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A Design Case Study for the Development of Water Dispenser for Pets Based on User-Centered Design

Focused on the Pet Industry in China

사용자 중심 디자인에 의한 반려동물용 급수기 개발에 관한 디자인 사례 연구

중국 반려동물 산업을 중심으로

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Abstract

The pet market in China is growing rapidly, and the trend of sophisticated pet care is obvious. This trend has given rise to multiple market segments in the pet consumer market, among which water dispenser for pets have become an important product. Chinese pet brands have serious concerns on the water quality, but user research shows users are still concerned about the high number of micro-organisms and bacteria that may be present in the water. This study adopts an integrated design approach, user-centered design, combining research on users and markets. The market research mainly analyzes the global trends and development of the market of water dispenser for pets, as well as the improvements and innovations in water quality of well-known domestic and foreign brands. User research collects Chinese pet owners' needs and concerns about pet water dispensers through questionnaires and interviews. Based on the results of market research and user research, combined with market trends and user behavior analysis, we proposed a smart water dispenser with a purified sewage separation system. Water contaminated by pets will be discharged into the waste water tank, ensuring that pets always have access to pure water. The design methodology proposed in this study can help designers respond to changing user needs and contribute to the continued growth of China's pet water dispenser market.

Keyword

Pet Water Dispenser(반려동물 급수기), User Research(사용자 리서치), User-Centered Design(사용자 중심 디자인)

요약

중국의 반려동물 시장은 급속하게 성장하고 있으며 이에 따라 반려동물을 위한 다양하고 세심한 관리를 더욱 필요로 하고 있다. 이러한 추세는 반려동물 소비시장을 여러 분야의 세그먼트로 나누어지게 하였으며 그 중에서도 반려동물 급수기는 중요한 제품 군으로 떠오르고 있다. 다양한 반려동물 급수기 브랜드들은 급수기 자체의 수질을 개선하기 위한 다양한 조치를 취해왔지만 사용자 조사결과 대부분의 사용자들은 여전히 물속에서 존재할 수 있는 미생물과 박테리아에 대해 우려를 하고 있는 것으로 나타났다. 본 연구에서는 사용자와 시장에 대한 연구를 결합한 통합 디자인 접근 방식으로 사용자 중심 디자인을 채택하였다. 시장조사는 주로 반려동물 급수기 시장의 세계적인 트렌드와 변화, 국내외 유명브랜드의 급수기 수질개선에 대한 노력과 혁신을 분석하였고 사용자 연구 자료는 반려동물 급수기에 대한 중국 반려동물 보호자들의 니즈와 불만사항에 대해 설문조사와 인터뷰를 통해 수집하였다. 시장조사와 사용자 연구결과를 기반으로 한 시장동향 및 사용자 행동분석을 결합하여 최종적으로 반려동물이 항상 정화된 물을 음용 할 수 있도록 급수장치에 폐수정화 시스템을 갖춘 스마트 급수기를 제안하였다. 본 연구에 적용된 급수기 개발을 위한 디자인 방법론은 디자이너가 변화하는 사용자 니즈와 트렌드에 대응하는 방법과 방향을 제시하며 개발된 제품은 반려동물 급수기 시장의 지속적인 성장에 기여 할 것으로 본다.

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1. Introduction

1-1. Research Background and Objectives

The pet market in China has been expanding significantly, with a growing trend towards sophisticated pet care[1]. There has been an increase in the segmentation of pet consumption categories, and smart water dispensers have become highly sought-after products in the Chinese pet market. Many pet product brands in China have made extensive efforts and attempts to improve water quality, such as continuously enhancing the effectiveness of water dispenser filters, and some brands have even incorporated filters with filtration capabilities comparable to those used for human consumption. However, research conducted on users has revealed that although filtered water may appear clear, many users still express concerns about the presence of numerous invisible microorganisms and bacteria in the water, as well as microbial films that cover the surfaces of water dispensers and are difficult to clean and filter.

This study adopts a combined approach of market research and user research[2]. The market research primarily analyzes the trends and developments in the global pet water dispenser market, as well as the improvements and innovations in water quality by renowned brands both domestically and internationally. User research, conducted through questionnaires and interviews, collects insights into the needs and concerns of Chinese pet owners regarding pet water dispensers. Despite the favorable user experience and safety of water dispensers, the pursuit of water quality remains a trend driving the iterative development of pet water dispensers. Numerous brands, including Xiaomi and Horman, prominent Chinese brands, are making efforts in improving water quality, which will undoubtedly have a new impact on the market for pet water dispensers[3].

Based on the findings from market research and user research, as well as insights into global trends in the pet water dispenser market and

1) Gromek N, Perek-Białas J. Why is pet goods consumption imperceptible for economists? A scoping review[J]. SN Business & Economics, 2022, p.172.

2) Signoretti I, Marczak S, Salerno L, et al. Boosting agile by using user-centered design and lean startup: a case study of the adoption of the combined approach in software development[C]//2019 ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM). IEEE, 2019, pp.1-6.

3) Pet Water Fountain Brands and Market Sales Proportion. , (2023,09,01), URL: https://www.phb123.com/pinpai/top37257

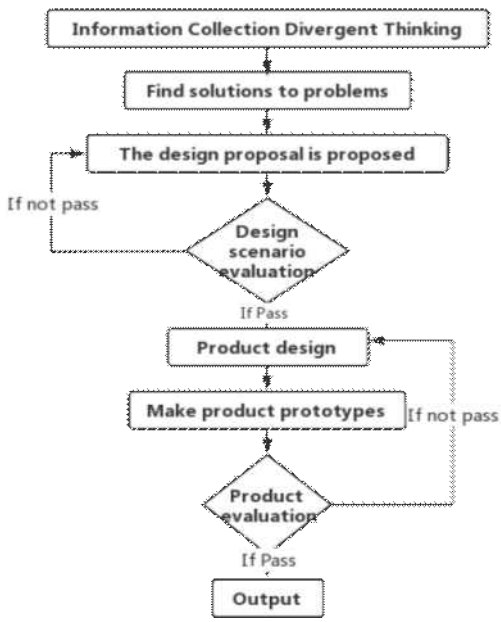
Chinese user behavior and preferences, we propose an intelligent pet water dispenser that features two water tanks and operates with a separation of clean water and wastewater, ensuring that pets always have access to a pure water source.

1-2. Research Scope and Methodology

This study focuses on the analysis of drinking behaviors and habits of cats and selects cat owners who are concerned about the drinking health of their cats as the research subjects. The scope of this study involves preliminary research on cat drinking habits, data collection and analysis of the development of the pet water dispenser market in China and related fields, analysis of users' requirements for water quality, and an examination of the impact of smart water dispensers on the drinking volume of cats. Furthermore, a water dispenser solution that ensures cats can drink the purest water is proposed.

The design methodology employed in this study follows the five steps of design thinking: empathize, define, ideate, prototype, and test. Additionally, the Double Diamond model proposed by the Design Council in the UK, which includes the stages of discovery, definition, development, and delivery, is utilized for divergent thinking and opinion collection processes, leading to specific outcomes. In terms of market research, trends and developments in the global pet water dispenser market, as well as improvements and innovations in water quality by renowned domestic a nd international brands, are collected and analyzed. This includes investigating and comparing the characteristics, technologies, and market shares of different branded water dispenser products. User research involves questionnaire surveys and interviews to gather the demands and concerns of Chinese pet owners regarding pet water dispensers. The questionnaire survey evaluates users' assessments of water quality safety, user experience, and functional requirements, while interviews provide deeper insights into user preferences and opinions[4].

Based on the analysis and conclusions drawn from the research findings, the product is designed. To validate the performance of the product, a basic product concept is developed, and prototypes are created and assembled. Subsequently, formal detailed design is conducted based on the initial product, and adjustments are made promptly to address any shortcomings. In order to enhance the design, the adjusted product undergoes evaluation by experts and consumers, and their feedback is discussed to modify and improve the design. Finally, a finished product is produced[5].



[Fig 1] Design process modified from 4D Process

4) Gestwicki P, McNely B. A case study of a five-step design thinking process in educational museum game design[J]. Proceedings of Meaningful Play, 2012. pp.37-67.

5) Schoonenboom, Judith, and R. Burke Johnson. "How to construct a mixed methods research design." Kolner Zeitschrift fur Soziologie und Sozialpsychologie 69. Suppl 2, 2017, p.107.

2. Theoraeical Research

2-1. Definition and Development of Pet Water Dispensers

Pet water dispensers are devices designed to provide a water source for pets, aiming to meet their drinking needs and maintain the freshness and cleanliness of the water supply. Regardless of the complexity of the water dispenser, ensuring the freshness and cleanliness of the water source is often of utmost importance[6].

During the early stages, in the 1960s and 1970s, as pet ownership became more widespread in households, people began to pay attention to the water needs of pets. At that time, pet owners typically used regular water bowls to provide water for their pets, but there were some issues such as lack of freshness and susceptibility to contamination. This prompted people to contemplate and design better solutions for pet water supply.

[Table 1] Basic Requirements for Pet Drinking dispenser

Requirements	Illustration	Content
Water Source Filtration		Multiple filtration system
Capacity		A large capacity and can meet water needs of pets.
water spray form		Pets prefer flowing water
Convenient Maintenance		Easy to disassemble and clean.

In the 1980s and 1990s, with advancements in technology and an increasing focus on pet health, innovative improvements were made in pet water dispensers. Early pet water dispensers were primarily gravity-fed systems that provided water through water tanks and small troughs. Some pet water dispensers were also equipped with simple filters to remove impurities and odors. Entering the 21st century, pet water dispensers became more intelligent and diverse. Modern pet water dispensers incorporate electric pumps or pumping systems to ensure water circulation, maintaining the flow and freshness of the water source. They are typically equipped with efficient filters capable of removing bacteria, odors, and impurities, ensuring clean and hygienic water. Some pet water dispensers also feature smart functions such as timed water supply, automatic water supply, and remote control[7].

The design of modern pet water dispensers has become increasingly diverse and personalized. They combine different materials, shapes, and colors to accommodate the needs of different pets and align with the aesthetic preferences of their owners. Additionally, some pet water dispensers integrate other functions such as food storage and environmental monitoring, providing comprehensive care and attention to pets.

[Fig 2] The development history of pet water dispensers

6) 田崇峰,赵中营,蒋其友等.
基于WiFi的智能宠物笼监测系统的设计与试验[J].
电脑与电信, 2017, pp.8-30.

7) 石玉轩.共生理念视野下的宠物用品设计研究[D].云南大学, 2020, p.140.

2-2. Structure and Classification of Pet Water Dispenser

[Table 2] Key Differences between Early and Recent Water Dispensers[8)]

Early pet water dispensers	Recent pet water dispenser	Key differences
		Water supply is provided in different ways
		Wired power / lithium battery
		Submersible pump / vacuum pump

The structure of pet water dispensers can vary depending on different models and designs, Generally, it mainly includes the components shown in the above figure.

Through comparison, it was found that the water containers of pet water dispensers are usually transparent or translucent, so that pet owners can easily monitor the water level and replenish the water source in time. The water container for the pet water dispenser can be made of materials such as plastic, stainless steel, or glass. Pet water dispensers usually have a dedicated area for pets to drink. This area can be a small trough, fountain design or other innovative structure.

Early pet water dispensers consisted only of water containers, gravity water systems, and drinking areas. With advancements in technology, pet water dispensers have incorporated submersible pumps that can operate fully immersed in water. These pumps are typically driven by an electric motor and are capable of drawing water and delivering it to the desired location through pipelines.[9)] In terms of controlling and regulating water flow, this may include adjusting the water flow rate, fountain height, water supply time, and amount of water. The control and adjustment functions can be personalized according to the requirements of different pets. In terms of gravity water supply system, the water supply system of pet water dispensers is usually based on the principle of water pump or gravity. Pump drinking fountains use electric or mechanical pumps to extract water from containers and provide a flowing water source. Gravity water dispensers use natural water supply through gravity in the container. When it comes to filtration systems, filters in pet drinking fountains help purify water by removing impurities, odors, and bacteria. Filters can be activated carbon, mesh filters, or other types of filter materials. The presence of filters ensures that pets have access to clean drinking water. In terms of the power system, for pet water dispensers that require electricity, they usually need to be connected to a power source or operated with batteries. The power supply or battery provides the necessary energy to drive a water pump or other electrical component to maintain the flow and operation of the water.

[Table 3] Comparison of pet water dispenser structures[10)]

Features	Early structures	recent structures
1.containers		
	Capacity is increased; Complexity is reduced.	

8) Key Differences between early and smart water dispensers, (2022.08.08.), URL: https://zhuanlan.zhihu.com/p/551327834

9)石玉轩.共生理念视野下的宠物用品设计研究[D].云南大学, 2020, p.49.

10) Large capacity hydraulic automatic water feeder, (2019.08.05.), URL:https://www.1688.com/

2.Power		
	Lithium batteries are safer and more convenient.	
3.Pump		
	The water pump and water are separated, less noisy.	

In the early days of pet water fountains, the water supply was based on gravity. Pet owners simply pour water into the container, and pets can drink through an opening below the water level. Water decreases as pets drink, adding water as needed. In pet water dispensers, submersible pumps are often installed at the bottom of the water reservoir. Submersible pump-based water dispensers are further categorized into wired submersible pump-based water dispensers and wireless submersible pump-based water dispensers.By connecting the submersible pump to the water reservoir, the pet water dispenser can continuously draw water into the reservoir and maintain a certain water level. They incorporate a wireless receiver or battery that provides power through wireless charging or by charging the battery directly.

Lithium battery vacuum pump pet water dispenser adopts lithium battery and vacuum pump technology to provide clean and fresh water for pets. The difference between this type of water dispenser and submersible water pump is that the battery and water pump are completely separated from the water, which realizes the complete separation of water and electricity, provides a clean and safe drinking experience for pets, and ensures that pets can get enough water for a long time even after a power outage. The parts of the water pump in contact with the water should be made of suitable food grade or drinking water grade materials, and the air pump is also helpful to the cleanliness of the water in addition to safety, because the water does not need to go through a complex structure like a submersible pump to run in the air pump, only through the silicone pipeline and silicone air valve, which will not pollute the water quality. Product design with sealing and leak resistance in mind. Preventing water or liquid leakage could lead to electrical failure or other safety risks.

2-3. Market status and analysis of smart pet water dispenser

We have studied the existing brands and products of smart pet water dispensers in the market, examining their sales performance, user feedback, and market share. Through this market analysis, valuable insights have been gained into the competitive landscape and development trends of the current smart pet water dispenser market, providing a solid foundation for subsequent design research.

[Table 4] 2022 Water dispenser Brands and Market Sales Proportion (online) [11)]

NO.	Brand	Illistration	Transaction (item)	Market share
1	Sweet		1013860	3.83%
2	homerun		932329	3.52%
3	Pet-kit		874341	3.30%
4	MI		535472	2.02%

11) Pet Water Fountain Brands and Market Sales Proportion. (2023.09.01.), URL:https://www.phb123.com/pinpai/top32235.html

				
5	U-ha		457257	1.73%
6	homerun		449924	1.70%
7	Pet-gugu		445278	1.68%
8	Pet-life		411875	1.56%
9	N-PET		362957	1.37%
10	Dreamer		344615	1.30%

The market for smart pet water dispensers is currently experiencing multifaceted development trends. With a deepening concern for pets, smart pet water dispensers are no longer just simple water devices; they come with increasingly diverse features such as timed water supply, water purification, and smart temperature control. Their exterior designs also exhibit more style and fashion, making them blend seamlessly with home decor. Moreover, pet owners are becoming more price-sensitive, and the market is gradually introducing economically affordable products. The application of smart technology further enriches the product offerings, catering to the growing needs of pet owners. These trends collectively drive the continuous development of the smart pet water dispenser market.

[Table 5] Development background of pet market

Features	Description
1.Market Situation	The pet market is gradually growing,
	Adopt stray animals and pay attention to animal welfare.
	Increasing demand for pet product
2.Function	The pet market is functionally diverse.
3.Style	Modern pet products and gear are becoming more and more popular, with a focus on design and aesthetics
	Personalized style pet clothing and accessories become the choice of pet owners
4.Economy	Products and services in various price ranges exist in the pet market, adapting to different budgets
	High-end pet supplies and luxury pet services also exist in the market
5.Portability	Portable pet carriers and strollers provide a convenient way for pet owners to get around
	Fold-out pet beds and drinking fountains are ideal for outdoor activities and travel
6.Intelligent	Smart pet surveillance cameras and feeders allow for remote monitoring and care of pets
	Smart collars track your pet's health data and provide real-time location

3. Design research methods

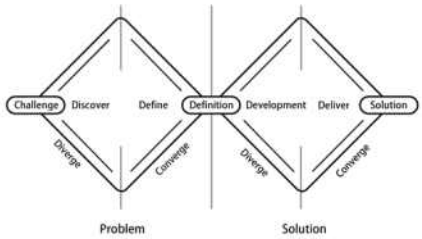
3-1. The solution to the problem

Double diamond model was first proposed by the British Design Society in 2005. It is often used in the process of requirements definition and design transformation in product development. The key is the divergence and convergence of design thinking, and finally to obtain an effective solution to the problem[12].

The traditional double diamonds model breaks down the product design and development process into four steps: identify the problem, define the problem, conceive the solution, and deliver the solution, explaining the

12) Liedtka J. Why design thinking works[J]. Harvard Business Review, 2018, 96(5), PP.72-79.

thought process of the problem from discovery to solution[13].



[Fig 3] Double Diamond

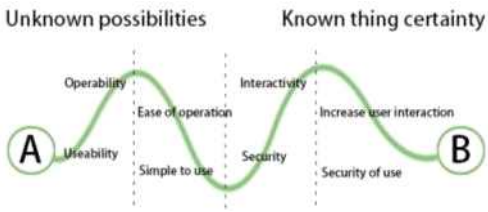
Problem Discovery Stage: The primary objective is to conduct in-depth research and analysis of existing problems, refining macro-market insights through divergent research, gaining further understanding of users' underlying needs, categorizing existing products in the market, and analyzing pain points of the products[14].

Problem Definition Stage: Defining the problem involves identifying the key points of the problem fundamentally. It starts with divergent research on the market, users, and the current state of products, delving deeper into users' underlying needs and addressing pain points of the products. There are two problems in pet water dispensers today: on the one hand, for pets, pets will bite wires in daily life, and pets are inconvenient to use. On the other hand, for users, there are concerns about the filtration system in the water dispenser, inconvenient plug-in problems and loud water pump noise.

Based on these findings, the most critical problem to be addressed is selected, enabling a focus on the core of the problem and forming the first diamond of the double diamond model, which is about doing the right thing[15].

Ideation Stage: The ideation stage is the process of seeking solutions to the identified problem. Starting from user needs and product pain points, it is also a process of expanding design inspiration. Through a series of design analyses, feasible solutions can be generated, and the product can be validated through experimental testing and market response to ensure it meets market and user requirements. From this, the most satisfactory product for users can be found, and the delivery of the solution, the delivery stage, can be completed. Product design is a complex innovation activity that involves the interaction, reasoning, and exploration of the designer's mindset, design process, and design strategies. Through the structural change of the pet water dispenser and the use of the most suitable accessories, the problems found in the first stage above are solved.

The double diamond model's design approach effectively helps to identify and solve problems in human-cat coexistence, adapt and improve as necessary based on practical circumstances, and follow the pattern of divergence and convergence to achieve better solutions.



[Fig 4] Product Develop Model

3-2. factors of User-centered design

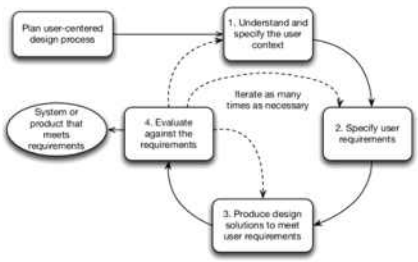
User-centricity refers to the approach of

13) Weisberg R W. Problem solving and creativity[J]. The nature of creativity: Contemporary psychological perspectives, 1988, P.148.

14) Keogh G L. The listing and categorization methods for simplifying the identification of customer pain points[D]. Saint Louis University, 2013. p.38.

15) Wang X, Huang Z, Xu T, et al. Exploring the Future Design Approach to Ageing Based on the Double Diamond Model[J]. Systems, 2023, P.404.

placing the needs, expectations, and experiences of users at the forefront when designing, developing, and delivering products, services, or systems. This approach emphasizes incorporating the user's perspective, goals, and behaviors into the design and decision-making processes to ensure that the final product or service meets user requirements and provides a positive user experience[16].



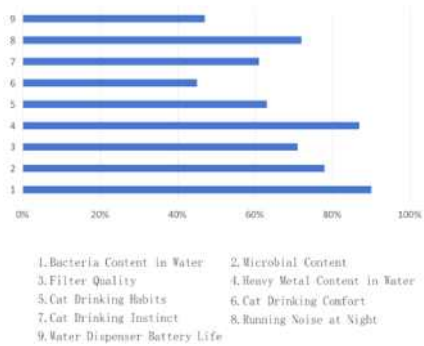
[Fig 5] User-centered model

According to the user-centered design principle,[17] , sorted out the four main aspects of operability, security, interactivity and security.

The author conducted user needs research from the following perspectives: ease of product operation, product safety in use, water source filtration and purification, accommodating the specific needs of pets, ease of cleaning and maintenance, and enhancing user interaction.

Satisfying user needs through user research, gaining an in-depth understanding of users and incorporating their feedback and opinions into the design process, can create a solution that is closer to the user's psychology and behavior. At the same time, it is possible to create a product or service that is user-friendly, easy to use and delightful. By focusing on aspects such as user interface, interaction, and usability, designers can ensure that users can use the product easily, reduce learning costs, and have a pleasant experience[18].

We selected 500 valid questionnaires and found that the most users concerned about the bacteria content in the water, followed by the heavy metal content in the water, and there were also some concerns about the microbial content in the water, the noise of nighttime operation and the quality of the filter element. Water dispenser battery life, cat drinking comfort and water micro-current are less concerned. Therefore, we selected the bacterial content in water, heavy metal content in water, microbial content in water, nighttime running noise and filter element quality as the main design issues. Current is a minor design concern.



[Fig 6] Questions and Attention

The survey was mainly distributed online by the author, which lasted for one month, and 500 questionnaires were effectively collected from cat users. The information in the first part of the questionnaire is analyzed to grasp the age, gender, education, occupation, and breeding funds of the user. The survey subjects were not specially selected, but distributed to

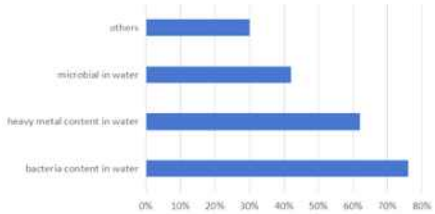
16) Damodaran L. User involvement in the systems design process-a practical guide for users[J]. Behaviour & information technology, 1996, PP.363-377.

17)黄文娟.以用户为中心的老年人娱乐产品设计[J].艺术品鉴,2021, PP.76-77.

18) Moreno-Ger P, Torrente J, Hsieh Y G, et al. Usability testing for serious games: Making informed design decisions with user data[J]. Advances in Human-Computer Interaction, 2012, P.4.

different levels of cat users. By paying attention to users' needs and actively engaging with them, a user-centered design approach can enhance user engagement and loyalty. Users feel valued and respected, and their feedback is taken seriously, which helps build positive user relationships and brand loyalty, which in turn drives word of mouth and user growth. We conducted a re-questionnaire survey on the key influencing factors and found that the results were the same, with consumers most concerned about the aspects bacteria content in water.

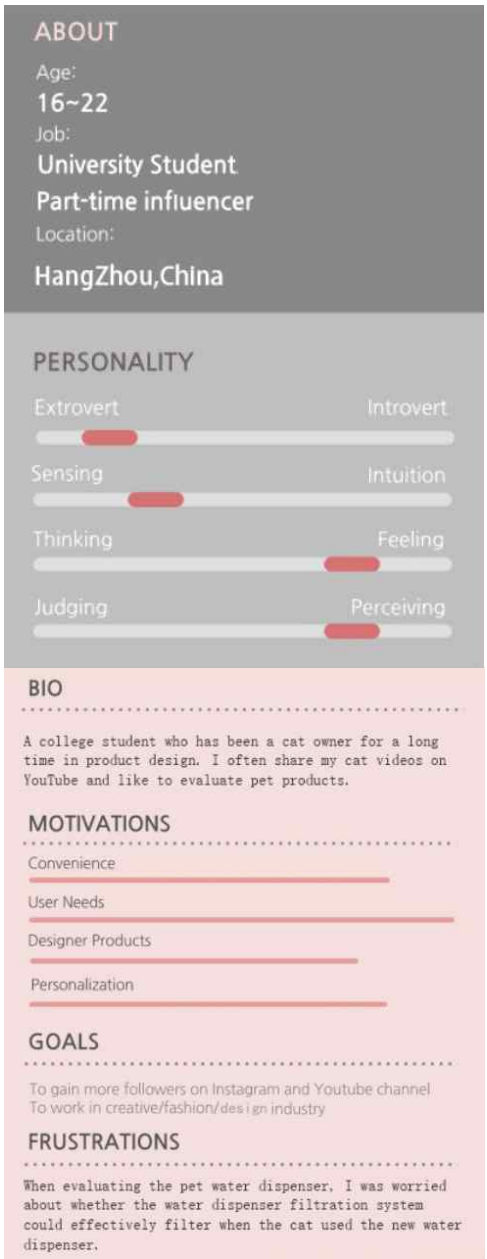
3-3. Define the problem and develop the scenario



[Fig 7] A test of the results

In this section, we define the problem and develop the scenario to determine the specific goals and scope of the study[19]. We will analyze the results of market research and user research to understand users' concerns and demands on the safety of water quality in pet water dispensers, and translate them into specific design issues. At the same time, we will consider the use of pet water dispensers in different scenarios, such as homes, pet shops, and veterinary clinics, to ensure the applicability and practicality of the design scheme. When analyzing the user journey map of a pet water dispenser, it is possible to identify different stages, the user's mood, and potential pain points.

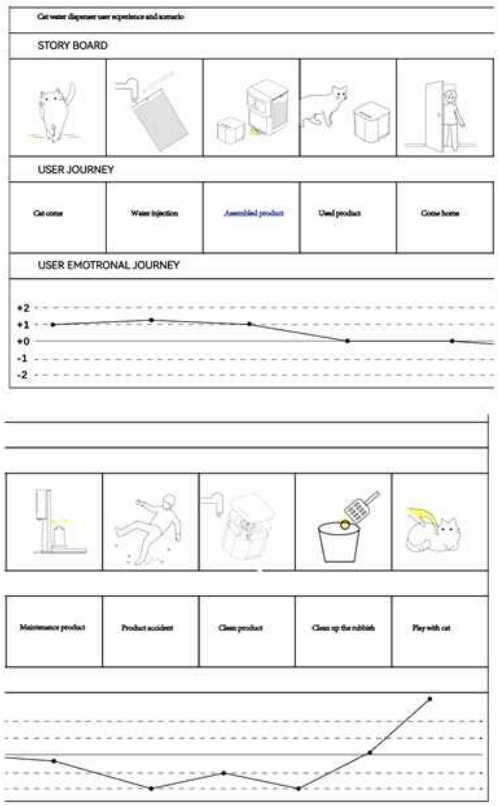
19) Toth F L. Policy exercises: objectives and design elements[J]. Simulation & Games, 1988, PP.235-255.



[Fig 9] Persona

Phase 1: At this stage, users may feel a sense of alertness as they realize that their pet needs more water, which may make them feel worried or concerned.Pain points: Users may be concerned about pet health, especially that insufficient hydration may lead to dehydration and other health problems. Stage 2: Users may

experience curiosity and difficulty making decisions at this stage. They will invest time in researching different pet drinking fountain options. Pain point: Users may be confused because there are various pet water dispensers on the market, and choosing the right one may make them feel challenged. Stage 3: Once users decide to adopt a pet water dispenser, they may feel satisfied because they have found a solution.Pain points: Users may face purchasing decisions at this stage, such as which model or brand to choose, and how to buy. Stage 4: Once the pet starts using the water dispenser, the user may feel satisfied and reassured knowing that the pet has a fresh source of water.Pain points: Users may be concerned about the performance of the water dispenser.



[Fig 8] User Journey Map

4. product design and development

4-1. Proposal of Design Concepts and Integration of Design Thinking

In the design process of the pet water dispenser, it begins with in-depth market research and user needs analysis to understand market trends and user expectations. Next is the concept design phase, which generates multiple innovative ideas and concretizes these concepts through prototyping. Subsequently, detailed engineering design takes place, considering materials, dimensions, and manufacturability. Finally, a series of testing and validation procedures are conducted to ensure product performance and reliability. This process ensures that the pet water dispenser's design not only meets market demands but also possesses high-quality design and performance.

Persona answers the question "who are we designing for", it is a powerful tool based on research results to help create product features by optimizing UX research, it not only represents a specific user, but they can be understood as typical of the behavior, attitude, skills and background of all potential users.

A lot of research data on product design is difficult to process, especially when we need to pay attention to the data throughout the process. Therefore, the user portrait will be a relatively more realistic and concrete object, although not a real person, but the most typical image of many real people. It can alert us to the needs of our users and help us create a better user experience model because real users will feel more comfortable using the product.

Based on user profiles, we compiled a series of questions and interviewed users.

[Table 6] User Interviews

1.Operability		◆ Easy to understand ◆ Easy to use ◆ Easy to operate
2.Useability		◆ Easy to cognitive ◆ Margin for error ◆ Durable
3.Interactivity		◆ Good feedback ◆ Friendly interaction ◆ Good performance
4.Security		◆ Safe to use ◆ Protection design ◆ Standby energy

According to the results of the interview, most users focus on the filtration system, they believe that when the pet water dispenser is used, the pet cannot drink all the water at the drinking place at once, so the remaining water may have bacteria. Microorganisms such as bacteria may not be filtered clean during filtration. Secondly, users focus on the automatic sensing system, which is easier to use with indicator displays, and attracts pets when they pass by.

4.2 Design, development and proposal

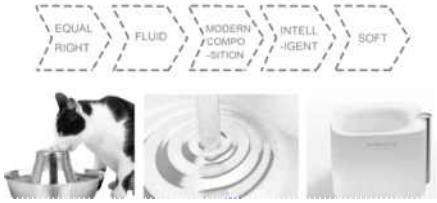
[Table 7] Comparison of Existing Products and Solutions

Factors	Existing products	Proposed products
1.water tanks	single water tan	Dual water tank
2.Filter level	General filter	Human grade filter
3.water resource	recycling	one time used water to reduce bacterial
4.Induced effluent	human body sensor	infrared sensors
5.Noise	More than 45db	less than 45db

Comparing and analyzing similar products within the latest product trends and the desired product portfolio can provide valuable information and guidance[20]. Such comparisons can help you understand the characteristics, advantages, and disadvantages of similar products in the market, as well as user feedback and demands. User needs intersect with design interactions and, based on these, key design keywords can be extract.

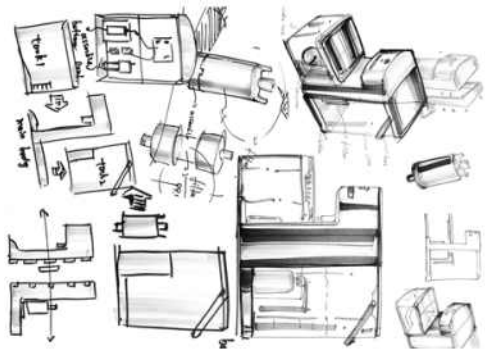
[Fig 10] Source of Inspiration

20) Babin, Barry J., and William G. Zikmund. Exploring marketing research. Cengage Learning, 2015, p145.



[Fig 11] Export Design keywords

Considering the drawbacks of existing products on the market and the needs of consumers, improvements will be made to the prototype in the product design, accompanied by sketching activities.



[Fig 12] Idea Sketches

The product innovation of the program and its impact on the economic industry:

[Table 8] The Product Innovation of the Program and its Impact on the Economic Industry

Different aspects	Detail
1.Product innovation surface	A structure that does not exist with existing products
	Product completely different water flow impact mode
	It is equipped with an efficient filtration system that filters out impurities and odors from the water, providing a clean, fresh water source
	Provide a variety of drinking methods to meet different cat preferences
	Designed to be easy to clean and maintain, the water source can be easily cleaned and replaced
	It is made of safe materials to prevent cats from ingesting harmful substances
2.Economy and industry	Gain an advantage in the domestic market to increase domestic sales and foreign sales
	Exports through mobile channels can capture global markets
	The effect of domestic market development is forecasted through the competition between enterprises and technology
	Promote the development of domestic and foreign pet markets
3.Project	The sensing mode ensures healthy water intake when your cat is home alone
	"Cat culture" prevails, and water dispensers are essential products for cats
	Human grade filter can make cat owners more assured about the health of their cats
	Connecting to the app allows "office workers" to keep an eye on their cats' health anytime, anywhere

The innovation of pet water dispensers offers several notable advantages to market development. Firstly, innovation enhances user experience by introducing intelligent features such as automatic water circulation and filtration, adjustable water flow rate, and timed water supply, ensuring convenient, clean, and fresh drinking water for pets. Secondly, innovative designs augment product attractiveness, setting them apart in the market landscape and distinguishing them from conventional water bowls or dishes. Additionally, innovative pet water dispensers are capable of meeting the diversified needs of various pets, tailored to accommodate differences in species, size, and palate, thus catering to a broader spectrum of market demands. Moreover, the incorporation of innovative designs reduces the risk of bacterial proliferation and water contamination, thereby enhancing the health and safety attributes of the water supply. These innovations stimulate market competition, propel continual product improvement by enterprises, steer consumer

trends, drive the market towards greater smart and user-friendly orientations, ultimately fostering growth and advancement within the entire pet water dispenser market.

4-3. Prototype development and validation

[Table 9] Prototype test of the scheme

Test items	Test content
1.Water tank	1.When the water level exceeds the maximum limit of the water level module, the equipment stops the water output and alarms. 2.minimum water level module, the equipment stops the water supply and alarms.
2.Induct-or	When the photoelectric switch determines that the cat has passed, the pump works for 15S, and does not produce water within 5 minutes after work.
3.Filter element	The device starts the filter for the first time for 60 days countdown.
4.Power supply	1. The electricity red light flash, when power less than 10%; 2. Connect the charger, the red light flashing 3 he current water supply mode indicator ring cell status based on the current mode light effect.
5.WI-FI module	1. Equipment connected to the user's phone 2. Daily use process stability
6.Cleani-ng effect	Through the booster module, the working voltage of the pump is provided to 5V, working for 15S and can clear the tank.
7.Timer Mode	The water is discharged once every 2 hours by default. The working voltage of the pump is 3.7V, and the working time is 15S.

Prior to the official market launch, a crucial step in the development of pet water dispensers involves prototype testing, commonly known as the handboard testing phase. This pivotal phase aims to assess and validate the design, functionalities, and performance of the pet water dispenser. During handboard testing, physical prototypes, crafted based on design blueprints or 3D models, are meticulously examined. This assessment encompasses several key aspects, including validating the product's visual aesthetics, dimensions, and adherence to the intended design. Moreover, the functionality of the pet water dispenser is rigorously tested to ensure proper water supply, filtration, and other intended operations. The quality of materials and manufacturing processes is also evaluated, thereby gauging durability and overall craftsmanship. Safety and user-friendliness are scrutinized, ensuring the product poses no hazards to pets or users while being straightforward to operate. Additionally, performance metrics such as water flow rates and filtration efficiency are measured, confirming alignment with design specifications. By conducting handboard testing, potential design or manufacturing issues can be detected and resolved early, assuring that the pet water dispenser undergoes thorough validation and refinement before entering the market, ultimately meeting the demands of both consumers and the market effectively.

[Table 10] Structure and Functional Test Process

Name	Prototype model	Test process
Internal and external structure		Product structural strength test
		Water pump monomer test
		Tightness of water flow system
filter element		Filter element monomer test

		Filter pass rate
Electronic function		Water flow test
		Inductive testing

At first, only one battery was used, and after several tests, it was found that the power supply efficiency of one battery could not support the water shock mode behind. Change for two batteries can solve the above problem, the front cover of the battery limit is adjusted. At the beginning of the market selected three human grade filter, after many tests and experiments, choose a filter with the best effect of removing impurities such as bacteria.The device has only one default working principle of the pump, the pump working voltage is 3.7V, and a new button is added at the back to change the mode. Based on the model of the prototype, issues encountered during the development process are validated, followed by adhering to the five principles of practicality, safety, interactivity, aesthetics, and sociability, in order to design and sketch a cat water dispenser. In the design sketch, the upper part of the water dispenser features a transparent water tank that can hold an ample amount of water and ensure a continuous flow of water.

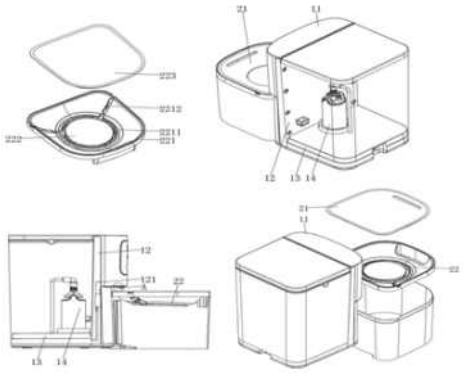
[Fig 13] Pet Water Fountain Design outcome

Water quality is the issue that users are most concerned about, so the detection of water quality is the focus of this test. Tests will be conducted from multiple aspects to ensure water quality. As shown in the picture above, the product adopts the design of two water tanks for the first time. The larger transparent water tank provides clean water source for pets after filtering, and the water drank by pets will be discharged into the small transparent water tank, so that It ensures that the pet drinks fresh water every time.

[Table 11] Water quality test result

Test items	Test items
Effluent turbidity NTU	≦0.20
Pigment retention	Can be detained
Dust particle counting Check the value for 30 seconds	0.3u≤100,0.5u≤20
coliforms	not detected

On the premise of using double water tanks to ensure that pets can drink new water every time, laboratory testing was conducted on the filtered new water. The testing items included effluent turbidity testing, pigment residue testing, dust particle testing, and coliform colony testing. , the test results all meet the standard requirements.



[Fig 14] Product Design Structure Diagram (Patent Registration)

Based on the feedback from internal product evaluation and rendering results, the final rendering has been selected. Consideration was given to using soft colors that harmonize with the environment and home decor, and selecting appropriate material representations to accurately convey the design concept and showcase the product in its intended usage scenarios and user experiences. During the modification process, the actual size of the product was discovered and adjustments were made to refine the details and ensure specificity. In the final stage, modifications are made to ensure the feasibility and objectivity of the proposed solution. To enhance the development, marketing, and design aspects, as well as gather additional feedback from external experts, the final results are subjected to evaluation and constructive opinions are collected. Subsequently, the feedback and ratings are organized, and the proposed solution is then modified accordingly.

Taking into account both consumer evaluations and internal developers' feedback, the summarized arrangement of the final design results is as follows:

[Fig 15] Final Design Image

5. Conclusion

In this study, a design solution for an intelligent pet water dispenser with two water tanks and separate operation for clean and wastewater was proposed, aiming to enhance water quality safety. The research combined market research and user surveys to identify key factors and objectives based on the analysis of market trends and user demands. By applying a design research approach, a comprehensive research process was achieved, covering problem definition, solution development, prototype design, and validation. Throughout the design proposal and development process, factors such as user needs, water quality safety, and practicality were carefully considered to ensure the rationality and feasibility of the design.

In the process of product design and development, innovative design thinking and a holistic approach were employed to improve water quality safety in the intelligent pet water dispenser through enhancements in filter design, clean and wastewater separation, material selection, and cleaning maintenance. Furthermore, prototype development and validation were conducted, verifying the effectiveness and reliability of the design proposal through laboratory and user testing. The findings of this study hold significant implications for the design and market

development of pet water dispensers. Improving water quality safety is a crucial factor in meeting user demands and promoting the market growth of pet water dispensers.

Our design solution not only addresses user concerns and needs but also incorporates innovative technologies and design concepts, offering an intelligent pet water dispenser that ensures access to clean water for pets. Future research can further explore the design and improvements of pet water dispensers to meet the diverse needs of different user groups. Additionally, the integration of smart technologies and data analytics can elevate the level of intelligence and user experience in pet water dispensers.

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