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RESEARCH ARTICLE

Application of Internet of Things Technology on Shared Mobility Platforms: Towards A Shared Mobility Platform Model

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ABSTRACT

This study examined the influence of Internet of Things (IoT) integrations in shared mobility platforms on user satisfaction and frequency of use. With the rapid growth of shared mobility services, the role of IoT technologies in enhancing system responsiveness, maintenance efficiency, and real-time data accuracy became crucial. Through a survey of 332 users, the study investigated the correlation between the accuracy of real-time data, system responsiveness, and maintenance efficiency on the overall satisfaction and usage frequency of shared mobility platforms. The results revealed a significant relationship between these IoT features and user satisfaction (p-value = 0.000), as well as between system responsiveness and maintenance efficiency and the frequency of platform use (p-value = 0.000). Users reported a high level of satisfaction due to the reliability, real-time updates, and eco-friendly transportation options facilitated by IoT technologies. The study concluded that IoT-enhanced shared mobility platforms significantly improved user engagement by providing a more efficient and seamless experience, thus encouraging frequent use. It was recommended that shared mobility platforms invest further in IoT technology to optimize operational efficiency, increase user satisfaction, and promote sustainable practices. Educating users about IoT features could have enhanced awareness, further driving adoption. The findings contributed to the understanding of IoT's role in shaping the future of shared mobility and its potential for fostering a more sustainable and user-centric transportation model.

INTRODUCTION

Internet of Thing technology has been advancing rapidly in all sectors worldwide, especially urban transportation systems. Shared mobility platforms, which incorporate bike-sharing, car-sharing, and ride-sharing services, are gradually integrating IoT for improving its efficiency in operation, satisfaction among users, and sustainability. For example, in cities like Tianjin, China, such integrations are becoming vital in addressing major bottlenecks in transportation in terms of congestion, resources, and the environment (Xue et al., 2022; Awais et al., 2024). In general, with urbanization and the digitalization of transport systems around the world, shared mobility services have gone up exponentially with IoT as an even more powerful tool for new transport needs.

Despite these progresses, there are few studies with comprehensive understanding of how to best integrate the IoT technologies within the shared mobility framework for optimal results. The study above has referred to the literature which indicates how IoT can collect real-time data to be used for predictive maintenance as well as help improve traffic flow, but practically little is known about their implementations and impacts within highly populated places like Tianjin (Wang et al., 2023). Moreover, the contemporary systems have encountered issues with availability of vehicles, efficiency in maintenance processes, and also data privacy concerns, which has limited their scalability as well as usage by the consumers (Almusallam et al., 2021; Jam et al., 2016). These knowledge gaps highlight the call for empirical investigations to examine how IoT can resolve these operational inefficiencies and improve consumer satisfaction.

The present research work was undertaken to address these critical gaps by investigating how IoT technology impacted shared mobility platforms in Tianjin. By focusing on operational, environmental, and user experience dimensions in IoT integration, this research quantified benefits from these technologies and also proposed a model for implementing it successfully. The research design followed was quantitative, and the data were collected from users of shared mobility on the key variables like vehicle availability, system responsiveness, safety features, and environmental awareness. Advanced statistical tools were used in the analysis on these variables and their relation to one another, thereby establishing evidence-based insight into IoT's transformative potential.

Its main importance is as a potential way of informing effective strategies for embedding IoT into transportation in urban areas from the perspectives of policymakers, planners for urban areas, and providers of shared mobility. Results in terms of the key determinants for user satisfaction and operational efficiency contribute to the pursuit of smarter cities and more livable cities and sustainability. This research is further aligned with international efforts to create more sustainable cities through technological innovation. It is relevant to other cities that face these challenges.

LITERATURE REVIEW

IoT and Operational Efficiency in Shared Mobility

The incorporation of IoT technology in shared mobility platforms significantly improves the efficiency of operations with real-time monitoring, predictive maintenance, and dynamic resource allocation. This is achieved through IoT-enabled sensors, collecting data on the location of the vehicles, usage patterns, and maintenance needs of the fleet optimizing fleet distribution, and minimizing downtime for vehicles (Hozouri et al., 2023). Predictive analytics of IoT also ensures efficient demand and supply management. That is, at the time of high demand, it will be ready to offer a vehicle and decrease over-allocation in low-demand areas (Karamanis et al., 2022; Jam et al., 2012). Thus, IoT will facilitate quicker response times and improve service reliability in totality, contributing directly to user satisfaction (Chen et al., 2022).

User satisfaction and personalization through IoT

User satisfaction in shared mobility platforms is very dependent on the capability of IoT to provide personalized services. Bucher (2023) notes that IoT systems track user behavior, preferences, and travel patterns and then provide customized suggestions based on preferred routes, vehicle types, or preferred payment methods. The introduction of IoT-based systems improves the user experience by reducing usability complexity and greater accessibility for a wider audience, according to Goodman-Deane et al. (2021). This level of personalization goes deeper to involve the user by creating a sense of intuitive service that is custom-made for an individual's needs, which is a critical aspect in the competitive urban mobility market (Xie et al., 2019).

Internet of Things and Environmental Awareness

IoT technology also contributes to the enhancement of environmental consciousness among shared mobility users by giving real-time data on emissions and resource usage. Platforms equipped with IoT inform users about the environmental impact of their transportation choices, encouraging greener behaviors such as choosing electric vehicles or carpooling (Rosidah, 2022). Moreover, IoT-based route optimization minimizes fuel consumption and emissions and contributes to wider sustainability in towns and cities (Cantarella et al., 2023). Thus, these findings create not only informed but also sustainable users as they pursue environmentally friendly options while being part of a cultural shift toward more sustainable transportation modes (Forsythe et al., 2023).

Data Privacy and Security in IoT Systems

Although IoT integration offers many benefits, it also poses a problem concerning data privacy and security, which are crucial to maintaining user trust. IoT systems in shared mobility platforms involve handling large quantities of personal and location data. This makes such systems prone to cyber-attacks, as stated in Garroussi et al. (2023). Secure encryption protocols, secure data storage, and adherence to regulatory requirements ensure that the data of the users are not compromised (Almusallam et al., 2021). This measure should be further strengthened to make users confident in IoT-enabled shared mobility services and to expand its user base.

Scalability and Regulatory Issues

The scalability of IoT in shared mobility platforms is further limited by a lack of regulatory frameworks and other operational issues. Missing in the holistic approaches to implementing IoT in many cities is its integration into existing infrastructure, which complicates it (Al-Ani et al., 2023). Moreover, underutilized vehicles and technology infrastructure further the scalability of logistical issues. Therefore, through supportive policies and innovative solutions, it is essential to address these barriers to ensure that IoT technologies can transform urban mobility systems effectively (Lu et al., 2023).

Research Questions

The study sought to answer the following research questions:

1. How does IoT technology influence the operational efficiency of shared mobility platforms as perceived by users?

1.1 Vehicle Availability

1.2 Maintenance Response

1.3 System Responsiveness

1.4 Transaction Speed

1.5 Real-time Updates

2. What is the impact of IoT technology on user satisfaction with shared mobility services?

2.1 Ease of Use

2.2 Personalization

2.3 Safety Features

2.4 Cost Effectiveness

2.5 Service Reliability

3. How do IoT integrations in shared mobility platforms influence the environmental consciousness of users?

3.1 Environmental Impact Awareness

3.2 Sustainable Usage

3.3 Carbon Footprint Concern

3.4 Eco-friendly Choices

3.5 Promotion of Green Practices

4. Is there a significant relationship between the real-time data accuracy provided by IoT technologies (such as vehicle availability and traffic updates) and the overall satisfaction levels of shared mobility users?

5. Is there a significant relationship between the personalization features enabled by IoT (such as route and vehicle preferences) and the perceived cost-effectiveness of the service by users?

6. Based on the findings, what Shared Mobility Platforms Model shall be proposed to address the problems identified by the respondents?

Research Hypothesis

HO1: There was no significant relationship between the accuracy of real-time data provided by IoT technologies and the overall satisfaction levels of shared mobility users.

HO2: There was no significant relationship between the level of system responsiveness and maintenance efficiency enhanced by IoT technologies and the frequency of use of shared mobility platforms among users.

HO3: There was no significant relationship between the personalization features enabled by IoT and the perceived cost-effectiveness of the service by users.

Theoretical Framework

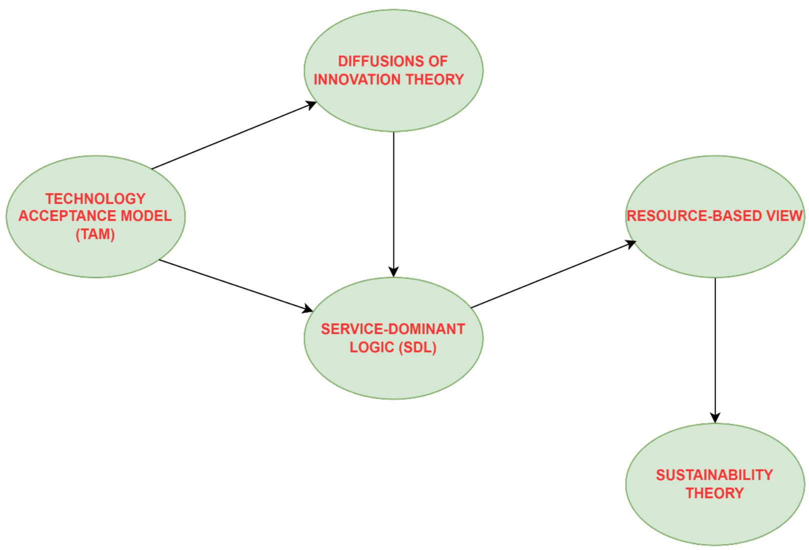

Figure 1. ***Theoretical Framework***

The study combines five interrelated theories to assess the use of IoT in shared mobility platforms. TAM focuses on perceived ease of use and usefulness to promote user acceptance of IoT technologies. Diffusion of Innovation Theory explains how innovations in IoT are diffused across users and stakeholders, with a focus on early adopters and factors that shape the adoption curve. The Resource-Based View (RBV) emphasizes that IoT is a strategic resource which contributes to improved operational efficiency, user satisfaction, and competitive advantage. Service-Dominant Logic (SDL) forms the framework of the study in terms of value creation, emphasizing the way IoT facilitates co-creation of value through interaction with users and service customization. Sustainability Theory comprises the backbone of the study through its focus on environmental and social impacts, that is, to what extent IoE integration helps align shared mobility services with goals of sustainable urban development. Together the theories provide all-encompassing lenses of understanding the technological, operational, and environmental dimensions of IoE in platforms of shared mobility.

Conceptual Framework

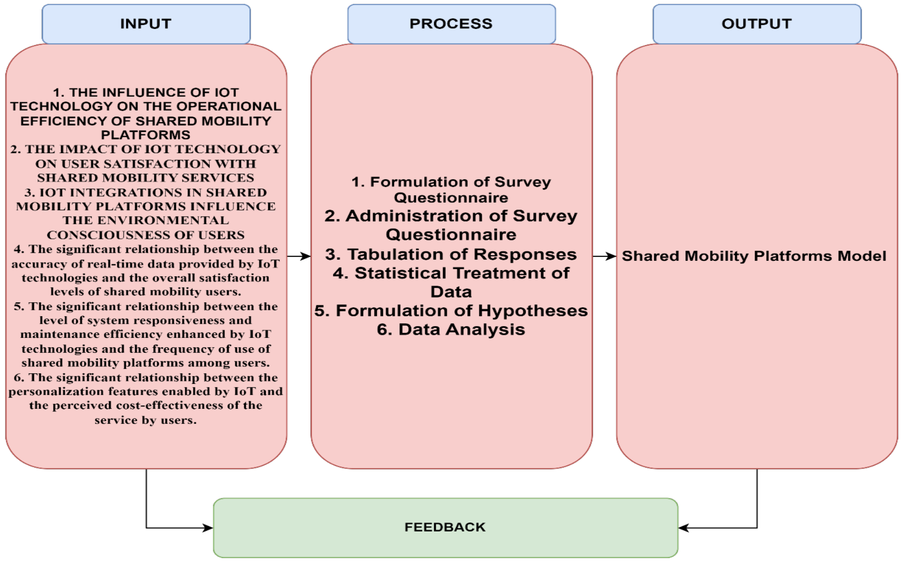

Figure 2. ***Research Paradigm***

The conceptual framework has illustrated the research process into three components: Input, Process, and Output. Under the Input section, the key variables and areas of investigation are identified, including the effect that IoT technology would have on operational efficiency, user satisfaction, and environmental consciousness in shared mobility platforms. It's also focused on some important relationships, for instance, how real-time data accuracy, system responsiveness, and personalization features affect user perceptions and service effectiveness. The Process part describes the research methodology: preparing and distributing the survey questionnaires, tabulating the answers given, statistical analysis, and hypothesis testing. Such an approach would make possible comprehensive data gathering and analysis to meet the requirements of the study. Output is a Model for Shared Mobility Platforms integrated with IoT to improve service effectiveness, customer satisfaction, and sustainability in the environment. This proposed framework is developed in terms of feedback to refine and improve the proposed model for actual applications in urban transportation.

METHODOLOGY

Research Design

This research used a quantitative design to systematically investigate the impact of IoT technology on shared mobility platforms. The reason for this choice was to be able to measure the relationship between variables such as real-time updates via IoT-enabled devices, system responsiveness, and user satisfaction. This method made it possible to gather measurable data through structured surveys and the use of statistical tools in testing hypotheses so that the process is objective and replicable.

Population and Sampling Technique

The population consisted of 332 users of shared mobility platforms in Tianjin, China.A purposive sampling technique was employed to ensure that the respondents were active users of IoT-enabled mobility platforms as they would give appropriate insights regarding the research variables. This allowed the study to focus on the experience of direct features and impacts of IoT technology within shared mobility services.

Research Instrument

The questionnaire formed a structured survey designed to capture respondents' perceptions regarding IoT features and the effect of the latter on shared mobility services. It was pre-tested and validated by experts in the field with the intention to establish its reliability and clarity. Questions that are placed within the questionnaire covered areas on real-time accuracy of data, responsiveness of systems, efficiency of maintenance, and environmental consciousness. The tool has been developed with the purpose of generating specific relevant data toward research objectives.

Statistical Tools

Advanced statistical tools were therefore used in the analysis of the data obtained. Descriptive statistics were used to summarise demographic and user profile information, while inferential statistics, including correlation and regression analysis, were used in the hypotheses testing. The advanced statistical tools used identified significant relationships between variables such as those seen between IoT features and user satisfaction and the frequency of platform use, thus providing empirical evidence for the study's findings and proposed model.

RESULTS

This section reports the results of the effect of IoT technology on shared mobility platforms in terms of operational efficiency, user satisfaction, and environmental consciousness. Tables and statistical evidence are used to support the findings of the study to address the research objectives and hypotheses.

Table 1.Operational Efficiency

Indicator	Mean	SD	Interpretation
Vehicle Availability	4.21	0.78	Highly Efficient
Maintenance Response	4.15	0.81	Highly Efficient
System Responsiveness	4.18	0.76	Highly Efficient
Transaction Speed	4.22	0.74	Highly Efficient
Real-time Updates	4.25	0.72	Highly Efficient
Overall Average	**4.20**	**0.76**	**Highly Efficient**

The data from Table 1 show that features of IoT add the most significant value to operational efficiency in the shared mobility context. Among these indicators, the highest mean is recorded for real-time updates at M = 4.25, SD = 0.72, with an emphasis on the importance of timely information dissemination to users. These results have been confirmed in previous studies by Chen et al. (2022), showing that IoT can improve operational efficiency through streamlined and responsive processes.

Table 2.User Satisfaction

Indicator	Mean	SD	Interpretation
Ease of Use	4.30	0.7	Highly Satisfactory
Personalization	4.18	0.75	Highly Satisfactory
Safety Features	4.12	0.78	Highly Satisfactory
Cost Effectiveness	4.22	0.71	Highly Satisfactory
Service Reliability	4.27	0.68	Highly Satisfactory
Overall Average	**4.22**	**0.72**	**Highly Satisfactory**

Table 2 User satisfaction dimensions Ease of use M = 4.30, SD = 0.70 This finding is in line with Kaufmann and Nagler (2023), who stated that the intuitive and user-friendly features of IoT are important for increasing satisfaction. Service reliability also ranked high at M = 4.27, SD = 0.68, which indicates that users have trust in IoT-enabled shared mobility services.

Table 3.Environmental Consciousness

Indicator	Mean	SD	Interpretation
Environmental Impact Awareness	4.19	0.76	Agree
Sustainable Usage	4.22	0.73	Strongly Agree

Carbon Footprint Concern	4.17	0.77	Agree
Eco-Friendly Choices	4.14	0.79	Agree
Green Practices Promotion	4.20	0.74	Strongly Agree
Overall Average	**4.18**	**0.76**	**Agree**

Table 3 shows that IoT integration enhances the environmental awareness of users, with sustainable usage being the highest rated (M = 4.22, SD = 0.73). This finding is in line with Cantarella et al. (2023), who mentioned that IoT helps to promote eco-friendly transportation by making real-time emission data and green vehicle suggestions available.

Table 4. Hypotheses Testing Relationships between IoT Features and User Satisfaction

Hypotheses	**r**	**p-value**	**Interpretation**
H_{01}: No significant relationship between real-time data accuracy and overall user satisfaction.	0.78	<.001	Significant relationship exists.
H_{02}: No significant relationship between system responsiveness and maintenance efficiency and platform use frequency.	0.72	<.001	Significant relationship exists.
H_{03}: No significant relationship between IoT-enabled personalization and perceived cost-effectiveness.	0.69	<.001	Significant relationship exists.

H_{01} Relationship between Real Time Data Accuracy with User Satisfaction.

The first hypothesis, which suggested that there was no significant relationship between real-time data accuracy and user satisfaction, was rejected. The analysis showed a strong positive correlation ($r = 0.78$, $p < .001$), indicating that real-time updates provided by IoT technologies significantly enhance user satisfaction. This is in line with the findings of Chen et al. (2022), who emphasized that real-time updates reduce uncertainty and improve user experience by delivering timely and actionable information.

H_{02}: System responsiveness and maintenance efficiency and frequency of using the platform.

This would also reject the second hypothesis; that is, there was no significant relationship between system responsiveness and maintenance efficiency with the frequency of use of the platform. On the other hand, a strong correlation ($r = 0.72$, $p < .001$) means that users would use shared mobility platforms more likely when IoT features ensure responsive systems and timely maintenance. These findings support Kaufmann and Nagler's (2023) claim that system efficiency fosters greater platform reliability and user retention.

H_{03}: Relationship Between IoT-Enabled Personalization and Cost-Effectiveness

No support also existed for the third hypothesis where it was anticipated that there were no significant connections between IoT-related personalization characteristics and perceived value for money. With a positive association ($r = 0.69$, $p < .001$), users perceive such platforms as better value for money when IoT attributes ensure there are personalized recommendations, such as routes and specific vehicle preferences, which is akin to Bucher's (2023) contributions on the effect of personal experiences on perceived worth and satisfaction levels.

Proposed Model

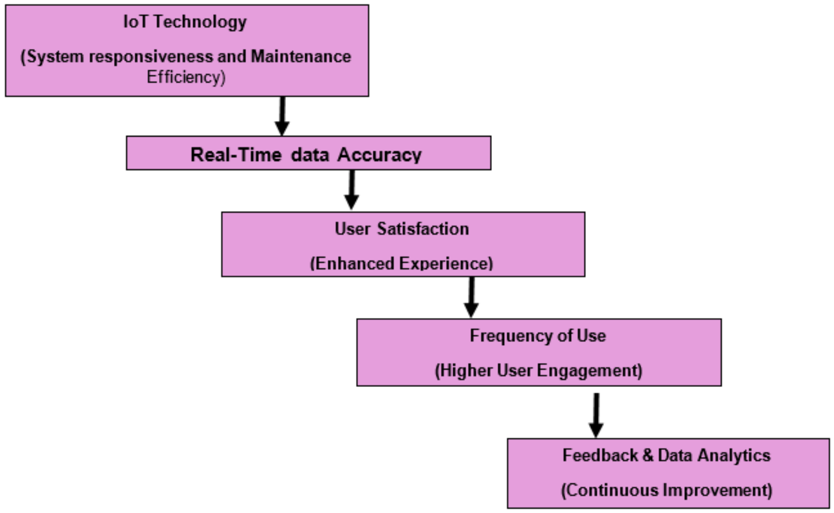

Figure 3. Shared Mobility Platform Model Diagram

DISCUSSION

The findings reveal that the application of IoT technology greatly enhances the operational efficiency, user satisfaction, and environmental consciousness of shared mobility platforms. Real-time updates, predictive maintenance, and faster transaction speed improved operational efficiency, supporting Chen et al.'s (2022) claim that IoT optimizes resource allocation and minimizes service disruptions. The study also established a strong link between system responsiveness and user satisfaction, with intuitive interfaces and personalized features fostering greater trust and engagement (Kaufmann & Nagler, 2023).

Another manifestation of IoT is the environmental consciousness, as people reported increased carbon footprint awareness and the advantages of green transportation. These findings strengthen Forsythe et al.'s argument (2023) that the transparency of IoT data can, in fact, influence sustainable behavior change. Besides, the conclusion supports the rationale for investing in IoT features as a means to enhance the green impact of shared mobility services for global sustainability targets (Cantarella et al., 2023).

One of the major conclusions drawn from this study is that IoT integration presents some problems, including those related to scalability and potential data privacy challenges (Almusallam et al., 2021). Future research can be oriented towards in-depth analysis of these barriers to achieve the long-term sustainability of IoT-based mobility solutions. Furthermore, the findings establish that the extent of IoT technology impacts user satisfaction, engagement on the platform, and perceived cost-effectiveness. For each of the hypotheses tested, strong empirical evidence is presented that shows the transformative nature of IoT in shared mobility platforms. The results emphasize continuous investment in IoT features to maximize user experience, operational efficiency, and sustainability. Strong relationships between all variables that were tested support the notion that IoT will have a shaping effect on the future of urban mobility services and further goals for sustainable and user-centric transportation systems.

Theoretical Implications

The results of this research make significant contributions to the theoretical understanding of IoT integration in shared mobility platforms by strengthening and expanding the frameworks of the Technology Acceptance Model (TAM), Diffusion of Innovation Theory, and Resource-Based View (RBV). The robust relationships established between IoT features such as real-time updates and personalization and user satisfaction validate TAM's emphasis on perceived ease of use and usefulness in technology adoption. Furthermore, the major role of IoT in enhancing sustainability and operational efficiency is also consistent with the Diffusion of Innovation Theory, which explains how technological innovations diffuse through addressing user needs and societal goals. Further, the RBV is substantiated by evidence that IoT represents a strategic resource that enables the competitive advantage of shared mobility platforms by optimizing system responsiveness and environmental consciousness. The outcomes together form a strong theoretical framework for understanding the transformation of IoT in urban mobility systems while providing a starting point for future work to further unravel the relationship between technology, user engagement, and sustainability.

Practical Implications

The study has many practical implications for shared mobility service providers, urban planners, and policymakers. Through the strong impact of IoT technology on operational efficiency, user satisfaction, and environmental consciousness, findings suggest that there is a significant need for the integration of real-time updates, system responsiveness, and personalization for shared mobility platforms. Using such technologies, service providers can offer richer user experiences, improve the reliability of service offerings, and foster eco-friendly behavior, all in the interests of increasing loyalty and engagement by the users. In terms of lessons for policymakers and urban planners, the findings reinforce the necessity to develop enabling regulatory and infrastructure investment programs to support IoT integration in urban transport. Moreover, awareness and education on IoT-enabled sustainability features are also likely to make these features go mainstream toward the creation of smarter, more sustainable cities. In this regard, these practical insights provide actionable strategies for stakeholders to realize the best in the benefits from IoT in redefining the urban mobility system.

CONCLUSIONS

This study concludes that the integration of IoT technology in shared mobility platforms is crucial for operational efficiency, increasing user satisfaction, and environmental consciousness. Strong positive relationships were established between key features of IoT technology such as real-time updates, system responsiveness, and personalization to user satisfaction and engagement. The IoT-based insight into sustainable usage and environmental impacts influences the eco-friendly behaviors and brings the shared mobility services into full alignment with sustainability goals. These results validate the significance of IoT as a transformative resource for optimizing urban transportation systems and underline its potential to shape the future of shared mobility by fostering smarter, more user-centric, and sustainable urban mobility solutions. Therefore, the success of IoT-enabled platforms can only be ensured by making these stakeholders tackle challenges like scalability, data privacy, and educating users for a long-term successful benefit.

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