**Article**

# Impact of Intelligent Technology in Balanced Urban-Rural Development: An Interdisciplinary Analysis from the Perspective of Residents Using Greater Tainan Bus App

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**Abstract:** With the rapid development of globalization and technology, Taiwan faces an increasingly widening gap in development between urban and rural areas, especially in remote areas such as the Longqi District of Tainan City. Thus, focusing on the urban-rural development disparity in remote areas of Tainan City, Taiwan, we explored the role of intelligent technology in improving the quality of life for residents. Against the backdrop of Taiwan's rapid urbanization and demographic changes, we investigated the impact of intelligent technology in achieving balanced urban-rural development, emphasizing the key role of intelligent technology in narrowing the urban-rural divide. The research methods including extensive survey analysis and factor analysis were used to analyze user satisfaction and service quality. Employing the Technology Acceptance Model (TAM) and Kano model combined with fuzzy logic analysis, the impact of the APP on enhancing the quality of life for residents in remote areas was assessed from the perspectives of the needs of the residents. The results highlighted the immense potential of smart transportation systems in improving the comfort and accessibility of rural residents and valuable perspectives for balancing urban-rural development. The findings indicated that the APP significantly positively impacted residents' transportation convenience and overall life satisfaction, underscoring the potential of intelligent transportation systems in promoting balanced urban-rural development and enhancing quality of life.

**Keywords:** Intelligent Technology, Balanced Urban-Rural Development, Technology acceptance model, Greater Tainan Bus App, Fuzzy Analysis

## 1. Introduction

In the contemporary era of rapid globalization and technological advancement, the disparity in development between urban and rural areas continues to widen coupled with changes in demographic structures, particularly trends of decreasing birth rates and an aging population. This is especially true in island economies such as Taiwan, where rapid urbanization significantly impacts resource allocation and infrastructure development. Consequently, residents in remote areas, such as Longqi District in Tainan City, face a relative scarcity of services and infrastructure. In addressing Taiwan's intensifying urban-rural development gap, intelligent technology, particularly artificial intelligence (AI) and smart transportation systems, shows immense potential. The application of intelligent technology improves infrastructure and services in remote areas, prevents population loss, and supports the preservation of local cultural industries, thereby enhancing quality of life and attractiveness.

The scope of intelligent technology encompasses AI, the Internet of Things (IoT), big data, etc., with applications spanning agriculture, education, healthcare, transportation, urban planning, and more. Smart transportation systems, serving as a bridge connecting remote areas to the outside world, enhance quality of life by opening up more opportunities for residents. However, understanding the perspectives, needs, and concerns of residents is crucial in the application of these technologies and generating impact for a smooth transition process where technology integrates into life and new opportunities that make living in remote areas more convenient and attractive. This is vital for encouraging current residents to stay or attracting new residents.

Particularly in remote areas such as Longqi District, intelligent technology is more than a theoretical discussion; it presents practical solutions to everyday inconveniences. The application of intelligent technology, primarily in the context of smart transportation systems, demonstrates its potential to promote balanced urban-rural development. This study focuses on the Greater

Tainan Bus App, a smart transportation system, exploring its potential to enhance the quality of life and transportation convenience for residents in remote areas. By integrating the Technology Acceptance Model (TAM) and applying regression analysis with the Kano Model combined with the Fuzzy Kano Model methodology, we assessed the impact of the Greater Tainan Bus App on improving the quality of life for residents in remote areas. The comprehensive analysis results not only aid in understanding user acceptance of smart applications but also provide a basis for developing intelligent technology application strategies based on user satisfaction and service quality. The results also guide the development of technological solutions for the future promotion of balanced urban-rural development. Furthermore, the study results reveal the challenges and opportunities faced in promoting intelligent technology applications in non-urban areas and provide practical insights and strategic recommendations for policymakers and technology developers to promote the balanced application of technology in urban-rural development.

## 2. Literature Review

### 2.1 Rural Development

The demographic structure of Taiwan shows rapid aging, as indicated by the Ministry of the Interior. The number of counties and cities experiencing aging has increased from 3 in 2011 to 15 by March 2018. This phenomenon is attributed to a complex array of factors, including employment opportunities, the maturity of the social security system, the quality and quantity of medical services, the convenience of transportation infrastructure, and housing issues. These factors collectively impact the outflow of young people and their willingness to have children, propelling Taiwan into an aged society at a pace exceeding that of other countries globally.

Faced with the increasingly severe issue of demographic imbalance worldwide, especially low birth rates and aging populations, the balanced development of urban and rural communities also has a profound impact. Researchers and policymakers have focused on issues such as rural education (Wood, 2023; Akmal & Azizbek, 2023) to promote birth rates (Doepke, Hannusch, Kindermann & Tertilt, 2023; Chang, 2023), encourage population migration, and integrate intelligence technology with long-term care (Lukkien et al., 2023). However, compared to that in urban areas, literature on the application of technology in rural and remote areas is relatively scarce. Therefore, this study was carried out to fill this research gap, with a particular focus on the practical application and benefits of intelligent technology in remote areas.

In November 2016, the Executive Yuan of Taiwan proposed the "Digital Nation and Innovative Economic Development Plan" aimed at overcoming past industrial development barriers, strengthening the construction of digital infrastructure, promoting the development of the digital economy, fostering equal participation in the internet society, and establishing a service-oriented digital government. The plan prioritizes remote townships, offshore islands, and indigenous areas to establish Digital Opportunity Centers and tribal library information stations as service bases (Executive Yuan, 2017).

### 2.2 Resident Satisfaction and Application of Technological Power

Resident satisfaction is a crucial indicator for assessing the livability of cities and has profound implications for public policy and urban planning. Peng et al. (2020) noted that in measuring residential satisfaction, the satisfaction of residents with neighborhood environmental characteristics such as environmental beautification, management and maintenance, and scenic views, often holds more significance than satisfaction with the features of the residences. This finding echoes the concept of livable cities proposed by the United Nations in 1996, which emphasizes that cities must meet the material and spiritual needs of their residents. Zhang and Huang (2021) studied Taichung City and indicated that the planning of livable cities must include elements such as low-carbon ecology and waterfront green revitalization. The research of Nieuwenhuijsen (2020) is particularly relevant against the backdrop of the increasing urban-rural development gap in Taiwan, especially in the rapid transition to a super-aged society. It highlights the integration of intelligent technology solutions such as the Greater Tainan Bus APP, into urban planning and transportation systems to enhance the quality of life for urban and rural residents. The application of intelligent transportation technology reduces the carbon footprint in urban and rural areas and improves the health and well-being of residents, ensuring equitable access to services and opportunities.

TAM proposed by Davis et al. (1989), is based on the theory of reasoned action and aims to predict and explain the degree of acceptance of new technology by residents. The model emphasizes the impact of external variables on individual beliefs, attitudes, and intentions, driven by perceived usefulness and ease of use. Subsequent studies, such as those by Succi and Walter (1999) and Li (2017), further confirmed the importance of these factors in the process of information technology acceptance. Research related to TAM has been widely applied in various fields, including its integration with the medical sector (Kamal, Shafiq, & Kakria,

2020) and studies related to learning (Rafique et al., 2020; Alfadda & Mahdi, 2021; Han & Sa, 2022). These studies showed that TAM is widely used in traditional domains and plays a significant role in emerging technology fields.

As shown in Fig. 1, TAM comprises five basic constructs, including the independent variable 'External Variable', mediating variables 'perceived usefulness', 'perceived ease of use', 'attitude', 'behavioral intention', and the dependent variable 'actual system use'.The acceptance level of residents towards new information technology can be explained using TAM. This model focuses on the interrelation between choice attitudes and cognition to predict customer acceptance of adopting new information technologies (Succi & Walter, 1999). By managing external factors through TAM, the perceptions of users towards internal beliefs and cognition can be influenced, thereby enhancing their acceptance of information technology and facilitating the smooth promotion of information technology.
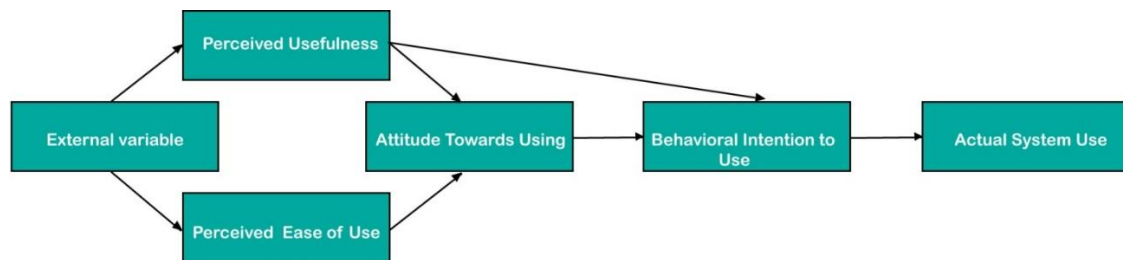


**Fig. 1.** TAM.

Davis et al. (1989) defined the main variables of TAM as follows. Perceived usefulness is when users believe the system is easy to operate, thereby enhancing their work efficiency. The higher the perceived practicality of the system, the more positive and proactive the user's attitude towards it. Perceived ease of use refers to when users subjectively feel that an information technology product is easy to use, indicating greater confidence and willingness to use the system more actively. Conversely, if the system is difficult to use, the willingness to use it decreases. Attitude toward information technology is influenced by perceived usefulness and ease of use. When users consider a system more useful, they also find it easier to operate and use, leading to a more positive attitude towards it. Moon and Kim (2001) found that perceived ease of use has a more significant impact on users' attitudes than perceived usefulness.

The research highlights the importance of intelligent technology in reducing the urban-rural development gap and underscores its potential to enhance residents' quality of life. The successful application of smart transportation systems depends not only on the advancement of the technology itself but also on a deep understanding of user needs and continuous optimization. This study, through in-depth analysis and understanding of residents' acceptance and needs for intelligent technology, can more effectively promote the balanced development of intelligent technology between urban and rural areas, thereby fostering overall societal harmony and progress.

In advancing smart transportation systems, it is crucial to deeply understand the specific needs and expectations of residents in remote areas, how intelligent technology can overcome these challenges, and enhance the quality and convenience of life in these areas. Understanding the key role of intelligent technology in promoting balanced urban and rural development can provide a reference for future policy-making and technological development. We applied TAM to smart transportation systems, particularly focusing on the impact in remote areas, to explore the potential of intelligent technology in narrowing the urban-rural development gap. In public services and technology applications, such as the Greater Tainan Bus APP, the acceptance of technology is closely related to the livability of the city and resident satisfaction. Especially for the elderly, the ease of use and usefulness of technology are crucial for their life adaptation and perception (Huang, 1992). By effectively managing external variables and adjusting internal beliefs, the acceptance and usage rate of new technologies can be enhanced, thereby increasing residents' satisfaction with their living environment.

## 3. Research Methodology

In the context of rapid digital technology advancement, intelligent technology's impact on urban and rural development is becoming evident, not only in economic, social, and cultural aspects but also in the public transportation sector. This study aimed to delve deeply into the strategic role of intelligent technology in promoting balanced urban-rural development, with a particular focus on the case study of the Tainan City Bus App. Choosing appropriate research methods and steps is crucial for accurately understanding the impact of intelligent technology on urban-rural development. Thus, we used factor analysis, Kano regression

analysis, and the Fuzzy Kano model. Initially, factor analysis was employed to identify the main factors concerning Tainan residents regarding the Bus App and potential variables influencing the public's use of the APP. Subsequently, Kano regression analysis was used to assess the impact of different APP features on user experience, satisfaction, and recommendation willingness. Finally, the Fuzzy Kano model was used to address the uncertainty in user feedback and enhance the functionality and satisfaction assessment. Using such methods, the efficacy of intelligent technology in urban and rural development was analyzed from a macro-to-micro perspective, providing a basis for decision-making.

### 3.1 Factor Analysis

A questionnaire was created based on TAM (Davis et al., 1989) to assess users' perceptions of the Greater Tainan Bus App. The questionnaire comprised nine items on a Likert five-point scale. It was pre-tested before its official distribution. The questionnaire was disseminated through an online platform in October 2023, yielding 357 responses. The Cronbach's alpha coefficient of 0.942 indicated an internal consistency and reliability of the questionnaire. For valid responses, the KMO and Bartlett's Test of Sphericity were analyzed as shown in Table 1. The KMO value was 0.963, and the p-value for Bartlett's test was 0.000 at a significant level (p<0.001), confirming that the dataset was suitable for factor analysis.

**Table 1.** KMO and Bartlett's test results.

| Kaiser-Meyer-Olkin | Measure of Sampling Adequacy | 0.963 |
|---|---|---|
| Bartlett's Test of Sphericity | Approximate Chi-Square Distribution | 1581.51 |
| | Degrees of Freedom | 36 |
| | Significance | 0.000 |

### 3.2 Kano Regression

The Kano regression analysis was used to investigate the factors influencing user satisfaction and recommendation willingness for the Greater Tainan Bus App. The analysis was conducted on 211 valid responses, screened from 357 initial questionnaires, from the respondents who confirmed downloading or the use of the APP. The regression analysis results were used to evaluate the impact of various APP features on users' overall experience, willingness to recommend to others, and overall satisfaction. Factors such as usability, utility, and convenience were considered in this analysis to determine which features significantly contributed to enhancing user satisfaction and recommendation willingness and improving the APP.

### 3.3 Fuzzy Kano model

The Fuzzy Kano model is a combination of the Kano model fuzzy logic. The Fuzzy Kano model was used to delve into the user experience of the Greater Tainan Bus App. The Fuzzy Kano model is appropriate to address the uncertainties and ambiguities in user feedback and provide a precise assessment of user experience. In this study, user satisfaction with different features of the APP and the contribution of these features were evaluated to enhance overall user satisfaction and loyalty. To this end, detailed feedback was collected from the residents of Longqi District, including 3 female and 4 male respondents. The residents, with over 30 years of residency, included community representatives to share their public transportation needs and residential backgrounds. Diverse backgrounds and experiences were crucial for a deep understanding of user satisfaction with the Greater Tainan Bus App. Through fuzzy mean analysis, subjective evaluations were transformed into quantifiable data, allowing for in-depth analysis and understanding of user satisfaction with various features of the Greater Tainan Bus App.

## 4. Results and Discussions

### 4.1 Factor Analysis

Using TAM's perceived usefulness, ease of use, and attitude as measurement dimensions, we clarified the factors of intelligent technology in achieving balanced urban-rural development. The relationship between cognitive and affective factors and technology application was also explored. The residents' acceptance of information technology was explained using TAM, with external variables influencing internal beliefs, attitudes, and intentions. Intelligent technology, being different from general products or services, made the residents willing to use it. The acceptance of the Greater Tainan Bus App was identified through perceived usefulness, ease of use, and attitude.

Table 2 shows the features of the Greater Tainan Bus App significantly which impact user satisfaction. The top three aspects are 'choosing to use is wise' (0.860), 'very practical for moving around in Tainan' (0.849), and 'the interface is not complex' (0.835). Compared to traditional bus inquiry methods, downloading and using the APP offered convenience to users with a user-friendly interface being a major factor in residents' acceptance and subsequent use. These three factors reflected the contribution of the Greater Tainan Bus App to daily life and embodied the core values of the smart city concept, aligning with the United Nations' goals for livable cities, especially in green public spaces, public transportation, and community participation. Moreover, the features were related to residents' satisfaction on a psychological level, pursuing the concept of a 'Comfortable Living City.' Providing an acceptable application for residents (0.835), requiring minimal effort to use (0.834), offering a better experience compared to past inquiries (0.818), and ease of learning and use after instruction (0.818) were beneficial for users less skilled in technology such as the elderly. Improving the efficiency of bus information queries (0.804) and making it easier to find bus information (0.799) showed that intelligent technology was increasingly integrated into life, revitalizing the unchanging lifestyles and social pulse in rural areas. Using TAM, it was found that residents' perceived usefulness and ease of use of new technology were the main causes of their acceptance. This aligns with the Theory of Reasoned Action, which suggests that beliefs and attitudes can predict behavioral intentions. In the present study, when users believed a technology positively impacted their daily lives, they were more likely to choose to use it.

**Table 2.** Factors affecting user satisfaction with the Greater Tainan Bus App.

| Project | Factor loadings |
|---|---|
| 2. Choosing to Use is Wise | 0.860 |
| 6. Very Practical for Moving Around in Tainan | 0.849 |
| 8. The Interface is Not Complex | 0.835 |
| 3. Acceptable Application | 0.835 |
| 7. Requires Minimal Effort to Use | 0.834 |
| 1. Using it is a Good Experience | 0.818 |
| 9. Easy to Learn and Use | 0.818 |
| 4. Improves the Efficiency of Bus Information Queries | 0.804 |
| 5. Easier to Find Bus Information | 0.799 |

*4.2 Kano Model Analysis of User Evaluation*

For a multidimensional regression analysis of user satisfaction with the Greater Tainan Bus App, we utilized the Kano Model regression analysis. The impact of product features on user behavior was evaluated in terms of experience evaluation, recommendation willingness, and overall satisfaction. Through the statistical analysis, user evaluations of the APP's various functions were conducted and key satisfaction-driving factors were identified. The results are the basis for developing marketing strategies, guidance for future development, and product improvement as they highlighted characteristics for user satisfaction.

Tables 3 and 4 show the correlation between user satisfaction and specific features. The negative and positive regression coefficients for each feature indicated positive impacts or drawbacks in user experience. "Using it is a Good Experience," "Choosing to Use is Wise," and "Requires Minimal Effort to Use" showed that when the APP's usability and utility were enhanced, user satisfaction significantly increased. "Improves the Efficiency of Bus Information Queries" under attractive quality indicated that for the public using the Greater Tainan Bus App, the efficiency of querying bus information was the most important factor attracting users, while the other eight items were one-dimensional attributes. To enhance user satisfaction, the Greater Tainan Bus App must continuously improve and optimize its various qualities to be practical for moving around in Tainan and allow the public to easily get started without much effort. When "Improves the Efficiency of Bus Information Queries" met user expectations, it impacted overall satisfaction. In the Kano Model, attractive quality features are typically not seen but increase user satisfaction and create a differentiated advantage. Thus, the Greater Tainan Bus App must be enhanced with features of additional value and surprise such as route planning optimized through AI, to enhance users' positive perceptions.

The eight evaluation items of one-dimensional attributes showed that the APP's usability, utility, and interface were basic requirements for user satisfaction to provide a good experience. When these fundamental requirements are not met, user satisfaction significantly decreases. However, when these characteristics are enhanced, their contribution to increasing satisfaction is limited, as users already consider them as expected services. Strategically, to enhance user satisfaction and promote the acceptance of intelligent technology, the developers of the Greater Tainan Bus App must focus on continuously improving these basic features while exploring new characteristics that create additional value, to exceed users' basic expectations.

In summary, the functional features of the Greater Tainan Bus App showed one-dimensional attributes in user satisfaction, with "Improves the Efficiency of Bus Information Queries" as an attractive quality having a positive impact on satisfaction. This indicates that the stability of basic functions is a prerequisite for user satisfaction, while features with expectations can significantly enhance satisfaction. Therefore, developers must balance these two aspects, continuously optimizing basic functions while innovating attractive features to enhance the user experience.

**Table 3.** Regression analysis result of user experience evaluations for the Greater Tainan Bus App.

| Evaluation item | β1 negative | Significance | β2 forward | Significance | $R^2$ | Quality classification |
|---|---|---|---|---|---|---|
| 1. Using it is a Good Experience | -0.196 | 0.002 | 0.440 | 0.000 | 0.284 | One-dimensional |
| 2. Choosing to Use is Wise | -0.270 | 0.000 | 0.498 | 0.000 | 0.407 | One-dimensional |
| 3. Acceptable Application | -0.256 | 0.000 | -0.470 | 0.000 | 0.362 | One-dimensional |
| 4. Improves the Efficiency of Bus Information Queries | -0.111 | 0.080 | 0.500 | 0.000 | 0.308 | Attractive |
| 5. Easier to Find Bus Information | -0.185 | 0.004 | 0.416 | 0.000 | 0.257 | One-dimensional |
| 6. Very Practical for Moving Around in Tainan | -0.260 | 0.000 | 0.441 | 0.000 | 0.330 | One-dimensional |
| 7. Requires Minimal Effort to Use | -0.295 | 0.000 | 0.504 | 0.000 | 0.412 | One-dimensional |
| 8. The Interface is Not Complex | 0.287 | 0.000 | 0.498 | 0.000 | 0.397 | One-dimensional |
| 9. Easy to Learn and Use | -0.270 | 0.000 | 0.501 | 0.000 | 0.406 | One-dimensional |

Regarding the willingness to recommend the Greater Tainan Bus App, features such as "Improves the Efficiency of Bus Information Queries" and "Easier to Find Bus Information" were classified as attractive qualities. This indicates that the public finds the bus information query function of the Greater Tainan Bus App convenient, serving as a motivation to recommend the APP to friends and family. The other seven items are identified as one-dimensional attributes, suggesting that basic functionalities of the APP such as "Using it is a Good Experience," "Choosing to Use is Wise," and "Acceptable Application" were essential factors influencing users to recommend the APP to others. The one-dimensional attributes of the seven evaluation items illustrated in Table 4 indicate that they are expected service standards by users. Failure to meet these standards negatively impacts the willingness to recommend. Therefore, to maintain and improve recommendation rates, continuous optimization of these basic functionalities is necessary, as inadequacy in these fundamental elements significantly impacts the willingness to recommend. Simultaneously, creating new features that bring additional surprises and value to users can help transition from basic satisfaction to proactive recommendation behaviors. In marketing promotions, "Improves the Efficiency of Bus Information Queries" and "Easier to Find Bus Information" are highlighted as main selling points to accentuate their added value. They enhance the satisfaction and loyalty of existing users and attract potential users, representing how intelligent technology can provide tangible assistance in daily life. By optimizing these attributes, the Greater Tainan Bus App can stand out in the market, effectively broadening its user base and reducing marketing costs.

The analysis result of the recommendation willingness for the Greater Tainan Bus App showed that the two attractive quality features, "Improves the Efficiency of Bus Information Queries" and "Easier to Find Bus Information" influenced user recommendation behaviors by satisfying basic expectations and adding extra value. This suggests that promotional strategies must emphasize these characteristics to attract new users, while continuously optimizing these Attractive factors to enhance user satisfaction, thereby consolidating the user base and promoting word-of-mouth spread.

**Table 4.** Regression analysis results for the willingness to recommend the Greater Tainan Bus App to others.

| Evaluation item | β1 negative | Significance | β2 forward | Significance | $R^2$ | Quality classification |
|---|---|---|---|---|---|---|
| 1. Using it is a Good Experience | -0.234 | 0.000 | 0.368 | 0.000 | 0.243 | One-dimensional |
| 2. Choosing to Use is Wise | -0.296 | 0.000 | 0.433 | 0.000 | 0.358 | One-dimensional |
| 3. Acceptable Application | -0.277 | 0.000 | 0.398 | 0.000 | 0.305 | One-dimensional |
| 4. Improves the Efficiency of Bus Information Queries | -0.123 | 0.065 | 0.422 | 0.000 | 0.236 | Attractive |
| 5. Easier to Find Bus Information | -0.169 | 0.009 | 0.401 | 0.000 | 0.233 | Attractive |
| 6. Very Practical for Moving Around in Tainan | -0.312 | 0.000 | 0.389 | 0.000 | 0.320 | One-dimensional |
| 7. Requires Minimal Effort to Use | -0.312 | 0.000 | 0.395 | 0.000 | 0.312 | One-dimensional |
| 8. The Interface is Not Complex | 0.226 | 0.000 | 0.473 | 0.000 | 0.325 | One-dimensional |
| 9. Easy to Learn and Use | -0.286 | 0.000 | 0.463 | 0.000 | 0.377 | One-dimensional |

Table 5 shows that the negative coefficients ($\beta 1$) for each evaluation item were significant (at a significance value of 0.05), indicating that if these items fail to meet user expectations, they negatively impact satisfaction. The significance of the positive coefficients ($\beta 2$) demonstrates that when these items meet or exceed user expectations, their positive contribution to satisfaction is also significant. Notably, the $R^2$ values for "Very practical for mobility in Tainan" and "Easy to get started with" were 0.425 and 0.418, indicating that these items played a more important role in the variance of user satisfaction. Although these features were categorized as one-dimensional quality, they remained key points in enhancing overall user satisfaction. Strategically, focus must be placed on the stability and optimization of these key items, while exploring potential attractive factors to enhance user loyalty and promote positive recommendation behavior.

The overall satisfaction with the Greater Tainan Bus APP was contributed to by 'one-dimensional' quality attributes. When the 'quality evaluation' is negative, it significantly impacts 'satisfaction'; conversely, when the 'quality evaluation' is positive, it also significantly enhances 'satisfaction'. This indicates that these attributes are basic expectations, including a good user experience, wise usage choices, and an easy-to-use interface, which are essential for user satisfaction with the APP. To enhance overall user satisfaction, APP developers need to ensure these one-dimensional quality attributes consistently meet users' fundamental needs. Additionally, the absence of significant attractive attributes in the data suggested that the development team must have considered adding more innovative features or enhancing existing functionalities to offer experiences that exceed basic user expectations, thereby further improving user satisfaction and loyalty. The regression analysis results underscore the one-dimensional impact of various functional characteristics of the Greater Tainan Bus APP on overall user satisfaction: basic attributes, if not meeting user expectations, have a significant negative effect on satisfaction; if expectations are met, they positively promote satisfaction. The development team needs to continually optimize these key functions to maintain the user base, and explore new innovative points to enhance the user experience, thus strengthening user loyalty and willingness to recommend.

**Table 5.** Regression analysis results for overall satisfaction with the use of the Greater Tainan Bus APP.

| Evaluation item | β1 negative | Significance | β2 forward | Significance | R² | Quality classification |
|---|---|---|---|---|---|---|
| 1. Using it is a Good Experience | -0.352 | 0.000 | 0.414 | 0.000 | 0.384 | One-dimensional |
| 2. Choosing to Use is Wise | -0.381 | 0.000 | 0.422 | 0.000 | 0.427 | One-dimensional |
| 3. Acceptable Application | -0.325 | 0.000 | 0.375 | 0.000 | 0.323 | One-dimensional |
| 4. Improves the Efficiency of Bus Information Queries | -0.193 | 0.003 | 0.452 | 0.000 | 0.312 | One-dimensional |
| 5. Easier to Find Bus Information | -0.264 | 0.000 | 0.379 | 0.000 | 0.278 | One-dimensional |
| 6. Very Practical for Moving Around in Tainan | -0.347 | 0.000 | 0.459 | 0.000 | 0.425 | One-dimensional |
| 7. Requires Minimal Effort to Use | -0.351 | 0.000 | 0.451 | 0.000 | 0.402 | One-dimensional |
| 8. The Interface is Not Complex | -0.323 | 0.000 | 0.462 | 0.000 | 0.388 | One-dimensional |
| 9. Easy to Learn and Use | -0.349 | 0.000 | 0.449 | 0.000 | 0.418 | One-dimensional |

To provide a basis for the market promotion strategy of the Greater Tainan Bus APP, we analyzed the impact of the APP on user behavior from three different perspectives: users' experience evaluation, willingness to recommend to others, and overall satisfaction with the APP. We integrated the regression analysis results of the Kano model to conduct an in-depth quality classification comparison of different functional characteristics of the Greater Tainan Bus APP (Table 6). Users' experience ratings, recommendation willingness, and overall satisfaction were evaluated. The result indicated that they reflected the impact of the APP on user behavior and the importance of basic one-dimensional quality characteristics in maintaining basic user satisfaction. Notably, 'Enhancing the efficiency of bus information queries' was classified as an attractive quality in both user experience evaluation and willingness to recommend to others, highlighting its contribution to user experience. When this feature exceeds users' basic expectations, it significantly increases user satisfaction and the willingness to recommend. This characteristic provides additional value beyond basic functions, offering users surprise and a superior experience, thereby motivating them to continue using the APP and actively recommend it to others, which is crucial for the market acceptance and word-of-mouth dissemination of the application.

**Table 6.** Analysis result of kano quality characteristics under user behavior indicators for the Greater Tainan Bus APP.

| Evaluation Items | Experience Use Evaluation | Willingness to Recommend to Others | Overall Satisfaction |
|---|---|---|---|
| 1. Using it is a Good Experience | One-dimensional | One-dimensional | One-dimensional |

| | | | |
|---|---|---|---|
| 2. Choosing to Use is Wise | One-dimensional | One-dimensional | One-dimensional |
| 3. Acceptable Application | One-dimensional | One-dimensional | One-dimensional |
| 4.Improves the Efficiency of Bus Information Queries | Attractive | Attractive | One-dimensional |
| 5. Easier to Find Bus Information | One-dimensional | Attractive | One-dimensional |
| 6.Very Practical for Moving Around in Tainan | One-dimensional | One-dimensional | One-dimensional |
| 7. Requires Minimal Effort to Use | One-dimensional | One-dimensional | One-dimensional |
| 8. The Interface is Not Complex | One-dimensional | One-dimensional | One-dimensional |
| 9. Easy to Learn and Use | One-dimensional | One-dimensional | One-dimensional |

*4.3 Quality Classification Using Fuzzy Kano Analysis*

By applying the Kano Model for quality classification, user satisfaction and dissatisfaction with specific product features were evaluated. The Kano Model reveals which features are basic expectations of users, and the result is used to enhance user satisfaction. The traditional Kano Model overlooks the subtle psychological differences among users and the deeper implications of the issues. Therefore, fuzzy logic is introduced in the Kano model to handle uncertainty and subjectivity. This allows for considering people's vague feelings towards a certain feature, ranging from very like to very dislike. Using fuzzy logic, user feedback can be more accurately captured and analyzed, and these data are transformed into concrete values for detailed quality classification.

In this study, we utilized the Fuzzy Kano model for quality classification. For setting an α-cut consensus level and standardizing the Fuzzy Kano Model, we used 0.4 as the threshold value for classification and decisions with classification values between 0.33 to 0.5. In this method, psychological diversity and discussion topics are considered to supplement the Kano Model's shortcomings in the subjectivity of semantic scales through the method of fuzzy mode. Through fuzzy mode analysis, we identified the quality attributes of the Greater Tainan Bus APP at the current stage, including basic satisfaction factors and optimization potential. These findings are crucial for the continuous improvement of APP functions and the enhancement of user satisfaction.

The necessary quality attribute of the Greater Tainan Bus APP is a good experience. It is necessary to let users know that the 'Greater Tainan Bus APP' is a wise and acceptable choice as it offers efficient bus information query and easy access to bus information, and is practical for mobility in Tainan with a simple user interface available without much effort and easiness to start with. These are one-dimensional quality attributes, indicating that the current use of the 'Greater Tainan Bus APP' is satisfactory, and satisfaction will be higher if more diverse and continuously optimized features can be provided.

Table 7 shows the satisfaction of Longqi District residents with various functions of the Greater Tainan Bus APP. The analysis results quantified residents' emotional responses (from like to dislike) to the APP functions using fuzzy logic and revealed which functions were favored or considered essential by users. Using fuzzy quantification, the degrees of affection and expectations of residents for each function were presented. The high affirmation of 'Choosing to use is wise' showed the significant attraction of this function. Conversely, medium or low scores for other functional items suggested meeting basic expectations. These emotional evaluations are crucial for the continuous improvement of the APP and the richness of the user experience, pointing to the need for developers to strive not only to meet basic needs but also to go beyond, offering additional value and enhancing the user experience.

**Table 7.** Fuzzy sample mean scores of positive responses.

| Evaluation Items | Like | Taken for Granted | Indifferent | Tolerable | Dislike |
|---|---|---|---|---|---|
| 1. Using it is a Good Experience | 0.25 | 0.29 | 0.05 | 0.00 | 0.00 |
| 2. Choosing to Use is Wise | 0.44 | 0.36 | 0.25 | 0.17 | 0.08 |
| 3. Acceptable Application | 0.35 | 0.21 | 0.02 | 0.00 | 0.00 |
| 4.Improves the Efficiency of Bus Information Queries | 0.26 | 0.23 | 0.05 | 0.04 | 0.00 |
| 5. Easier to Find Bus Information | 0.33 | 0.24 | 0.02 | 0.00 | 0.00 |
| 6.Very Practical for Moving Around in Tainan | 0.35 | 0.20 | 0.03 | 0.01 | 0.00 |
| 7. Requires Minimal Effort to Use | 0.31 | 0.23 | 0.03 | 0.01 | 0.00 |
| 8. The Interface is Not Complex | 0.34 | 0.18 | 0.07 | 0.00 | 0.00 |
| 9. Easy to Learn and Use | 0.30 | 0.26 | 0.03 | 0.00 | 0.00 |

The analysis of the average numbers of fuzzy samples in Table 8 provides the result of user reactions to the absence of various functions in the Greater Tainan Bus App, from a reverse perspective (i.e., the emotional response when quality is not met). The degree of dissatisfaction of users with functions increased when they were not fulfilled. Notably, high scores under the 'Dislike' category was observed for 'Improving the Efficiency of Bus Information Queries' suggesting that the absence of this function severely impacted user satisfaction negatively. This highlights the significance of features for user experience and the disproportionately adverse effects of their absence. Such information is instructive for setting priorities and formulating improvement plans, especially when resources are limited and focus must be concentrated on areas that have the greatest impact on user experience.

**Table 8.** Fuzzy sample mean scores of negative responses

| Evaluation Items | Like | Taken for granted | Indifferent | Tolerable | Dislike |
|---|---|---|---|---|---|
| 1. Using it is a Good Experience | 0.00 | 0.00 | 0.08 | 0.23 | 0.28 |
| 2. Choosing to Use is Wise | 0.00 | 0.00 | 0.06 | 0.20 | 0.33 |
| 3. Acceptable Application | 0.00 | 0.00 | 0.03 | 0.22 | 0.34 |
| 4. Improves the Efficiency of Bus Information Queries | 0.00 | 0.00 | 0.01 | 1.95 | 4.95 |
| 5. Easier to Find Bus Information | 0.00 | 0.00 | 0.02 | 0.13 | 0.43 |
| 6. Very Practical for Moving Around in Tainan | 0.00 | 0.00 | 0.18 | 0.20 | 0.42 |
| 7. Requires Minimal Effort to Use | 0.00 | 0.00 | 0.03 | 0.20 | 0.36 |
| 8. The Interface is Not Complex | 0.00 | 0.00 | 0.18 | 0.11 | 0.30 |
| 9. Easy to Learn and Use | 0.00 | 0.00 | 0.14 | 0.18 | 0.27 |

The analysis results presented in Table 9 show the perceptions of the residents in the Longqi District regarding the quality attributes of the Greater Tainan Bus App. Residents' emotional responses (positive or negative) were analyzed for the correlations with the importance of product features. Most functions were perceived as one-dimensional qualities, indicating these are basic standards expected by users. Their absence led to dissatisfaction, while their presence did not necessarily increase satisfaction. For Longqi residents, these functions were fundamental elements of the APP. Notably, no feature was categorized as an attractive quality, implying the potential for the APP to enhance user satisfaction and add extra value. To improve user satisfaction, APP developers must focus on the stability and efficiency of these essential functions. Moreover, the developers must introduce attractive quality features to meet basic expectations and enhance the user experience and satisfaction. This is particularly crucial for localized intelligent technology applications such as the Greater Tainan Bus App as they need to align with the specific needs and usage habits of residents.

The results of the fuzzy Kano analysis in evaluating user satisfaction with the Greater Tainan Bus App revealed the detailed perceptions of Longqi residents towards the APP's features. The residents valued basic functionalities such as usability and practicality, highlighting the necessity of meeting their needs. However, the absence of these features causes significant dissatisfaction, underscoring the importance of maintaining these basic attributes. Simultaneously, localized intelligent technology applications need to be developed to accommodate the needs of residents. New features must be incorporated to provide experiences beyond expectations to enhance user satisfaction and the appeal of the application.

**Table 9.** Determination of quality attributes for the Greater Tainan City Bus App.

| Evaluation Items | Forward | Negative | Quality Classification |
|---|---|---|---|
| 1. Using it is a Good Experience | taken for granted | dislike | Must-be |
| 2. Choosing to Use is Wise | like | dislike | One-dimensional |
| 3. Acceptable Application | like | dislike | One-dimensional |
| 4. Improves the Efficiency of Bus Information Queries | like | dislike | One-dimensional |
| 5. Easier to Find Bus Information | like | dislike | One-dimensional |
| 6. Very Practical for Moving Around in Tainan | like | dislike | One-dimensional |
| 7. Requires Minimal Effort to Use | like | dislike | One-dimensional |
| 8. The Interface is Not Complex | like | dislike | One-dimensional |
| 9. Easy to Learn and Use | like | dislike | One-dimensional |

## 5. Conclusions

Urban-rural development disparity is observed in many countries due to rapid urbanization and demographic changes. The application and effectiveness of intelligent transportation systems were explored to enhance the quality of life for residents in remote areas such as Longqi District in Tainan City. The residents' needs and perspectives on the system were analyzed in terms of acceptance and response. They have been less emphasized in prior urban-rural development studies. A resident-centered research methodology was used to understand the potential and challenges of intelligent technology to improve residents' lives and narrow the urban-rural divide. The user-centric approach in this study offers understanding and resolving issues of urban-rural development imbalance, underscoring the importance of integrating intelligent technology in balanced urban-rural development strategies.

By combining TAM and the Kano model with fuzzy logic analysis, we assessed user satisfaction and service quality of the Greater Tainan Bus APP. Using the multidimensional approach, we evaluated the impact of intelligent technology in remote areas. The significant influence of the Greater Tainan Bus APP was found in enhancing transportation convenience and overall quality of life for residents in remote areas. The intelligent transportation system improves connectivity and accessibility in remote areas. They enable residents to conveniently access essential services and facilities and significantly increase overall satisfaction with their living environment. The system is important in promoting social and economic participation in communities and residents' quality of life. It also alleviates the urban-rural development gap. The analysis results of this study revealed the effectiveness of the intelligent transportation system as a convenient and reliable transportation option. The results emphasize the importance of integrating intelligent technology into urban-rural development and support using these technologies to enhance residents' quality of life.

Future research is demanded to further explore the application of intelligent technology in other remote areas, considering the needs and challenges of different regions. Such a deeper investigation into the role of intelligent technology in enhancing social participation and economic development in urban and rural areas contributes to finding solutions for balanced urban-rural development in Taiwan and globally.

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