Analysis and Research on Design Sample of Urban Mobile Toilet

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Abstract. Based on the questionnaire survey of mobile toilet users, this paper designed the four different samples of urban mobile toilets according to the research results, which are ecological limo mobile toilet, modular mobile toilet, container-type mobile toilet and 3D printing mobile toilet. Four design features of mobile toilets, such as flexibility and mobility, technological advancement, humanistic care and ecological protection, are summarized theoretically. The current mobile toilet design are also to meet the needs of The Times development, and facilitate green travel, also promote the development of urban civilization, and provide effective reference for the construction of urban sanitation industry.

1. Introduction
Urban mobile public toilets get their name from their mobility, and their advantages are obvious as opposed to the traditional fixed toilets. The mobile public toilets are light in shape and structure, and can be freely matched with colors, and are applicable to tourist attractions, commercial streets, stations, docks, city squares, large construction sites and other public places with dense population. [1]

We have investigated the service condition of the mobile toilet in Wuchang district, Wuhan city, Hubei province from Nov. to Dec. in 2018, made field survey the mobile toilet of Dutch Garden, Optical Valley walking street, Wuchang railway station, then did the questionnaire survey from 200 respondents selected, analyzed data to obtain the usage and satisfaction of using mobile toilets of different users, and the specific research results are shown in Fig. 1.

![Fig.1 Analysis of the users’ usage and satisfaction ratio](image)

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From the above figure shows that mobile toilets are generally accepted by users, it needs to be enhanced.

Due to the poor appearance, lack of humanization design; not very mobility, weak environmental protection and energy saving; lack of dedicated maintenance, poor sanitation, the utilization rate of mobile toilets is low. Since the data in Fig. 1 is from Wuchang district, one of the three towns in Wuhan, it can reflect the development status of mobile toilets in Wuhan and even in the midlands from the point to the surface.

In view of the survey on the user experience status above, a large number of urban mobile toilet improvement design studies have been carried out in this paper, which can be mainly divided into ecological limo mobile toilet, modular mobile toilet, container-type mobile toilet and 3D printing mobile toilet. The specific design cases are discussed below.

2. Design sample analysis of mobile toilet

2.1 Design scheme of the ecological limo mobile toilet

The ecological limo mobile is a trailer-type mobile toilet. The whole toilet is pulled by external forces and moved to the public area where there is a great demand. Due to its strong mobility, high utilization rate of compartment space, and meeting the needs of multiple users, the ecological limo mobile has gradually become the focus of social attention.

The ecological limo mobile is composed of three parts: a powerful pickup truck, a mobile toilet of the main vehicle body, and a waste recovery vehicle. It provides toilet services mainly for the elderly, the sick, pregnant, infants and other vulnerable groups, but also takes into account the toilet needs of normal people. The design idea comes from the RV transformation. At present, our automobile culture has been popularized by the public, and the emerging RV life will be more and more in the future. Therefore, the transformation of RV into mobile toilet will provide help for more people, also could beautify the home environment, and enhance the comprehensive competitiveness of China's cities. [2]

The design innovation of the ecological limo mobile is mainly reflected in that it solve the problem of no outdoor sewer and discharges of excreta and other pollutants relying on the septic tank of the main vehicle body and the rear hanging waste recovery vehicle. And it solve the problem of water shortage or lack of water relying on the 1.5 ton storage tank of the main vehicle body; Also, it solve the power supply problem relying on 12 solar panels and a charging box of the main vehicle body. Public toilets converted from RV can adapt to seasonal tourism activities and mobility problems. And more, the ventilation facilities on the roof of the ecological limo mobile provides clear outdoor air. The framework of the ecological limo mobile is seen in Fig.2.

![Fig.2 The framework of the ecological limo mobile](image)
2.2 Design scheme of the modular mobile toilet
The modular mobile toilet adopts movable board room model and steel frame structure, which can meet the requirements of rapid disassembly and assembly. Meanwhile, it is connected to the underground special septic tank, which can be connected to the municipal sewage system and will not cause pollution to the urban environment.

The modular mobile toilet is a square shape, and the degree of the fittings assemble are high and they are high quality and durable. The outside of the toilet is designed with metal card slot, which is convenient for quick assembly and installation. At the same time, the modular plates are made of environment-friendly materials, which are suitable for mass production and also economical and practical. The modular mobile toilets can be divided into the single toilets, the third rest room, sanitary staff management room and other functional spaces.

The modular mobile toilet could be used individually or in multiple combinations with the change of population flow, but also free combination with the terrain site change, such as monomer form, rows form, small combination form, medium combination form, large combination form. Through preliminary user experience research, this case tries to meet the toilet needs of different users, different time periods and different regions.

The design innovation of the modular mobile toilet is mainly reflected in modular and humanization design applying in the mobile toilet. By using the modularity concept, it does the design innovation on the basis of the traditional mobile public toilet, not only is simple assembly easy, but also achieves the diversification of service functions. In terms of humanization design, the third rest room is constructed to provide convenience for the vulnerable groups. Sanitary staff management room is set up to provide office space for toilet managers, as shown in Fig. 3.

2.3 Design scheme of the container-type mobile toilet
The container-type mobile toilet has appearance design of novel and beautiful, covers small floor space and is flexible movement. Through the research results analysis of the previous user experience, two container toilets for men and women are designed, with the specific size of 6 meters in length, 2.4 meters in width and 2.6 meters in height, and the two toilets are of the same size. In the men’s rest room, there are 4 squatting rooms, 3 urinals and 1 open hand washing room. There are 5 squatting rooms and 1 internal hand washing room.\(^3\)

The container-type mobile toilet has the advantages of good seal, waterproofness and no environmental pollution. Secondly, the container toilet is welded steel structure, and the toilet frame
meets the mobile demand. Thirdly, the steel material of the green fiberglass on the toilet surface has good acid resistance, alkali resistance, salt fog resistance, suitable for the use in the humid, corrosive environment. Fourthly, the container-type toilet is suitable for the formalization, batch, standardized production.

The design innovation of the container-type mobile toilet is mainly reflected in the environmental protection concept of turning waste into treasure and the transformation and reuse of waste materials. The container-type mobile toilet is suitable for use in tourist attractions, commercial streets, living squares and other areas, as shown in Fig.4.

![Fig.4 Male and female containerized toilet renderings](image)

2.4 Design scheme of the 3D printing mobile toilet
Most parts of the 3D printing mobile toilet are 3D-printed and assembled modularly through computer, which is giving a memorable experience. Its interior space is bright and clean and capacious, with a fashionable geometric modeling. While the yellow and black color of the outside of the toilet gives people a strong sense of technology. At the same time, the parts of the 3D printing mobile toilet can lengthen service life, enhance the flexibility and convenience of the toilet. The rendering has been made by Shanghai Huajie environmental equipment manufacturing co. as shown in Fig. 5.

![Fig.5 The 3D printing mobile toilet built by Shanghai Huajie environmental equipment manufacturing co., LTD](image)

3. Design features of the mobile toilet
The image of a city is not only based on the architectural appearance like a skyscraper, nor only based on the gorgeous and beautiful urban scenery. These are much important, but the more important than these are whether the residents living in the city are happy, so the perfect public environmental service
facilities are exactly what they want. The appropriate increase of urban mobile toilets can not only alleviate the problem of going to WC, but also leave a good impression on the public, which is an important embodiment of improving the soft power of the city. Through the analysis of the above four design cases of mobile toilets, the design features of mobile toilets are concluded theoretically, which will help people to carry out the design and construction of mobile toilets in the future, and also contribute to the progress of urban civilization.

3.1 Flexibility and mobility
Compared with traditional public toilets, the most important feature of urban mobile toilets is their flexibility and mobility, which is also its design feature. Traditional public toilets are usually fixed, it requires fixed site selection, structural form, building materials, construction technology, etc., and requires a longer construction time and higher construction costs, which are in danger of being demolished within a few years because the speed of urban planning not is as fast as that of urban development. \[4\]

The mobile toilet is a good solution. At present, the mobile toilets are mainly divided into three structural forms, namely, trailer-type, handling-type and hoisting-type. The trailer-type mobile toilets are pulled by external forces and moved to public areas where demand is high. Due to their strong mobility, high utilization of compartment space and meeting the needs of multiple users, they have gradually become the focus of social attention. For example, the design case of the ecological limo mobile toilet is the representative. The structure of the handling-type mobile toilet is concise, and its material is lightweight, suit to carry, can combine freely according to the size of population flow, and its installation time is short, can rebuild by the mobile houses commonly, for example, the modular mobile toilet design is a representative. The hoisting-type mobile toilets generally have a small area and fewer toilet seats, but they can be loaded and hoisted by the trolley. Compared with fixed public toilets, which are limited by landforms, the hoisting-type toilets can be moved as a whole to reduce the losses caused by urban planning and construction. For example, the case of the container toilet design is the representative. All these embody the flexibility of the mobile toilet design.

3.2 Technological advancement
By using the modularity concept, it does the design innovation on the basis of the traditional mobile public toilet, not only is simple assembly easy, but also achieves the diversification of service functions.

For example, the 3D printing toilet design case is built by recycling construction waste with using computer digital technology, which is full of a sense of technology and art, making people unforgettable. Another example is the modular mobile toilet design case, which uses high-precision modules to produce various types of mobile toilets with different functions to meet the needs of different regions. At the same time, the developed countries in the world also have many advanced cases of mobile toilet design, such as the lifting mobile toilet in England, is command through the remote control technology, the toilet is like a sewer manhole cover in daytime, the whole toilet rises from the underground at night, for people to go to the toilet. In the United States, for example, Internet ride-hailing services offer mobile toilets, the users can request toilet services by leaving messages on the Internet. Although the area of mobile toilet is small, the mobile toilet is the height concentration of nation strength of science and technology and economy.

3.3 Humanistic care
The quality of life of modern people continues to improve, the mobile toilet not only meets the toilet needs of ordinary men and women, but also need pay attention to the needs of vulnerable groups such as the elderly, sick, disabled, pregnant and young. For example, the design cases of the ecological limo mobile toilet and the modular mobile toilets all consider the toilet needs of vulnerable groups, and set up the third rest room, mothers-and-child room, barrier-free urinals, barrier-free hand washing sink, barrier-free path, barrier-free handrail and other health facilities. City mobile toilet can be said to be
"sparrow is small, five internal organs are complete", which is a important representative of nation development strength of science and technology, economic.In the mobile toilet, the development of humanistic care design is the concentrated embodiment of material civilization and spiritual civilization, is an important symbol of social progress, and also has important social significance to improve people's personal quality, cultivate the public moral consciousness and promote the construction of spiritual civilization.

### 3.4 Ecological protection

The design features of the ecological protection of the urban mobile toilets are mainly reflected in the following aspects: using solar panels to collect energy for self-sufficiency; recycling water resources to conserve water; mobile vehicles do not occupy land resources; container structure with good sealing, do not pollute the environment; modular plates suitable for mass production, reduce economic costs; waste collection box is suitable for recovering feces and purifying feces; computer digital printing technology with energy saving and high efficiency. [5] At present, people's living environment is being constantly challenged. The mass all need to establish the concept of ecological protection, and the design of the mobile toilet more should be ecological protection. For example, the design cases of the ecological limo mobile toilet, modular mobile toilet, container-type toilet, and 3D printing toilet are all examples.

### 4. Conclusion

At present, for solving the problem of going to WC, many areas often build new or rebuilt toilets, re-planning, or even spend a huge amount of money to build luxurious toilets, which waste a lot of social resources at the same time, but also fail to effectively solve the problems of people's livelihood. As an important part of urban public facilities, the mobile toilets should be vigorously promoted. From the perspective of user experience, this paper discusses four new design cases of mobile toilets, hoping to provide effective reference to the sanitation industry. Today, the public do not need luxurious public toilets, but only need to increase the design and development of the mobile toilets when necessary, so as to meet people's needs and also improve the image of urban civilization.

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