Exploring the Prospects and Development of Transforming Petrol Stations into Community Green Spaces

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Abstract. Against the backdrop of global climate change, environmental pollution, and the spread of new energy sources, petrol stations as a potential source of pollution are becoming an important issue in the energy transition. The aim of this paper is to explore the prospects and potential of transforming urban petrol stations into community green spaces. It also explores the possible positive impacts of petrol station transformation in terms of improving the environment and enhancing the quality of life of community residents. The research methodology covered questionnaires and in-depth interviews. The questionnaire drew on the views of community residents from a wide range of ages, occupations, and backgrounds. In-depth face-to-face interviews provide a fuller understanding of residents' expectations and needs. The results of the study show that community residents expect petrol stations to transform into community green spaces and integrate into community life. In addition, it is hoped that the transformed space sites will actively build green infrastructure and promote sustainable community development. A comprehensive analysis of the questionnaire and interview data led to the conclusion that there are challenges and opportunities for the transformation of petrol stations into community green spaces. In the future, it should continue to promote energy transformation and facilitate the transformation of petrol filling stations into community green spaces, so as to jointly enhance the urban environment and the quality of life of community residents. This research provides a useful reference for urban planning and sustainable development, expanding the perspectives and methods of urban green transformation.

Keywords: Energy Transformation; Petrol station; Community Green Space; Quality of life of the community.

1. Introduction

In an increasingly interconnected and rapidly changing global context, climate change, environmental pollution and the need for widespread adoption of renewable energy sources are at the center of global concerns. At the same time, with the signing of the United Nations Sustainable Development Goals (SDGs) and the Paris Climate Change Agreement, the issue of how to effectively improve air quality in urban and neighborhood environments has attracted a great deal of attention [1]. Transport systems of the past have relied heavily on fossil fuels, and petrol stations have long symbolized a dependence on non-renewable energy sources. However, the widespread availability of new energy sources, electric vehicles, and battery development can effectively address the nexus between energy, transport, air quality, climate change, and health [1]. Based on this, petrol stations, as a source of urban environmental pollution, urgently need to face energy transformation and upgrading. This transformation has great potential to address the multilayered challenges facing society at this stage of its development. Against this background, this paper will undertake an in-depth exploration that examines the potential for transforming and upgrading petrol stations into community green spaces. This study used diverse research methods, including qualitative interviews and quantitative surveys. The study aims to bridge the gap between sustainable development, technological innovation, and urban planning. Reveal the views and expectations of the various stakeholders, which cover community residents, vehicle owners, community organizations, and merchants. The interweaving of these different perspectives will contribute to a comprehensive analysis of the feasibility, challenges, and potential for transformation and upgrading of petrol stations. Ultimately, building resilient and liveable neighborhoods through sustainable design and planning opens up new and sustainable paths for urban development [2].

2. Transformation of Petrol Stations

2.1. Climate Change and Environmental Pollution

Reduced air quality due to climate change and environmental pollution problems caused by the traditional energy sector have far-reaching impacts on daily life [1]. Global climate change has led to a high incidence of extreme weather events, and cities and neighborhoods are facing increasing risks from natural hazards [3].

At the same time, environmental pollution has seriously affected people's health and quality of life. Millions of people currently die each year from cardiovascular disease due to climate change and changing patterns of weather conditions, with air pollutants accumulating incrementally each year [4]. Such health problems are exacerbated as a direct result of air pollution. Pollution also affects the aesthetics and livability of cities and reduces people's satisfaction with urban life. In addition, environmental pollution has a negative impact on ecosystems, disrupting ecological balance and threatening biodiversity and ecological stability.

Positive environmental measures are therefore imperative in order to safeguard the health and safety of urban residents, improve the quality of the urban environment, and meet the challenges of climate change. Strengthening the energy transition, reducing greenhouse gas emissions, and promoting sustainable lifestyles are all aimed at building greener, cleaner, and more liveable cities and communities, and realizing a harmonious coexistence between human beings and nature.

2.2. Impact of New Energy Penetration and Emission Reduction Targets on the Energy Sector



Fig. 1. The energy sector landscape is changing.

The spread of new energy sources and emission reduction targets have had a profound impact on the energy sector. As awareness of climate change and environmental protection increases globally, more and more countries and regions are increasing their efforts to limit and reduce carbon emissions. This has had a huge impact and challenge on the traditional energy industry.

As Figure 1 shows, the traditional fossil fuel supply chain is subject to competition from cleaner energy sources, forcing the energy industry to shift to more environmentally friendly and sustainable methods of energy production. Innovative concepts such as renewable energy and electric vehicles are changing the landscape of the energy industry [1]. This has not only prompted the energy sector to change its development strategies but has also spawned new business models and opportunities, such as photovoltaic and wind power generation.

Meanwhile, to realize the Paris Climate Change Agreement as soon as possible, countries have set targets to reduce greenhouse gas emissions and are committed to reducing greenhouse gas emissions and improving air quality [1]. This has prompted the energy sector to adopt more stringent environmental protection measures to reduce the emission of pollutants and promote the wider application of clean energy in order to meet the emission reduction targets. This has also prompted the energy industry to accelerate the pace of innovation and introduce more efficient and low-carbon energy technologies to meet the needs of the market and society.

However, energy transition and environmental sustainability do not happen overnight, new energy penetration and emission reduction targets do have a positive impact on the energy industry, promoting its transformation and upgrading, and prompting it to develop in a greener and more

sustainable direction [5]. But there is no global solution yet and countries are trying to reduce the risk of environmental pollution and climate change by adopting corresponding strategies [5].

2.2.1. Environmental pollution situation and urban heat island effect issues

As a first-tier city in China, Shanghai inevitably faces problems such as environmental pollution and the urban heat island effect, which makes the renovation of petrol stations particularly urgent and important. Environmental pollution has a significant impact on a city like Shanghai. Air pollution is a serious problem, with high concentrations of atmospheric pollutants such as particulate matter, sulfur dioxide, and nitrogen oxides, posing a potential threat to the health of citizens. With long-term exposure to pollution, people may face health risks such as respiratory diseases and cardiovascular diseases. In addition, environmental pollution has caused damage to urban ecosystems, affecting the growth of vegetation and the quality of water bodies, leading to the disruption of the ecological balance.

At the same time, the problem of Shanghai's urban heat island effect cannot be ignored. The urban heat island effect refers to the phenomenon of higher temperatures in urban areas relative to surrounding rural areas. Due to large population concentrations, dense buildings, and traffic emissions, heat build-up in cities leads to higher temperatures, affecting the comfort and ecology of the city. Against this background, petrol stations, as energy facilities in cities, need to adapt to new environmental challenges and promote sustainable urban development.

2.2.2. The need for petrol station transformation

Rapid urban development has forced sustainable urban planners to reconsider important measures that need to ensure balance by renewing and partially re-establishing human interaction with ecosystem services [6]. In today's context of increasing concern for environmental protection and sustainable development, petrol stations, as a major source of energy consumption and environmental pollution, and in conjunction with Shanghai's environmental pollution situation and the urban heat island effect, it is not difficult to realize the urgent necessity of petrol stations as a potential object of renovation.

By transforming petrol stations into community green spaces, such as pocket parks, community gardens, or small green squares, heat can be absorbed, and air purified, and a more pleasant ecological environment is created for the city. In addition, urban development requires more multi-purpose community spaces, and petrol stations, which are often geographically located on major urban transport routes, have the potential to become centers of community life. Big data research shows that there is a growing demand for community facilities and green spaces for people who want more places to relax and socialize. By transforming petrol stations into integrated community centers, the diversified needs of residents can be met and the overall quality of life in the community can be enhanced. Such a transformation will not only help to improve the quality of life for residents but is also in line with Shanghai's strategic goal of sustainable development.

3. Research and Data Collection

3.1. Design and Use of Questionnaires and Interviews

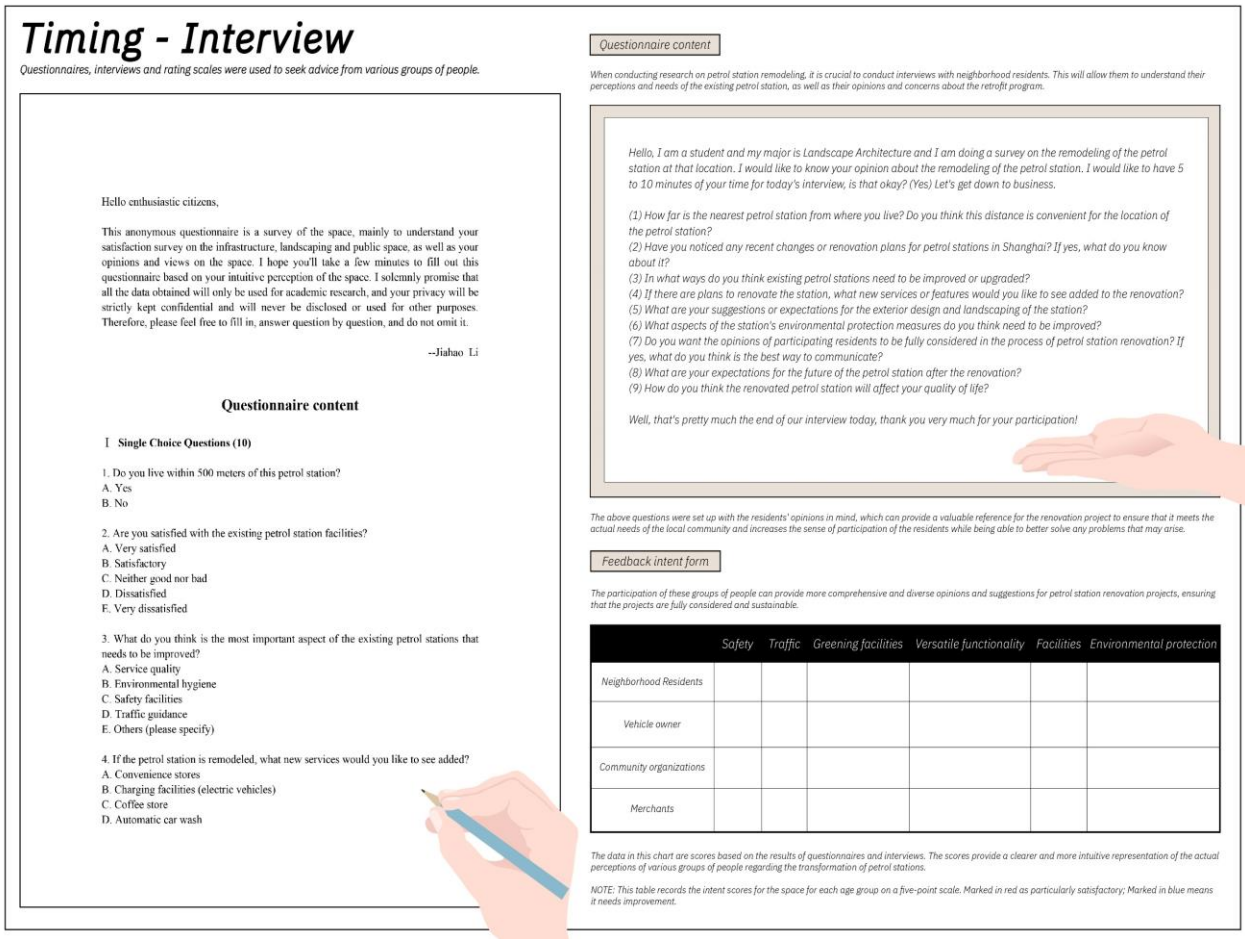


Fig. 2. Questionnaire content and interview outline.

As shown in Figure 2, the questionnaire and interview outline provide a comprehensive understanding of the motivations and impacts of petrol station transformation around both quantitative and qualitative dimensions. Healthy living environments require organizations from different policy areas as well as individuals to participate in building those [7]. By organically combining the two methods of questionnaires and interviews, the expectations of community residents and stakeholders are taken into account to provide a more targeted and practical design solution for the transformation of petrol stations.

The questionnaire was used as a quantitative research tool to collect views and opinions from a wide range of community residents, vehicle owners, environmental organizations, and traders. The questionnaire questions were carefully designed to cover a wide range of aspects such as the role of petrol stations in community life, environmental needs, and expectations of green facilities. By analyzing the data recovered from the questionnaires, it is possible to understand the views of different groups of people on the renovation of petrol stations, so that the needs and expectations of the community can be better grasped. This helps to integrate the views of more stakeholders in the design process and ensure that the transformation program is closer to the reality of the community.

On the other hand, interviews, as a qualitative research method, aim to dig deeper into the intrinsic motivations and potential challenges of petrol station transformation. Face-to-face interaction with community members and petrol station staff provided opportunities for in-depth interviews. By listening to their experiences, perspectives, and suggestions, it was possible to gain a deeper understanding of the petrol station's place in the community and the expectations of residents in terms of green transformation and functional expansion. The results of these interviews provided richer

contextual information for the development of the retrofit program and helped guide design decisions more specifically.

3.2. Sources and Credibility of Research Data

The sources of data for the study included two main methods, questionnaires and interviews, and rigorous methods of data collection and processing were used to ensure the credibility as well as reliability of the data. These data not only represent the results of quantitative and qualitative research but also reflect the true picture of the needs and expectations of community residents.

Firstly, the questionnaire was designed and distributed to cover a wide range of community residents, including people of different ages, occupations, and backgrounds, ensuring a diversity of perspectives. Methods such as random sampling and targeted sampling were used to ensure the representativeness and reliability of the sample. The questions set within the questionnaire are clear and concise to avoid misunderstanding and bias, thus increasing the credibility of the data.

Second, in-depth interviews increased face-to-face interaction with community members. This qualitative approach to research enables a deeper understanding of residents' ideas and needs and access to more specific and detailed information. Adoption of open-ended questions to encourage residents to express themselves freely so as to obtain authentic and reliable data.

3.3. Summarise the Results of the Questionnaires and Interviews

The results of the questionnaire showed that the majority of residents were supportive of the petrol station conversion. They generally agreed that petrol stations should not only be a place to provide fuel but should also provide more functions and services to the community. Several residents mentioned that they hoped that the renovated petrol station could be equipped with more green facilities, leisure space, or even a small venue for community activities. In addition, many people also stressed the importance of safety and hoped that the retrofitted petrol stations would pay more attention to the design of traffic flow and pavements to ensure the safety of pedestrians and vehicles.

During the course of the interviews, further insights into residents' perspectives were gained. Some residents mentioned that they expected the renovated petrol station to integrate with the community and become part of residents' daily lives. There was also mention of a desire for petrol stations to have community libraries, fitness areas, and even community farm gardens to cater to all age groups. In addition, many people stressed the importance of environmental protection and hoped that petrol stations could be retrofitted with renewable energy to reduce the impact on the environment.

3.4. Perceptions and Suggestions for Green Space Transformation

	Safety	Traffic	Greening facilities	Versatile functionality	Facilities	Environmental protection
Neighborhood Residents	3	5	3	3	3	3
Vehicle owner	4	5	3	3	4	3
Community organizations	3	4	3	3	4	3
Merchants	4	4	3	3	4	4

The data in this chart are scores based on the results of questionnaires and interviews. The scores provide a clearer and more intuitive representation of the actual perceptions of various groups of people regarding the transformation of petrol stations.

NOTE: This table records the intent scores for the space for each age group on a five-point scale. Marked in red as particularly satisfactory; Marked in blue means it needs improvement.

Fig. 3. Results of questionnaires and interviews.

Figure 3 shows the results collated from the combined analysis of the questionnaires and interviews. From Figure 3, it can be seen that: the opinions and suggestions of various groups of people on petrol station renovation plans mainly focus on increasing green facilities, providing diversified functions and services, and focusing on safety and environmental protection. These comments and suggestions have provided important inputs to design proposals, ensuring that can better meet the needs of the community and achieve goal of transforming the petrol station into a community green space.

4. Prospects for the Transformation of Petrol Stations

4.1. Analysis of Past Successful Design Cases of Petrol Station Conversion

A striking example is PetroChina Station No. 1 near Suzhou Creek in Shanghai, once a historic state-owned petrol station. Its initial layout lacked transparency and efficient traffic flow, limiting its development potential. The regeneration of the petrol station has transcended these constraints, reimagining its use and allowing it to evolve into a vibrant public space that reconciles contemporary needs with historical resonance. This transformation has set an example for the transformation of petrol stations around the world.

Another fascinating example is the ‘Cineroleum’ project, which cleverly reinvented a disused London petrol station into a cinema haven. The project demonstrates imaginative repurposing to energize neglected urban spaces.

Transformed into public spaces, these success stories have not only beautified the urban environment but also positively impacted the community. They create more opportunities for social interaction in the community, provide places for leisure and recreation, and promote interaction and communication among community residents. Taken together, the successful transformation of these cases into public spaces not only brings a blend of greenery and culture to the urban environment but also creates a better living experience for community residents. These positive impacts fully demonstrate the importance of the transformation of petrol stations into public spaces for cities and communities, and provide useful insights for future urban planning and development.

4.2. Explore the Potential Transformation of Petrol Stations into Community Green Spaces

4.2.1. Emphasis on environmental friendliness and green eco-building



Fig. 4. Perspectives on the transformation of petrol stations into community green spaces.

As shown in Figure 4, environmental friendliness and green eco-building will be key elements in the prospect of transforming petrol stations into community green spaces. Small urban green spaces are more environmentally friendly and sustainable compared to the original petrol stations. These small green spaces can help each community to mitigate environmental problems in the area such as urban heat islands and heat waves [8]. At the same time, this will promote sustainable urban development and create a more livable urban environment for the future.

4.2.2. Explore innovative community green space functions and benefit-sharing mechanisms



Fig. 5. Green markets.

The first innovative feature worth exploring is the Green Bazaar, as shown in Figure 5. The petrol station can be converted into a regular green market, providing a platform for community residents to network, trade, and share. There can be stalls with organic produce, handicrafts, local specialties, and more. This design aims to create a framework for a shared residential landscape under the concept of urban commons, which will benefit the residents within this neighborhood by encouraging and inspiring them to engage in collective action, as well as contributing to local economic development [9].



Fig. 6. Community farm gardens.

In addition, the community farm garden included in Figure 6 is a potential strategic community engagement innovation project [10]. Through community planting activities around petrol stations, residents can participate in planting in collaboration with community partners to experience the beauty of nature up close and build an active lifestyle [10]. This not only meets the residents' demand for fresh ingredients but also helps to improve the community's green resources and social environment [10].

5. Conclusion

In summary, this paper provides a comprehensive discussion of the prospects and development of petrol stations' transition to community green spaces. The strong link between urban development and environmental protection has become a global concern, and petrol stations, as an integral element of cities, have great potential for transformation into community green spaces. This paper provides an in-depth analysis of all aspects of this transformation process, looking at the needs and expectations of community residents and incorporating an interdisciplinary approach to provide strong support and guidance for petrol station transformation.

The transition of petrol stations to community green spaces has had a positive impact in terms of improving the environment and the lives of people in the community. The positive impact of this

transformation on the community was also confirmed in combination with the positive expectations of the community for the transformation of the petrol station as shown through the questionnaire and interview data. By introducing environmentally friendly equipment and green infrastructure, the transformed petrol stations will not only reduce environmental pollution but also create a healthier and more livable living environment for the community.

In order to further advance the energy transition and facilitate the realization of petrol stations to community green spaces, this paper recommends proactive policy measures and support from the government and relevant stakeholders. On the energy front, petrol stations are encouraged to adopt renewable energy to reduce carbon emissions and to achieve the objectives of environmental protection and sustainable development. In addition, enhanced community involvement and awareness-raising will help increase the understanding and support of community residents in the transformation of petrol stations. The establishment of an interdisciplinary cooperation platform to facilitate exchanges in the fields of design, environmental protection, and urban planning will help accelerate the transformation process.

The direction of development involved in the transformation of petrol stations into community green spaces contains both challenging elements and opportunities. In future practice, there is a need for sustained efforts to promote energy transformation to further facilitate the change from petrol stations to community green spaces, thereby jointly contributing to the improvement of the urban environment and the quality of life of community residents.

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