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Adoption behavior of water efficiency labeling: origin, research progress and theoretical framework – evidence from China

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ABSTRACT

Research on the adoption behavior of water efficiency labeling is of great significance for improving citizens' water-saving consciousness and promoting water-saving techniques and standards. This study sorted out 559 papers about adoption behavior and then systematically analyzed the origin and research progress of water efficiency labeling in different fields. Finally, related theories and empirical analysis are integrated, and a research framework of 'gold ingot' that focuses on adoption behavior is constructed. The study found that the research mainly involves three contents in the current: adoption behavior of corporate users, adoption behavior of rural households and adoption behavior of individual users. Based on the above literature analysis, this study proposes a theoretical framework for research on the adoption behavior of water efficiency labeling.

Key words: Adoption behavior, Gold ingot, Theoretical framework, Water efficiency labeling

HIGHLIGHTS

- Based on the scientific measurement, this paper sorted out 559 literatures on adoption behavior and analyzes its origin, evolution, frontier, clustering characteristics, etc.
- This study takes the adoption behavior as the core and combines a theoretical foundation and empirical analysis to construct a theoretical framework.
- The adoption behavior is divided into three categories.

1. INTRODUCTION

The global average surface temperature increased by 0.66 °C from 1961–1990 to 2000–2019, and a 1 °C increase in global warming may lead to dangerous climate changes, such as rising sea levels, melting glaciers and reducing freshwater resources (Valipour *et al.*, 2021). Water is an essential fundamental resource for humankind. With the rapid development of society and economy as well as population growth, these issues such as water shortage, aggravated water pollution and water ecology deterioration have gradually become crucial factors restricting sustainable development (Wang & Wang, 2012). The *per capita* water resource of China is only one-fourth of the world average. In a certain year, China's water shortage is more than 50 billion cubic meters, and nearly two-thirds of the cities have varying degrees of water shortage. Due to these issues, the National Development and Reform Commission, the Ministry of Water Resources and the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China jointly promulgated the 'Management measures for the Water Efficiency Labeling' in September 2017. It promulgated the first implementation rule

'Implementation Rules for Toilet Water Efficiency Labeling' in January 2018. It is hoped that these rules will help to promote water-saving technology advancement and efficient water-saving products, enhance citizens' water-saving awareness and improve their water-using efficiency. It also means that the water efficiency labeling system has been formally implemented as a critical mandatory water-saving measure in China, which can effectively drive producers to improve their product water-saving performance and guide consumers to choose efficient products.

According to statistics, since the implementation of the 'Implementation Rules for Toilet Water Efficiency Labeling', more than 2,000 toilet manufacturers have registered on the 'China Water Efficiency Labeling Network' by June 2020. Their geographical distribution is shown in Figure 1. It is clear that enterprises in Guangdong Province account for about 63% of the total in China. Meanwhile, Chaozhou city, located in Guangdong Province, is known as the 'China Porcelain Capital', in which most of the daily ceramics, sanitary ware and electronic ceramics are produced. Enterprises in Chaozhou account for about 49% of the total in Guangdong Province, most of which are small and medium-sized private enterprises. Meanwhile, these kinds of enterprises in Zhejiang, Shanghai and Henan accounted for 13, 10, 4 and 3%, respectively, and there are 69 laboratories with water efficiency inspection and testing qualifications. In addition, there are 37 third-party laboratories, including national-level centers, provincial-level testing institutions and third-party inspection and testing enterprises; the 32 laboratories that remain are affiliated to enterprises, mainly internationally renowned laboratories and laboratories of large domestic sanitary ware enterprises.

Judging from the situation, although the water efficiency labeling system has just been established, the supervision and management mechanism has not yet been built. In addition, it covers a small range of products, only including two types of water products: toilets and dishwashers. The proportion of water-saving products with first-level water efficiency is not high (see Figure 2), indicating that their water-saving technology needs improving. Furthermore, there is a lack of incentive policies, restrictive measures, etc. These existing problems have seriously influenced the implementation effect of the water efficiency labeling system. In the '14th Five-Year Plan', China has proposed that it is imperative to implement national water-saving actions, promote green production and lifestyles and support high-quality development. This puts forward more urgent requirements for the effective implementation of the water efficiency labeling system.

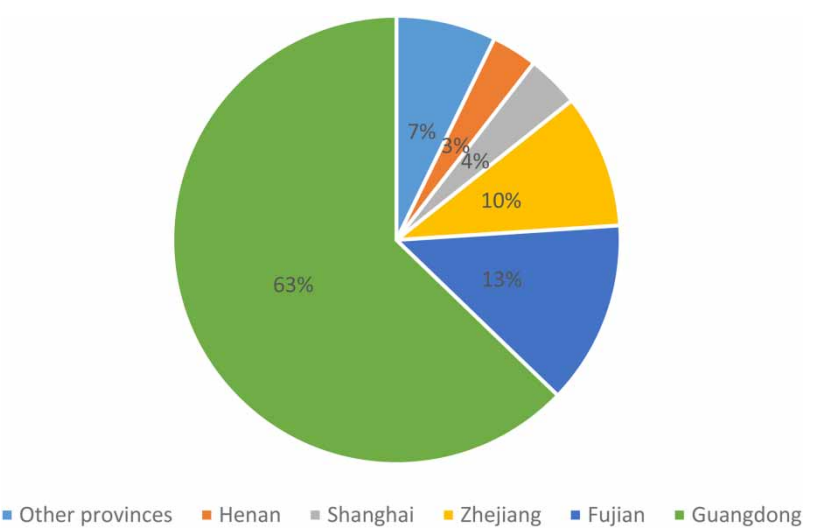

Fig. 1. | Distribution of enterprises registered on 'www.waterlabel.org.cn'.

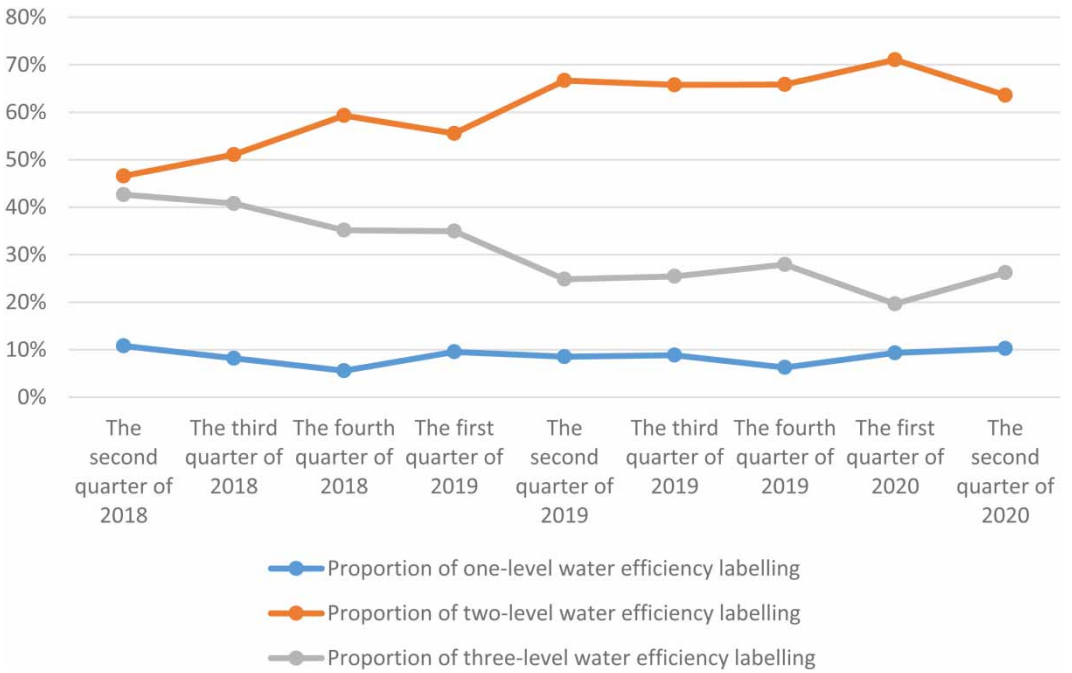

Fig. 2. | Proportion of toilets with different water efficiency levels.

Judging from the research today, although many countries have successively implemented water efficiency labeling systems, and some studies have introduced the system and its implementation regulations, there is still very little literature on water efficiency labeling, let alone its adoption behavior. The reason may be that the promotion time of the water efficiency labeling system is relatively short, which has not attracted much attention from the society and academia. Due to the urgent need for practice and the importance of theoretical development, it is necessary to carry out systematic research on it. Therefore, this paper first reviews the literature on water efficiency labeling and adoption behavior. Then, it analyzes the adoption behavior of the water efficiency labeling based on the research results above. Finally, it provides new solutions for the research on the adoption behavior of the water efficiency labeling. This paper is expected to help scholars understand the core themes, research progress and future research directions of the adoption behavior of the water efficiency labeling, promote its theoretical innovation and management practices and further realize its more application value.

2. PROPOSAL OF WATER EFFICIENCY LABELING

Australia is the first country to implement the water efficiency labeling system and issued the 'Water Efficiency Labeling and Standards Act 2005'. It stipulates that the complete water efficiency labeling information should include star rating (the product water-using efficiency), water consumption rate and detailed information of the registered product (the company of the registered product, its license number and the product testing standards). So far, the water efficiency labeling has been popularized to seven plumbing products and equipment there, including faucets, urinals, shower nozzles, washing machines, dishwashers, toilet facilities and flow controllers, and has made significant progress. In 2017, the total amount of water saved in Australia reached 112 GL, and it is expected that the amount will increase to 186 GL/year by 2026 and 231 GL/year by 2036 (Fane *et al.*, 2020). Singapore is also one of the countries that implemented the water efficiency labeling

system earlier. The 'Water Efficiency Labeling Scheme' was issued in 2006, which divided the water efficiency labeling level into 0/1/2/3, and implemented the way that companies would voluntarily adopt. The scheme was changed to mandatory adoption way from July 1, 2009, and some products retain voluntary adoption (Public Utility Board, 2013). In June 2006, the United States Environmental Protection Agency (EPA) initiated the WaterSense certification program, which stipulates that products with the WaterSense label must comply with EPA's water efficiency and performance specifications and obtain independent third-party certification and support. Since the implementation of the project, the United States has not only saved US$32.6 billion in water and energy, but also saved 1.5 trillion gallons of water while avoiding 78 million tons of greenhouse gas emissions (Schein *et al.*, 2019). Chini *et al.* (2016) conducted statistics on water consumption of water-saving household appliances registered with 'Energy Star' or WaterSense. They found that the potential water-saving amount per household per year is 36,900 gallons. In 2008, Portugal launched the water efficiency labeling Program, which was adopted voluntarily and covered products such as toilets, faucets and showers (Armando & Carla, 2010). Europe introduced water efficiency labeling in 2014. It is a voluntary program developed and supported by the European Faucet and Valve Industry (CEIR). The program provides a unified classification system for all member states to inform consumers of the water consumption of the product, not only for the entire European Union but also for Israel, Switzerland, Russia, Ukraine and Turkey.

China is the first non-developed country to introduce the water efficiency labeling system. In 2017, according to the existing water efficiency labeling system, China promulgated the 'Water Efficiency Labeling Management Measures' and systematically defined its concept. It pointed out that water efficiency labeling refers to the conformity mark of the water efficiency grade and other performance of the product, which comes from the self-declaration and information filing of the enterprises. In addition, there are already water efficiency limit values, water efficiency grade standards and water efficiency labeling implementation rules for toilets and dishwashers, and the implementation rules for dishwashers will be implemented on April 1, 2021. According to preliminary statistics, the implementation of the water efficiency labeling system will save at least 6 billion cubic meters of water per year, equivalent to more than 12 billion yuan in water costs. Products with water efficiency labeling in countries/regions around the world is shown in Table 1.

Table 1. | Products with water efficiency labeling in countries/regions around the world.

Countries/regions	Voluntary	Mandatory
Australia		Faucet, urinal, shower head, washing machine, Dishwasher, toilet equipment and flow controller, shower head, faucet
Singapore		Sink/bib faucet, low-capacity flush tank, toilet flush valve and water-saving toilet, washing machine, dishwasher
USA	Bathroom sink taps/accessories, toilets, urinals, showerheads, irrigation controllers, showers	
Portugal	Water products such as toilets, faucets and showers, toilet kit, water tank, tap, shower	
European Union	Water recirculation device, toilet controller, flush toilet, electric shower, etc.	
China		Toilet, dishwasher

3. RESEARCH PROGRESS ON ADOPTION BEHAVIOR

3.1. Literature review

The existing research centered on adoption behavior is scattered in different fields, and these academic papers are published in various journals. Therefore, it is a considerable challenge to sort out and analyze the literature systematically. Denyer & Neely (2004) believe that it is necessary to define its scope before systematically combing the literature to help clarify the thread and status of its evolution (Denyer & Neely, 2004). Furthermore, research on adoption behavior involves multiple disciplines and different research fields. Therefore, a reasonable research design helps to identify the evolution of the literature objectively and, to a certain extent, reduce the selection subjectivity of literature. Therefore, it is vital to set the literature retrieval strategy and exclusion criteria based on scientific methods and then set our research boundaries. The bibliometric method can accurately reflect the development and change of a certain research field and has the advantages of timeliness, accuracy and authority. This article explores the adoption behavior based on this method, trying to discuss its theoretical traceability, knowledge base and research trends. The scientific knowledge graph has the characteristics of 'graph' and 'spectrum': it is not only a visual knowledge graph but also a serialized knowledge pedigree, which can clearly show the complex relationship between knowledge units or knowledge groups, such as network, structure, intersection, evolution or derivation. Based on the visualization of scientometrics, this paper adopts the Citespace analysis software developed by Professor Chen Chaomei to explore the research on adoption behavior. It is mainly based on the co-citation theory (co-citation) and pathfinding network algorithm (path Finder) to measure the literature (collection) in a specific field and finally explores the key path and its knowledge inflection point of discipline evolution. In addition, it analyzes the potential dynamics of discipline evolution and explores its development frontiers by drawing a series of visual atlas (Chen *et al*., 2015). Its outstanding feature is to conduct a comprehensive analysis of numerous literature and display the evolution of the field on the knowledge graph of the citation network, using multi-time-sharing dynamic citation analysis visual language and clever spatial layout. Meanwhile, it will also automatically identify the citation node literature as the knowledge base, and the research frontiers represented by co-citation clustering (Li & Chen, 2016).

Therefore, based on the visualization of scientometrics, this paper adopts CiteSpace analysis software to carry out research. The literature involved in this paper comes from two sources: the first is the Web of Science core collection database, and the second is the Peking University core and CSSCI databases. The search keywords are 'adoption behaviour' and '采纳行为 (adoption behavior in Chinese)', and the search time is set to 1970–2020.

This paper retains the literature that contains the above keywords in the title or abstract field. In addition, this paper also traces the index and citations of selected literature and ensures that important literature is not missed. Finally, a total of 808 kinds of literature were obtained as the initial samples of this paper.

Moreover, we also screen and exclude the retrieved literature to ensure that they are closely related to the research topic. Three exclusion criteria are conducted: First, since the focus of this paper is the initial adoption behavior, the literatures about the post-behavior and continuous adoption are excluded. Second, although the keyword 'adoption behavior' appears in the title, abstract or content, the research goal and primary content are not about the adoption behavior of the water efficiency labeling, such literature is also excluded. Third, although the adoption behavior is involved, these literatures are limited to the use of statistical methods for comprehensive analysis and description and lack any theoretical or mechanism elaboration, which are also discarded in this paper. Based on these three criteria, after strict screening and exclusion, this paper finally got 559 kinds of literature. Subsequently, we apply information visualization software to perform co-occurrence analysis results of keyword and network clustering of clipping operations. The selection time is 1996–2020, and the time segment is set to 2 years. The result is shown in Figures 3 and 4.

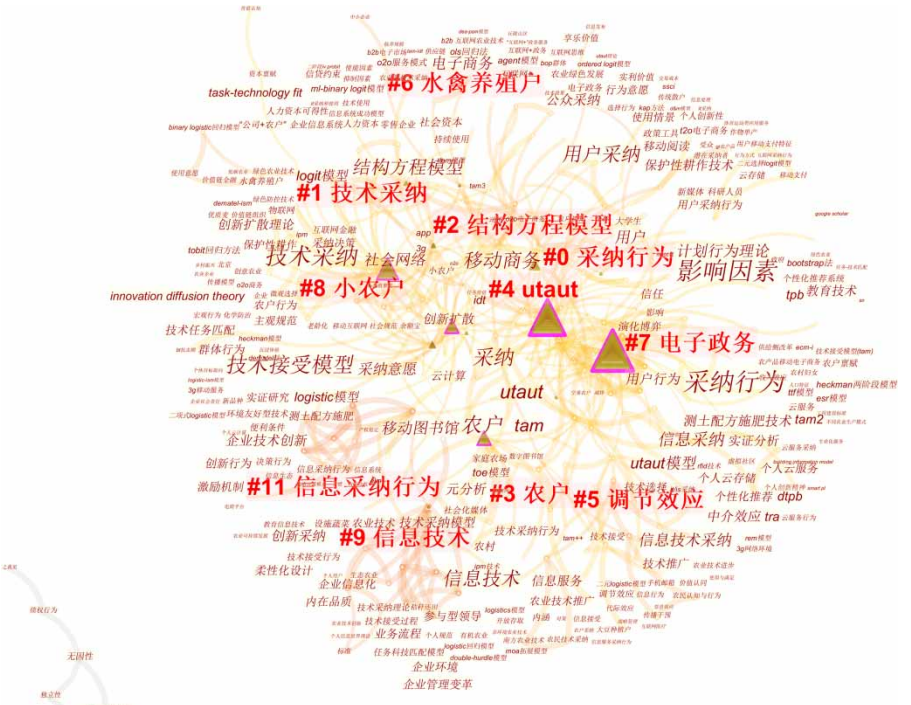

Fig. 3. | Co-occurrence analysis results of keyword '采纳行为 (adoption behavior in Chinese)'.

Based on the analysis results, this paper constructs the 'gold ingot' framework for the study of adoption behavior (Zhou *et al*., 2017), consisting of two levels: core topics and theoretical foundations, as shown in Figure 5. As shown in Figure 5, the research on adoption behavior includes three core themes: adoption behavior of corporate users, adoption behavior of rural households and adoption behavior of individual users. Furthermore, the theoretical basis is divided into four parts, namely, Unified Theory of Acceptance and Use of Technology (UTAUT), Diffusion of Innovations Theory, Technology Acceptance Model, the Theory of Planned Behavior and two empirical statistical analysis methods (logit model and probit model).

3.2. Literature analysis

The above analysis shows that adoption behavior contains three different research cores – adoption behavior of corporate users, adoption behavior of rural households and adoption behavior of individual users – which represent its three various but inherently logically related aspects. It can be seen from the Yuanbao framework that technical characteristics and environmental factors are the common key factors to the three adoption behaviors. Since the adoption behavior of each subject is different, the factors that influence each adoption behavior also include its own characteristic factors. The characteristic factors of the adoption behavior of corporate users are organizational factors, while those of rural households are personality and family characteristics, and those of individual users are psychological factors. The following will organize the literature scattered in other fields and disciplines around these three cores and analyze the adoption behavior in different categories.

3.2.1. Adoption behavior of corporate users

So far, scholars have explained the adoption behavior of corporate users from different perspectives, such as model empirical research (Deng *et al*., 2008; Tsai & Tang, 2012), the connotation and performance of adoption

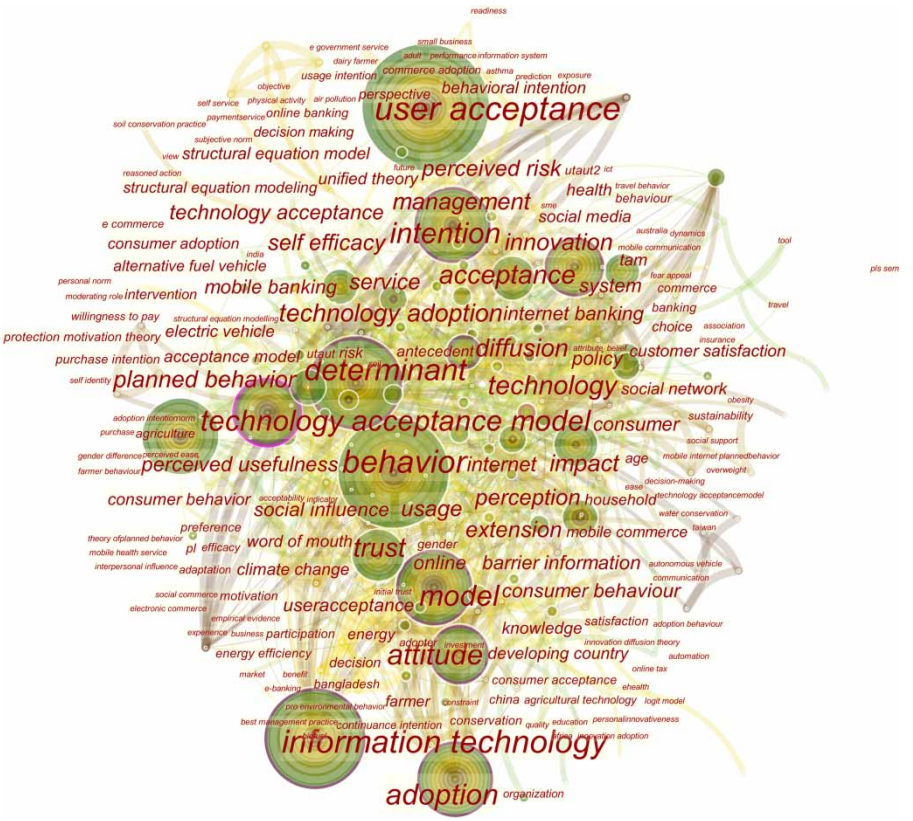

Fig. 4. | Co-occurrence analysis results of keyword 'adoption behavior'.

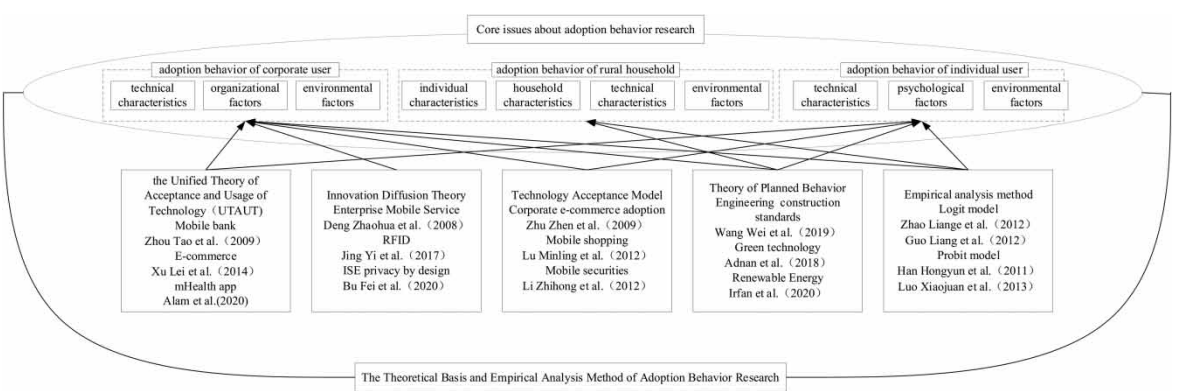

Fig. 5. | 'Gold ingot' framework for adoption behavior research.

behavior (Zhu & Li, 2008), adoption decision (Du & Zhu, 2010) and influencing factors (Chin *et al.*, 2015; Awa, 2018; Skafi *et al.*, 2020). As the rapid technology development has led to the acceleration of technological updates, the adoption of new technologies by enterprise users has become the hot topic at home and abroad.

Therefore, its influencing factors have become a core issue. By investigating the adoption behavior of corporate users of mobile payment, it is found that the task and technical characteristics and the matching degree of the task and technology have a significant impact on the adoption of mobile payment (Cao, 2008). Furthermore, studies have found that market expansion effects, consumer loyalty and channel conflicts in e-commerce are the main external factors that influence their adoption behavior (Du & Yu, 2016), while internal factors include organizational strategy and e-readiness, the cognition of decision-making groups, entrepreneurial characteristics, performance and effort expectations, etc. (Zhu & Zhao, 2009, 2011). The adoption of emerging technologies has always been the topic of scholars, and its influencing factors can be divided into three categories: (1) technical characteristics, for example, technology adoption cost, technology usefulness, security, characteristics and complexity (Wang *et al*., 2014; Skafi *et al*., 2020); (2) organizational factors, such as organizational competitive pressure, innovation needs, organizational experience, senior management and organizational adoption capabilities (Jing & Li, 2017; Skafi *et al*., 2020) and (3) environmental factors, which mainly refer to government policies, external environmental pressure, economic environment and supporting facilities (Xu *et al*., 2017; Awa, 2019).

Compared with enterprises, the adoption behavior of government is more minor, most of which focus on the adoption of new media (such as government affairs Weibo, government affairs WeChat and mobile clients). Technology and organization are the main factors that influence the adoption behavior of government, and the impact of environmental factors cannot be ignored simultaneously (Zhang *et al*., 2020). The representative study about the adoption behavior of corporate users is shown in Table 2.

Research has found that the limitations of single theory research are becoming more and more obvious, and researchers are increasingly inclined to the combination of multiple theories (Zhu & Zhao, 2009; Jing & Li, 2017). Therefore, scholars tend to analyze the adoption behavior of corporate users more comprehensively on the basis of multi-theory combination. The technology acceptance model, the social cognitive theory and the planned behavior theory are integrated into this field. Based on these mature theories, scholars have begun to study the adoption behavior of multiple theories, thus effectively overcoming the limitations of a single theoretical research.

3.2.2. Adoption behavior of rural households

Adoption behavior of rural households is divided into the cognitive phase, the persuasion phase, the decision-making phase, the implementation phase and the confirmation phase (Zhu, 2004). Empirical research has been applied to it and has its unique characteristics. According to the existing study, the factors that influence the adoption behavior of rural households are divided into four categories: (1) Individual characteristics include age, gender, education level, cognition, values and attitudes and risk preference which are the factors that scholars focus on. Age and risk aversion have a significant negative impact on technology adoption behavior, and high age is one of the essential reasons for 'partial adoption' of agricultural technology (Han & Yang, 2011; Mao *et al*., 2018). Gender and age are the origin factors for the contradiction between the adoption willingness and behavior of rural households (Yu *et al*., 2017). Education level is one of the main driving forces for the adoption behavior of rural households, but farmers with shorter or longer education years are unwilling to adopt new technologies (Luo *et al*., 2013; Connor *et al*., 2020). Cognition, value and attitude have an important impact on the adoption behavior of rural households (Gao, 2010; Srijna *et al*., 2019). (2) Household characteristics are one of the crucial factors that influence the adoption behavior of farmers, mainly including the proportion of agricultural income (Han & Yang, 2011; Guo & Hou, 2012), part-time householder (Zhao & Cai, 2012), the status of household durable assets (Luo *et al*., 2013) and household wealth (Srijna *et al*., 2019). (3) Technical characteristics include technical guidance,

Table 2. | Representative research on adoption behavior of corporate users.

Scholar (year)	Theory	Influencing factors
Cao (2008)	Task technology fit theory	Task and technology characteristics, matching degree between task and technology
Zhu & Zhao (2009)	Technology acceptance model, social cognitive theory, strategic management theory	Organizational strategic intent and e-readiness (value perception and IT resource readiness)
Zhu & Zhao (2011)	Social cognitive theory	Cognition of decision-making groups, organizational e-readiness (value perception and IT resource readiness)
Tsaia & Tang (2012)	Inter-organizational information system	Social support, power structure, organizational readiness, procedural flexibility, senior management support
Xu *et al.* (2014))	The unified theory of acceptance and usage of technology (UTAUT)	Entrepreneur characteristics, performance expectations, effort expectations
Wang *et al.* (2014)	'Technology Acceptance and Application'	Usefulness, security, network externalities
Chin *et al.* (2015)	Case study	Technical, organizational, social and personal factors
Jiang (2016)	Technology acceptance model	Business model innovation
Du & Yu (2016)	Competitive technology adoption framework	Market expansion effect, consumer loyalty, channel conflict
Jing & Li (2017)	Classic IT/IS adoption theories such as technology acceptance model, diffusion of innovation theory, Institutional theory and dynamic capabilities perspective	Technical characteristics, external competitive pressure, corporate innovation needs, adoption costs, adoption capabilities
Xu *et al.* (2017)	Grounded theory	External subject factors, income factors, environmental factors
Awa (2019)	Technology–organization–environment (TOE)	Technical characteristics, adoption costs, policy factors
Wang *et al.* (2019)	Theory of planned behavior	Subjective norms, perceptual behavior control, adoptive attitudes
Lu *et al.* (2021)	Theory of planned behavior, grounded theory	Imitation pressure, strategic value judgment and perceptual behavior control
Skafi *et al.* (2020)	TOE, the situational theory	Technical factors (complexity and security), organizational factors (senior management support and previous IT experience), environmental factors (infrastructure and government initiatives)

implementation convenience, technical understanding ability and technology availability which have a significant positive impact on the adoption behavior of rural households (Han & Yang, 2011; Connor *et al.*, 2020). However, the factors closely related to the technology show an increasing trend with the increase of non-agricultural income. The proportion of non-agricultural income is negatively correlated with technology adoption behavior (Wang *et al.*, 2018). (4) Environmental factors are divided into social factors, economic factors,

political factors and cultural factors. The expansion of social networks has a significant role in improving the adoption behavior of rural households (Geng *et al.*, 2017b; Yang, 2018). Exchange benefits, communication costs, communication scope and learning from others are important driving forces for their adoption behavior (Yang & Ju, 2014; Zhu *et al.*, 2014). In addition, economic incentives can significantly promote the adoption behavior of rural households, and the impact of market incentive mechanisms is significantly greater than that of government incentive mechanisms (Geng *et al.*, 2017b; Bijttebier *et al.*, 2018). A variety of factors such as policy propaganda, government subsidies, agricultural technology promotion and rural culture work together on the adoption behavior of rural households, which has a significant impact on it (Gao, 2010; Tong & Liu, 2018; Yu *et al.*, 2020). The representative research on the adoption behavior of rural households is shown in Table 3.

Table 3. | Representative research on adoption behavior of rural households.

Scholar (year)	Method	Influencing factors
Gao (2010)	Field survey	Rural culture, values of farmers, social class of farmers, rural grassroots organizations, agricultural insurance, agricultural extension system, cultural quality of farmers, risk preference, their attitudes towards new agricultural technologies
Han & Yang (2011)	Bivariate probit measurement model	Land features, technical guidance, age, the proportion of agricultural income, arable land area, fertilization idea, technical understanding ability, technology acquisition
Zhao & Cai (2012)	Logit model	Field school, part-time Householder, farmland scale
Guo & Hou (2012)	Logit model	Education level, percentage of agricultural income, age, information received, area of arable land, non-governmental organizations
Luo *et al.* (2013)	Probit model	Average age, household durable assets status, the number of contacts with technicians, education years
Zhu *et al.* (2014)	Computer simulation	Individual heterogeneity, social norms, learning from each other
Yang & Ju (2014)	Game model	Communication benefits, communication scope, communication costs
Yu *et al.* (2017)	Logistic-ISM (Interpretative Structural Model) model	Gender, age, herd mentality, soil fertility, planting scale, awareness of ecological environment policy, awareness of fertilizer reduction actions, awareness of the importance of green production
Geng *et al.* (2017b)	Ordered logit model	Economic incentives, social networks
Nadia *et al.* (2018)	Planned behavior theory	Adopt attitude, subjective norms, perceived behavior control
Yang (2018)	Ordered probit model	Ageing, social networks
Bijttebier *et al.* (2018)	Field survey	Plant physical characteristics, agricultural specialization, culture, politics, socioeconomic conditions
Mao *et al.* (2018)	Econometric model	Risk preference
Srijna *et al.* (2019)	Binary regression model	Household wealth, food security awareness, government intervention
Connor *et al.* (2020)	Questionnaire and field survey	Education level, ease of implementation, satisfaction, non-food income

3.2.3. Adoption behavior of individual users

The adoption behavior of individual users involves different fields. According to the co-occurrence analysis of keywords, its research mainly focuses on mobile services, mobile reading, mobile commerce, elderly and medical, etc. The technology acceptance model and the planned behavior theory are widely used as their theoretical basis. As research progresses, the two theories have been continuously enriched, which, in turn, significantly improve the interpretation and prediction of behavior (Duan & Jiang, 2008; Bian, 2012). User perception is an influencing factor that scholars pay close attention to and act on different aspects in different research fields. In mobile payment, risk perception and cost perception influence the adoption behavior of individual users (Yang *et al*., 2012). Pleasure perception, ease of use perception and mobility perception significantly influence the adoption of mobile services by users (Han *et al*., 2012). In addition, the factors that influence users to adopt mobile commerce mainly include ubiquitous perception, personalized perception, context perception and risk perception (Lu *et al*., 2012). Meanwhile, the perception of usefulness and ease of use will have a significant impact on the adoption behavior of individual users in various fields (Li *et al*., 2012; Wang, 2015; Elhajjar & Ouaida, 2019). The influencing factors of the adoption behavior of individual users can be divided into the following three categories: (1) Psychological factors mainly include user perception, behavior and attitude (Wang *et al*., 2015; Li & Zhong, 2016), user expectations (Liu, 2015; Geng *et al*., 2017a; Yuen *et al*., 2021), cognition (Farivar *et al*., 2020), self-efficacy (Mzaa *et al*., 2020; Irfan *et al*., 2020) and user trust level (Liu, 2015; Li & Zhong, 2016). (2) Technical characteristics mainly include compatibility (Yang *et al*., 2012), matching degree of task and technology (Liu, 2015), task characteristics (Wang, 2015) and technical characteristics and convenience (Mzaa *et al*., 2020). (3) Environmental factors mainly refer to subjective norms (Yang *et al*., 2012; Elhajjar & Ouaida, 2019), social influence (Liu, 2015; Geng *et al*., 2017a), information environment (Wang *et al*., 2015) and information quality (Li *et al*., 2012). The representative research of adoption behavior of individual users is shown in Table 4.

4. THEORETICAL FRAMEWORK FOR THE RESEARCH OF ADOPTION BEHAVIOR OF WATER EFFICIENCY LABELING

The above analysis shows that although there are three different hotspots in the research of adoption behavior, these three points are not mutually replaceable but complementary. Although the research on the adoption behavior of the water efficiency labeling has not been involved, these different hotspots allow us to develop a research framework for it. Based on the scientific measurement method, this paper sorts out the theoretical origins, research evolution, academic frontiers, clustering characteristics and knowledge base of the adoption behavior. It constructs the theoretical framework for the adoption behavior of the water efficiency labeling. The conclusions are as follows:

1. *Explore the adoption behavior of enterprise users*: The State Council pointed out in the 'Several Opinions on Promoting the Modernization of the Housing Industry and Improving the Quality of Housing' and the 'Guidelines for the Implementation of Commercial Housing Decoration Once in Place' that according to the actual situation, it requires scientific planning and step-by-step implementation to gradually eliminate rough houses and directly provide consumers with fully-furnished finished houses. The Ministry of Housing and Urban-Rural Development issued the 'Thirteenth Five-Year Plan for the Development of the Construction Industry'. It proposed that the area of newly started fully furnished residential buildings should reach 30%. Based on the above statistics, sanitary products are one of the leading products involved in the water efficiency labeling and one of the infrastructures for house decoration. Therefore, research on the adoption behavior of the water efficiency labeling by real estate enterprises is fundamental, and the water efficiency labeling is inseparable from water-saving technologies and standards. The adoption behavior of enterprise users is affected by many factors and

Table 4. | Representative research on adoption behavior of individual users.

Scholar (year)	Research field	Theory	Influencing factors
Yang & Yan (2011)	E-learning behavior	Rational behavior theory, planned behavior theory, technology acceptance model	Psychological factors, technical factors, resource factors
Yang *et al.* (2012)	Mobile payment	Valence theory	Relative advantages, compatibility, risk perception, cost perception, individual innovation, subjective norms and image
Han *et al.* (2012)	Mobile payment	Information systems, behavioral sciences and psychological theories	Pleasure perception, flow experience, ease of use perception, mobility perception
Lu *et al.* (2012)	Mobile commerce	Technology acceptance model	Ubiquitous perception, personalized perception, context perception and risk perception
Li *et al.* (2012)	Mobile securities	Technology acceptance model	Perception of usefulness, perception of ease of use, information quality, structural guarantee
Liu (2015)	Social network service	Unified theory of acceptance and usage of technology (UTAUT), task technology fit theory	Matching degree of task and technology、behavior expectations, social influence, contributing factors, trust perception
Wang (2015)	Mobile learning	Technology acceptance model, task technology fit theory	Task characteristics, technical characteristics, matching degree of task and technology, perception of usefulness, perception of ease of use
Wang *et al.* (2015)	Information adoption	Technology acceptance model	Information, information technology, information environment, information adoption attitude
Li & Zhong (2016)	Mobile O_2O commerce	Decomposed theory of planned behavior	Behavior attitude, perceived behavior control, subjective norms, value perception, service provider trust, context perception, technology trust
Geng *et al.* (2017a)	Information adoption	Unified theory of acceptance and usage of technology (UTAUT)	Performance expectations, social influence, information quality, information environment, effort expectations, risk perception
Farivar *et al.* (2020)	Smart wearable device	Cognitive complexity theory, aging theory	Equipment complexity cognition, cognitive age, subjective well-being
Yuen *et al.* (2021)	Autonomous vehicles	Trust theory, health belief model, attitude theory	Safety perception, result expectation, action reminder, self-efficacy, trust
Irfan *et al.* (2020)	Renewable energy	Planned behavior theory	Self-efficacy, awareness of renewable energy, perception of neighbor participation
Mzaa *et al.* (2020)	mHealth app	Unified theory of acceptance and usage of technology (UTAUT), neural network model	Performance expectations, social influence, hedonic motivation, privacy, convenience, self-efficacy, trust, lifestyle
Elhajjar & Ouaida (2019)	Mobile banking		Digital literacy, resistance to change, risk perception, ease of use perception, usefulness perception, subjective norms, personal innovation

involves many participants, so its adoption behavior is more complicated (Wang *et al*., 2019). In addition, the existing research on the adoption behavior of corporate users mainly focuses on the adoption behavior of technology and information. As a kind of information label, the adoption behavior of the water efficiency labeling is different from technology and information to some extent. Future research can focus on the following issues: (1) Exploring the influence mechanism of the adoption of water efficiency labeling from the perspective of the enterprise. Refine the factors that influence the adoption behavior of the water efficiency labeling of enterprise users by combining with related theories (Xu *et al*., 2017), and construct its impact mechanism model (Lu *et al.* 2021). It is necessary to comprehensively consider factors such as technology, organization and environment when establishing a new theoretical framework and (Li & Jing, 2015). (2) Carry out empirical research on the adoption behavior of water efficiency labeling of enterprise users. Empirical research is conducted to propose theoretical hypotheses or testing theories. Models can be constructed and hypotheses can be proposed on the basis of theoretical analysis, while extensive investigations can be carried out, data can be obtained and statistical analysis tools can be adopted to test and revise conceptual models.

2. *Research the adoption behavior of the water efficiency labeling of rural households*: Based on the above analysis, the adoption behavior of rural households has its uniqueness and focuses on technology. Although scholars have carried out a lot of empirical research on the adoption behavior of rural households, their conclusions are pretty different (Hu *et al*., 2020). Moreover, the research on the adoption behavior of the water efficiency labeling of the rural household has not been involved; future research can pay attention to the following issues: (1) Explore the water efficiency labeling catalogue of agricultural water-using products. Research in various countries shows that agricultural irrigation products have not yet been included in the water efficiency labeling plan. The 'China Water Resources Bulletin 2019' issued by the Ministry of Water Resources shows that the effective utilization coefficient of farmland irrigation water is only 0.559, and agricultural water consumption accounts for 61.16% of the total in the country. Chinese agriculture can achieve all-round water-saving by adopting water-saving technologies, improving water resource utilization efficiency, strengthening water management and developing new technologies (Zhang *et al*., 2005). It is very important to carry out research on the water efficiency labeling of agricultural products, which can promote the development of agricultural water-saving technologies and improve agricultural water-using efficiency. (2) Research the influencing factors about adoption behavior of the water efficiency labeling of rural households. Although the influencing factors about the adoption behavior of technology have specific reference significance for the water efficiency labeling, there are still large differences between the two. Therefore, it is vital to study the influencing factors about the adoption behavior of the water efficiency labeling of rural households to promote its development.
3. *Research on adoption behavior of the water efficiency labeling of individual users*: Although the 'Thirteenth Five-Year Plan for the Development of the Construction Industry' proposes to popularize fully furnished finished houses, the penetration rate will only reach 30% by 2020, and the rest still need buyers to decorate by themselves. Therefore, it is necessary to study the adoption behavior of the water efficiency labeling of individual users. Although many countries have begun to implement the water efficiency labeling, there are few studies on the adoption behavior of water efficiency labeling. The adoption behavior of rural households and enterprise users mostly focuses on technology and information. Both the energy efficiency labeling and the water efficiency labeling are affixed to the product's packaging, indicating the resource utilization efficiency of the product, and the action mechanism of the two is similar to a certain degree. Environmental labels, such as carbon labels, eco-labels and green labels, are identical to the water efficiency labeling. While providing information to consumers, they will also significantly influence the adoption behavior of individual users. The research results of these labeling systems also have a certain reference value for the water

efficiency labeling. Through analysis, it is found that there is a massive gap in the research on adoption behavior of the water efficiency labeling, mainly including the following two points: (1) The existing literature focuses on the research on the concept and design of the water efficiency labeling and its implementation effect and seldom involves the adoption behavior of the water efficiency labeling from the perspective of the individual user. Therefore, whether individual users pay more attention to the water efficiency labeling information when purchasing, and whether they trust the information and stimulate their adoption behavior, these issues need to be further studied. (2) There are few research results on the factors that influence the adoption behavior of the water efficiency labeling, and there is no exploration of its internal mechanism. Existing studies mostly adopt qualitative or quantitative methods to analyze the influence of various factors on the adoption behavior of the water efficiency labeling of individual users. Still, there are very few studies on how the water efficiency labeling influences the adoption behavior of individual users based on numerous influencing factors. Therefore, it is imperative to develop the consumer adoption behavior model of the water efficiency labeling with Chinese individual users as the research group.

5. CONCLUSION

By systematically summarizing 559 articles related to adoption behavior in the Web of Science core collection, Peking University core and CSSCI database from 1996 to 2020, this paper constructs a 'gold ingot' framework for adoption behavior research. It divides this research result into three hotspots: adoption behavior of corporate users, adoption behavior of rural households and adoption behavior of individual users. Through literature review, it is concluded that the influencing factors of adoption behavior of corporate users are technical characteristics, organizational factors and environmental factors; the main factors that influence adoption behavior of rural households are personality characteristics, household characteristics, technical characteristics and environmental factors; and that of the individual user are psychological factors, technical features and environmental factors. Based on the above analysis, this paper proposes a new research framework for the adoption behavior of the water efficiency labeling.

So far, there have not been many studies on the adoption behavior of the water efficiency labeling. In response to these issues raised in this paper, it is suggested that scholars should be able to deeply understand the internal mechanism of adoption behavior of the water efficiency labeling, and further improve and perfect the research by using multiple paradigms, thereby narrowing the gap between theoretical research and practice.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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