 2 and 3 should reinforce the improvement of service facilities and public spaces together with the control and remediation to the existing industrial pollution problem; and Sample Areas 4 and 5 have to enhance the ecological performance of green spaces by introducing vertical greening for an environmental quality improvement. For the cases of transformation- and optimization-oriented regeneration that may continue causing production waste, a recycling industry chain is encouraged to reduce pollution and conserve energy at source and finally realize a synergetic development in environment, society, and economy.
In the future, China’s industrial parks will be geared with suitable strategies to the needs of industrial landscape regeneration for a post-industrial growth with broader environmental benefits. **LAF**

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