Study on the Reuse of Abandoned Shared Bicycle Materials

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Abstract. The abandoned shared bicycle materials was redesigned and reused to manufacture fitness bikes, in basis of the analysis of its function and structure, to boost its recyclability. This work was referred from the mature re-manufacturing technology. The structure and dimensions including lever length, seat height and crank length of fitness bike were analyzed using ergonomics method.

Key Words: Shared Bicycle; Recycling; Fitness bike.

1. Introduction
Mobile internet technology has built a platform for the development of Shared Bicycle because of the users of Shared Bicycle have experienced explosive growth. Unfortunately,in operation appeared the phenomenon of "bicycle cemetery" in cities, which caused waste of resources and environmental pollution. Recycling system is immature, such as low recycling price resulting in recycling barriers. At present, most of the existing researches are about sharing economic and piled public bicycle system [1, 2]. It ignores the importance of recycling whereas how to effectively recycle Shared Bicycle has become an urgent problem. The way of re-manufacturing in Germany is useful for the redesign of Shared Bicycles. whereas how to effectively recycle Shared Bicycle has become an urgent problem. The components of the Shared Bicycle were split and the relevant specific dimensions were determined under the premise of ergonomics. An exercise bike was redesigned through the 3Dmax expression.

2. Shared Bicycle recycling method
German Automobile Recycling Experimental Center classifies used cars. Determine the best dismantling step. After inspection, parts with separate scrap levels will be refurbished and refurbished, improve the recycling rate of components to 95% [4]. There are certain similarities between the recycling of Shared Bicycle and cars. Based on the operation flow chart of the dismantling of ALBA vehicles in Berlin, this paper discusses recycling and utilization of Shared Bicycle. During the disassembly process, the fixing device is first removed. The reusable components are removed, and the basic components are finally removed. Considering the principle of minimum energy consumption, the types of materials should be cut in the development and recycling design, so that parts can be easily dismantled and maintained, and energy consumption can be reduced in the life cycle. Therefore, the raw materials of the fitness bike design mostly follow the Shared Bicycle parts.
3. Shared Bicycle function structure

The Shared Bicycle has 25 parts, including a frame, tires and chain. Depending on the working characteristics of each component, its structure can be roughly divided into guiding system, driving system and braking system [3]. (1) Guide system: Composed of handlebars, front fork, front wheel and other components. The handlebars have a different texture and are made of rubber; the upper end of the front fork is connected with the handlebar component and the lower end is connected with the front axle component; the front tires are 26 inches, and the tires are butyl rubber inner tubes. (2) Drive systems: Composed of pedal, chain, flywheel and other components. The pedal assembly is mounted on the left and right crank on the axle assembly to convert flat power into power; adopt a chain drive, turn the crank, the middle shaft and the chain flywheel of the pedal force to make the rear wheel rotation. (3) Brake systems: Composed of brake parts. OFO Shared Bicycle mainly adopts wire-pull disc brake, through the tension of the wire, drive the brake pad in the calipers to rub against the disc. This sets up a braking effect.

![Figure 1. OFO Shared Bicycle explosion map.](image)

4. Results and analysis

Fitness bike movement way: The pedal drive sprocket is driven by the chain to the left wheel and then to the right wheel, and then finally transmitted to the seat through the crank rocker mechanism. The fitness bike is elevated, and the front wheel axles are on the same horizontal line as the rocker bracket fulcrums, which together form a crank rocker mechanism. The fitness bike is elevated, and the front wheel axles are on the same horizontal line as the rocker bracket fulcrums, which together form a crank rocker mechanism. The child seat is fixed by riveting and rocker bar. The rocker bar is fixed on the bracket by two bearings, which can freely go up and down. The connecting rod is inserted into the rocker and driven up and down by the connecting rod under the action of the crank of the opposite wheel. The child seat follows the seat of Shared Bicycle. From the perspective of safety, the handle is adjusted to fit the grasp size of children, and the front pedal of children's seat following the stents of Shared Bicycle. The front fork of Shared Bicycle is employed to supporting parts on both sides of connecting rod. The body adopts a single front fork to facilitate the circular motion of the wheel. Draw the fitness bike in 3Dmax software, like this is shown in Fig.2. The feasibility of seesaw function is illustrated by selecting four state comparison diagrams. When the wheel drives the connecting rod to turn, showing the rising state, the seat under the lever principle and the gravity action, the seat will show the downward trend. Similarly, when the state is falling, the seat will rise.
A. Connecting rod with wheel nadir state.  
B. Connecting rod with wheel peak state.  
C. Connecting rod with wheel closest point state.  
D. Connecting rod with wheel farthest point state.  

Figure 2. General structure of exercise bike.  

4.1. Size Specification  
According to the size analysis of OFO Shared Bicycle, the optimal length range of connecting rod of fitness bike is studied. Among them, the value range of the seat height and the position relationship between the three nodes are very important for comfort, and the reason crank length is also an important site of the fitness bike.
4.1.1. Lever length. In order to ensure the safety of mechanism movement, the preset Angle of theta is 30°, and the motion Angle of the seat is 60°. Tire size of the 2.0 version OFO Shared Bicycle is 26 inches, while the diameter of JK is 640mm and the radius of DO is 320mm. HK is 200mm above ground height of fitness bike. According to figure 3, JK=EF, so JG=GE. The minimum length of the lever is GC=CO+OG=320+\frac{320}{\tan\theta}≈874mm, the longest length of the lever is JI=GJ+GI=\frac{320}{\sin\theta}+\frac{320+200}{\sin\theta}≈1680mm. Therefore, the value range of the lever is between 874mm~1680mm, take the intermediate range is 1200mm.

4.1.2. Location of three nodes. Three points is handlebars, seat, pedal. The relative position between the handlebar and the seat determines the rider's upper body position, and the height of the handlebar is too high or too low to cause discomfort. The position of the seat relative to the axis of the central axis is a key to determine whether the muscle strength of the lower limb muscles can be effectively utilized [5]. Under the guidance of ergonomics theory, men's P95 and women's P5 are used as valves to adjust the key size of the fitness bike according to the actual situation. The size data [6] involved are shown in Table 1.

Table 1. Body size of fitness bike. (Unit: mm)

| Measuring project              | Male P95 | Women P5 | Measuring project              | Male P95 | Women P5 |
|--------------------------------|----------|----------|--------------------------------|----------|----------|
| Height                         | 1775     | 184      | Sit two elbows and shoulders wide | 489      | 378      |
| Leg add foot                   | 448      | 342      | Body foot wide                  | 105      | 80       |
| Thick chest                    | 245      | 170      | Shoulder breadth                | 403      | 320      |
| Thigh length                   | 505      | 402      | Hip width                       | 334      | 290      |
| Standing shoulder height       | 1455     | 1195     | Sitting elbow height            | 1096     | 899      |
| Standing position cubits high  | 1096     | 899      | Sitting thigh thick             | 151      | 113      |
| Upper limb length              | 569      | 455      | lower limb length               | 1063     | 851      |

The optimal operating height of the upper limbs is 76mm lower than the elbow and is self-binding [7]. Handlebar height should be less than P5 women's elbow height, assuming that the average sole thickness is 25mm. The height range of handlebars is 899-76+25mm<h<1195-25mm, 848 mm≤h≤1170mm, take an intermediate range 1000mm; seat height shall meet the minimum percentile woman's template, h seat = calf height + thigh length + sole correction = 342+402+25=769mm, take 770 mm; the distance between handlebars and seats should take into account the arm length and design margin of the maximum percentile male and the minimum percentile female, the maximum value is...
upper arm + forearm length = 455mm, the minimum value is 245 + 18 = 263mm, 263mm ≤ h ≤ 455mm, take an intermediate range 360mm.

4.1.3. Crank length. Now the common way to determine the length of the crank is to take 1/10 of the height [8]. According to the human body template, the average height of Chinese adults is about 1700mm. Therefore, the length of the crank is about 170mm.

5. Conclusion
The abandoned OFO Shared Bicycle the form of motion of the bicycle and the seesaw combined by the crank rocker mechanism. The Shared Bicycle after the full service period is recycled, dismantled and reused. Through the man-machine size analysis of fitness bike, the length of the lever is 1200mm, the height of handlebar is 1000mm, the height of seat is 770mm, the distance between handlebar and seat is 360mm, and the length of crank is 170mm. In addition, the author of the fitness bike size design is still in a preliminary exploration, to deeper research, but also needs to carry out ergonomic experiments.

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