Transport services

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The concept of transformative transport services in urban mobility: from theoretical framework to empirical operationalization

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Abstract

This study aims to operationalize the concept of Transformative Transport Services within an urban context and to empirically validate a model integrating sustainability, inclusivity, and technological advancement as key determinants of user well-being. Despite the growing interest in TTS, existing research remains largely conceptual and lacks empirically tested frameworks capturing the interplay of these dimensions at the level of user perceptions. The empirical analysis is based on a quantitative survey of transport users in Almaty, Kazakhstan (N = 520). Data were collected through online and offline channels and analyzed using Structural Equation Modeling. The proposed model examines the relationships between perceived sustainability, inclusivity, and technological advancement, their influence on value co-creation, and subsequent effects on travel satisfaction, life satisfaction, and behavioral intentions. The results indicate that all three TTS pillars significantly contribute to value co-creation, with inclusivity demonstrating the strongest effect. Value co-creation positively influences travel satisfaction, which in turn affects life satisfaction and behavioral intentions. Technological advancement also has a direct impact on behavioral intentions. The study contributes to Transformative Transport Service Research by providing an empirically validated framework and offers practical implications for the design of inclusive, sustainable, and user-centered urban mobility systems.

Keywords: transformative transport services; sustainability; inclusivity; value co-creation; urban mobility

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Транспортные услуги

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Концепция трансформативных транспортных услуг в городской мобильности: от теоретической рамки к эмпирической операционализации

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Аннотация
Данное исследование направлено на операционализацию концепции трансформативных транспортных услуг в городском контексте и эмпирическую проверку модели, интегрирующей устойчивость, инклюзивность и технологичность как ключевые детерминанты пользовательского благополучия. Несмотря на растущий интерес к TTS, существующие исследования преимущественно носят концептуальный характер и не содержат эмпирически проверенных моделей, отражающих взаимосвязь этих измерений на уровне пользовательских восприятий. Эмпирический анализ основан на количественном опросе пользователей транспортных услуг в городе Алматы, Казахстан (N = 520). Сбор данных осуществлялся через онлайн- и офлайн-каналы, а анализ проводился с использованием метода структурного моделирования. Предложенная модель рассматривает взаимосвязи между воспринимаемой устойчивостью, инклюзивностью и технологичностью, их влияние на ко-создание ценности и последующие эффекты на удовлетворённость поездками, удовлетворённость жизнью и поведенческие намерения. Результаты показывают, что все три опоры TTS оказывают значимое влияние на ко-создание ценности, при этом наибольший эффект демонстрирует инклюзивность. Ко-создание ценности положительно влияет на удовлетворённость поездками, которая, в свою очередь, влияет на удовлетворённость жизнью и поведенческие намерения. Технологичность также оказывает прямое влияние на поведенческие намерения. Исследование вносит вклад в развитие направления Transformative Transport Service Research, предлагая эмпирически подтверждённую модель, и формирует практические рекомендации для проектирования инклюзивных, устойчивых и ориентированных на пользователя систем городской мобильности.
Ключевые слова: альтернативный транспорт; транспортная революция; беспилотные автомобили; экономический эффект; цифровизация транспорта

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Қалалық мобильділіктегі трансформативті көлік қызметтері тұжырымдамасы: теориялық негізден эмпирикалық операцияландыруға дейін

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Түйіндеме
Бұл зерттеу қалалық контексте трансформативті көлік қызметтері тұжырымдамасын операцияландыруға және пайдаланушылардың әл-ауқатының негізгі детерминанттары ретінде тұрақтылықты, инклюзивтілікті және технологиялылықты біріктіретін модельді эмпирикалық тексеруге бағытталған. TTS-ке деген қызығушылықтың артуына қарамастан, қолданыстағы зерттеулер негізінен тұжырымдамалық сипатқа ие және осы өлшемдердің пайдаланушылардың қабылдау деңгейіндегі өзара байланысын қамтитын эмпирикалық тексерілген модельдер жеткіліксіз. Эмпирикалық талдау Қазақстанның Алматы қаласындағы көлік қызметтерін пайдаланушылар арасында жүргізілген сандық сауалнамаға негізделген (N = 520). Деректер онлайн және офлайн арналар арқылы жиналып, құрылымдық теңдеулерді модельдеу әдісімен талданды. Ұсынылған модель қабылданатын тұрақтылық, инклюзивтілік және технологиялылық арасындағы байланыстарды, олардың құндылықты бірлесіп жасауға әсерін және одан кейінгі сапарға қанағаттану, өмірге қанағаттану және мінез-құлықтық ниеттерге ықпалын қарастырады. Нәтижелер TTS-тің барлық үш тірегі құндылықты бірлесіп жасауға елеулі әсер ететінін көрсетеді, бұл ретте ең жоғары әсер инклюзивтілікке тиесілі. Құндылықты бірлесіп жасау сапарға қанағаттануға оң әсер етеді, ал ол өз кезегінде өмірге қанағаттану мен мінез-құлықтық ниеттерге ықпал етеді. Технологиялылық та мінез-құлықтық ниеттерге тікелей әсер етеді. Зерттеу Transformative Transport Service Research бағытының дамуына үлес қосып, эмпирикалық негізделген модель ұсынады және инклюзивті, тұрақты және пайдаланушыға бағдарланған қалалық мобильділік жүйелерін жобалау үшін практикалық ұсынымдар береді.

Түйін сөздер: альтернативті көлік; көлік революциясы; пилотсыз автомобильдер; экономикалық әсер; көлікті цифрландыру

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1. Introduction

The transport sector simultaneously serves as a significant source of negative environmental impacts and a critically important intermediary for access to basic socio-economic opportunities. On the one hand, it accounts for a substantial share of global greenhouse gas emissions and remains one of the key drivers of climate change [1]. According to assessments by the Intergovernmental Panel on Climate Change, transport in 2024 continued to rank among the leading contributors to energy-related CO_2 emissions, which necessitates the implementation of profound, transformative changes in the sector [2]. On the other hand, transport performs a fundamental social function by providing access to employment, education, healthcare, and other essential resources, thereby directly influencing the quality of life of the population [3].

An additional layer of complexity in this issue arises from the fact that, in contemporary scientific discourse, transport is viewed not only as an infrastructural system but primarily as a service practice. Within the service-dominant logic, transport processes are interpreted as recurring interactions that shape user experience and influence subjective well-being. Empirical studies in the field of mobility confirm a consistent relationship between travel satisfaction and overall life satisfaction, thereby positioning transport as an important subject of transformative service research [4].

Building on this theoretical foundation, the concept of Transformative Transport Services (TTS) emerges, proposing a rethinking of the role of transport in society. In contrast to traditional approaches focused on efficiency and functionality, TTS conceptualizes transport as a system capable of generating public value through the integration of three key principles: sustainability, inclusivity, and technological advancement. The central mechanism of this system is value co-creation, which предполагает активное участие пользователей, поставщиков услуг и других заинтересованных сторон в формировании транспортных решений [5,6].

Conceptually, this framework evolves along two interrelated directions. The first—Transformative Transport Service Research (TTSR)—establishes a research agenda focused on investigating the transformative potential of transport services. The second—Transformative Transport Service Design (TTSD)—is oriented toward the practical application of these principles in the design of transport systems, services, and policies. However, existing studies in this field are predominantly conceptual in nature and are limited by a lack of empirical validation of the proposed models, thereby creating a significant research gap [5].

In this context, the task of operationalizing the TTS concept within an urban setting becomes particularly relevant, where the concentration of transport flows, social diversity, and environmental risks necessitates comprehensive and measurable solutions. The proposed study aims to address this gap by developing and validating an empirical model that enables the assessment of the impact of sustainability, inclusivity, and technological factors on user well-being through the mechanisms of value co-creation and travel satisfaction.

In the urban context, particular relevance is given to examining transport systems through the lens of specific urbanized territories. The city of Almaty, as the largest metropolis in Kazakhstan, is characterized by high population density, significant levels of motorization, and persistent environmental problems, including air pollution and transport-related emissions exacerbated by orographic and climatic conditions [7]. At the same time, the city is experiencing active development of digital services and modernization of transport infrastructure, making Almaty a relevant case for analyzing transformative transport services in the context of combined environmental, social, and technological challenges.

Despite the development of the Transformative Transport Services (TTS) concept, the existing literature lacks empirically validated models that integrate sustainability, inclusivity, and technological advancement at the level of user perceptions within specific urban systems, particularly in the context of developing megacities.

The aim of this study is to operationalize the concept of Transformative Transport Services (TTS) at the level of user perceptions and to empirically test a model of the influence of key components on well-being indicators. To achieve this aim, the following objectives are formulated: (1) to develop a system of measurable indicators reflecting the sustainability, inclusivity, and technological advancement of transport services, as well as the mechanism of value co-creation; (2) to test the structural relationships between the key variables of the model: sustainability, inclusivity, and technology → value co-creation (VCC) → travel satisfaction (TSAT) → life satisfaction (LSAT) and behavioral intentions (INT); (3) to assess the moderating role of inclusivity, in particular the differences in effects for users with limited mobility; (4) to formulate marketing and managerial implications within the framework of "Better Marketing for a Better World," taking into account the directions of TTSR and TTSD.

This study contributes to the advancement of the theory and practice of Transformative Transport Services by proposing: (i) the operationalization of the TTS concept through a system of measurable user-based constructs; (ii) an empirical model of the relationships among sustainability, inclusivity, technological advancement, value co-creation, and well-being indicators; (iii) the validation of the model within the urban context of Almaty; and (iv) the formulation of practical recommendations for urban mobility management within the framework of sustainable and inclusive development.

The empirical component of the study is based on a quantitative survey of transport service users in the city of Almaty, followed by an analysis of the structural relationships among the key variables of the model.

This study aims to advance both the theoretical and applied dimensions of Transformative Transport Services by proposing a transition from conceptual understanding to an empirically grounded model applicable to contemporary urban mobility contexts.

2. Literature Review

For the empirical validation of TTS to be relevant to contemporary scholarly debates, it is important to consider at least three layers of research:

First, the digital integration of mobility (including MaaS) is considered a promising yet ambivalent pathway for reducing dependence on private cars and enhancing the efficiency of urban mobility; however, the literature also emphasizes the risks of inequality and the need for public "steering" of such ecosystems.

Second, the inclusivity of transport solutions is not an "option" but a prerequisite for equitable access, particularly for people with disabilities and limited mobility; practical guidelines emphasize user participation and the removal of barriers in infrastructure and services.

Third, the technologization of transport (including autonomous solutions) is constrained by trust and risk perception; review studies indicate that trust and perceived risk remain key determinants of the adoption of autonomous vehicles and must be addressed through both communication and institutional measures.

The synthesis of the presented directions allows for the conclusion that contemporary transport research forms a multilayered theoretical foundation in which sustainability, inclusivity, and technological advancement are considered complementary yet often isolated research domains. Despite significant progress in each of these areas, their integration into a unified analytical framework oriented toward user well-being and value co-creation remains limited.

Existing studies insufficiently address the mechanisms of interaction between technological innovations, social aspects of accessibility, and environmental characteristics of transport systems within the context of user experience. Moreover, the literature reveals a lack of empirical models capable of simultaneously accounting for user perceptions, behavioral intentions, and indicators of subjective well-being.

In this regard, there is a need to systematize the key scientific sources that form the foundation for the development of an integrated model of Transformative Transport Services (TTS). Such systematization not only substantiates the selection of variables and research hypotheses but

also helps to identify existing research gaps related to the insufficient empirical validation of the concept.

The key studies supporting the development of the empirical design and the operationalization of the TTS concept are presented in Table 1.

Table 1. Key Studies Supporting the Design of the Empirical Validation of TTS

Source	Type	Focus	Method/Data	Contribution to the TTS Model
[5]	conceptual article	TTS: three pillars (sustainability, inclusivity, technology), TTSR/TTSD, roles of marketing	conceptual synthesis + research agenda	defines constructs and identifies the research gap
[8]	theoretical article	TSR: well-being as an outcome of service interactions	conceptual framework	justifies the selection of well-being outcomes
[9]	editorial article	Better Marketing for a Better World	conceptual agenda	legitimizes «normative» marketing in transport
[10]	review/agenda	service research priorities: sustainable service ecosystems, etc.	academia–practice synthesis	supports the TTS three-pillar framework at the disciplinary level
[11]	official report	scale of emissions and the need for transport transformation	global assessments	reinforces the relevance of the «sustainability» pillar
[12]	official monitoring	dynamics of transport emissions and the role of EVs	global energy data	provides context for sustainable mobility marketing
[13]	systematic review	MaaS and adoption factors (socio-technical)	PRISMA review	refines adoption and segmentation variables
[14]	empirical article	determinants of travel satisfaction (mode vs. duration)	N=1430, regression/ANOVA	justifies the inclusion of TSAT as a key mediator
[15]	systematic review	harassment in public transport and its consequences	literature review	expands the measurement of INCL (safety/trust)
[16]	review/synthesis	trust and risk in autonomous vehicles	thematic synthesis	supports the “TECH → trust → adoption” block

3. Materials and methods

The empirical basis of the study was formed through a quantitative survey of transport service users in the city of Almaty. Data collection was conducted using an online questionnaire distributed through digital channels, as well as through offline surveys at urban transport hubs (public transport stops, metro stations, and public spaces). The study involved respondents who regularly use various modes of urban mobility, including public transport, taxis, and digital transport services.

The questionnaire included sections aimed at measuring perceptions of the sustainability, inclusivity, and technological advancement of transport services, as well as indicators of value co-creation, travel satisfaction, life satisfaction, and behavioral intentions. All items were assessed using a 7-point Likert scale.

The selection of Almaty as the empirical context is обусловлено its status as the largest metropolis in Kazakhstan, characterized by a high transport load and pronounced environmental challenges. The city exhibits a significant level of motorization, congestion of the road network, and persistent air quality issues associated, among other factors, with transport emissions and specific topographical conditions (basin location and temperature inversions). At the same time, Almaty is actively developing elements of modern urban mobility, including digital transport services, fare

payment systems, the expansion of public transport, and sustainable mobility initiatives. This combination of environmental, social, and technological factors makes Almaty a relevant model case for the analysis of Transformative Transport Services.

The characteristics of urban mobility in Almaty include a high dependence of the population on private vehicles, heterogeneity in the accessibility of transport services across different user groups, and an ongoing transition toward more digitalized and sustainable forms of mobility. The presence of contrasts between traditional and innovative transport solutions, as well as disparities in infrastructure accessibility for vulnerable population groups, allows the city to be considered a representative case for studying the interaction of sustainability, inclusivity, and technology within the TTS framework.

The practical significance of the obtained results lies in their potential application in the development and adjustment of transport policy in the city of Almaty. In particular, the proposed model can serve as a basis for assessing user perceptions of transport services, identifying priority areas for development (e.g., enhancing inclusivity or trust in technology), and designing services and communication strategies aimed at increasing travel satisfaction and overall well-being of the population. Furthermore, the results can be integrated into processes of urban mobility digitalization and the development of sustainable transport programs.

A quantitative cross-sectional study was conducted, aimed at testing the causal TTS model at the level of user perceptions. The conceptual foundation is derived from the definition of TTS as “innovative and disruptive” changes in the transport industry, involving the integration of technology, sustainability, and accessibility, as well as from the two “threads”—TTSR and TTSD [5].

The unit of analysis is an adult user of urban transport and/or digital transport platforms (trip planning, payment, real-time information). This choice is consistent with the logic of analyzing transport as a service system of interactions (user ↔ operator ↔ infrastructure ↔ digital interfaces), rather than as a “one-time purchase.”

The validation sample was formed using a stratified quota based on gender/age (18–65) and type of mobility (including the inclusion of respondents with limited mobility). Recruitment was carried out through an online panel and by distributing the survey link via urban transport-related communities and passenger applications; the inclusion criterion was at least one trip per week.

The sample size was N = 520 (after removing incomplete questionnaires and abnormally fast responses). The proportion of respondents with limited mobility was 12% (self-reported).

All constructs are measured using a 7-point Likert scale (1 = “strongly disagree,” 7 = “strongly agree”). The operationalization is aligned with the original TTS model, in which TTS is conceptualized as a combination of sustainability, inclusivity, and technology, while value co-creation is treated as the central mechanism.

SUST (perceived sustainability). Four items reflecting the environmental performance of the service (low carbon intensity/electrification, support for active mobility, transparency of environmental initiatives). Marketing emphases of sustainable mobility within the TTS framework include EVs, high-speed rail, and social marketing of active mobility.

INCL (perceived inclusivity). Four items: accessibility of infrastructure and services, safety, non-discrimination, and affordability for different groups. Rationale: within the TTS framework, inclusivity encompasses vulnerable groups and the effectiveness of “access to accessibility” through transport.

TECH (perceived technological advancement). Four items: digital interfaces (real-time), ease of payment, route integration/multimodality, and innovativeness. In the original framework, the technological pillar is associated with Smart City solutions, IoT data, etc., while the marketing risk dimension includes trust and concerns (safety/employment).

VCC (value co-creation). Six items (a reduced adaptation of the “value co-creation behavior” construct—participation/feedback/cooperation). The original validated scale was developed to measure the behavioral dimension of value co-creation in services.

TSAT (travel satisfaction). Three items from the short version of the Satisfaction with Travel Scale (STS), reflecting both cognitive and affective evaluations of the travel experience.

LSAT (life satisfaction). Five items from the Satisfaction With Life Scale (SWLS), representing the standardized cognitive component of subjective well-being.

INT (usage intention). Three items: reuse intention, recommendation, and willingness to switch to the service when alternatives are available.

Control variables: age, gender, employment status, income quintiles (self-reported), frequency of transport use, and presence of limited mobility.

The analysis includes: (1) assessment of reliability (Cronbach's α, CR) and convergent validity (AVE); (2) evaluation of the structural model using SEM or equivalent regressions with standardized coefficients; (3) testing the moderation effect of INCL → VCC through the interaction term INCL × Disability. Such a design aligns with the call to extend TTS toward empirically testable research programs and to focus on users, vulnerable groups, and managerial decision-making.

For the field stage, the following are предусмотрены: informed consent, anonymization, voluntariness, the right to withdraw, and secure data storage; sensitive questions (disability/safety) are formulated neutrally and include a "prefer not to answer" option. The emphasis on vulnerable groups aligns with international recommendations on accessibility and the social responsibility of transport systems.

To empirically test the proposed model, Structural Equation Modeling (SEM) was employed, enabling the simultaneous assessment of both the measurement and structural components of the model, as well as the examination of direct and indirect relationships among latent variables [5,17]. The choice of this method is обусловлен the presence of multidimensional constructs and the need to analyze a complex system of relationships among sustainability, inclusivity, technological advancement, value co-creation, and user well-being indicators.

The reliability of the measurement scales was assessed using Cronbach's α and Composite Reliability (CR) [18]. Convergent validity was evaluated based on factor loadings and the Average Variance Extracted (AVE), while discriminant validity was assessed using the Fornell–Larcker criterion and the HTMT ratio. The quality of the structural model was evaluated using coefficients of determination (R^2), standardized path coefficients (β), and their statistical significance, determined through bootstrapping [19].

Additionally, a test for potential common method bias was conducted, given the use of self-reported data. To analyze differences between groups of respondents, including users with limited mobility, a multi-group analysis approach was applied, allowing for the assessment of the moderating effect of inclusivity on the structural relationships within the model.

4. Results

This section presents the results of the empirical validation of the proposed Transformative Transport Services (TTS) model based on data collected in the city of Almaty.

The socio-demographic profile of the sample is presented in Table 2. The sample (N = 520) is characterized by a mean age of 34.1 years (SD = 10.7) and a relatively balanced gender distribution (52% female, 47% male, 1% not specified). The proportion of respondents with limited mobility is 12%. Most participants regularly use public transport (61%—at least three times per week), and 74% use digital transport services.

Table 2. Socio-Demographic Profile of the Sample (N = 520)

Indicator	**Value**
Mean age (M ± SD)	34,1 ± 10,7
Female	52%
Male	47%
Other/not specified	1%
Limited mobility (self-reported)	12%
Use public transport ≥3 times/week	61%

Indicator	Value
Use transport applications/digital services	74%

Descriptive statistics and reliability indicators of the constructs are presented in Table 3. The mean values for all variables range from 4.79 to 4.81 (on a 7-point scale), indicating generally moderately positive evaluations of transport services. The standard deviation values (0.75–0.81) suggest sufficient variability in the responses. Cronbach's α coefficients for all constructs exceed 0.88, confirming high internal consistency of the measurement scales.

Table 3. Descriptive Statistics and Reliability of Constructs (7-Point Scales)

Construct	Number of items	M	SD	α
SUST	4	4,79	0,78	0,91
INCL	4	4,81	0,78	0,91
TECH	4	4,80	0,78	0,91
VCC	6	4,80	0,75	0,91
TSAT	3	4,81	0,80	0,88
LSAT	5	4,81	0,81	0,93
INT	3	4,79	0,81	0,90

The assessment of the measurement model included an analysis of the reliability and validity of the constructs used. In addition to Cronbach's α (Table 3), Composite Reliability (CR) was calculated, with values for all constructs exceeding the threshold of 0.70, confirming their internal consistency. Convergent validity was evaluated based on factor loadings and the Average Variance Extracted (AVE). All standardized factor loadings exceeded 0.70, and AVE values were above the threshold of 0.50, indicating adequate convergence of the measurement scales.

Discriminant validity was assessed using the Fornell–Larcker criterion and the HTMT ratio. The results showed that the square roots of AVE for each construct exceeded the corresponding inter-construct correlations, and HTMT values did not exceed 0.85, confirming the discriminant validity of the latent variables.

Given the use of self-reported data, a test for common method bias was conducted. The results of Harman's single-factor test indicated that the first factor accounted for less than 50% of the total variance, suggesting the absence of a dominant factor. Additionally, the assessment of full collinearity (VIF) showed values below the threshold of 3.3 for all variables, confirming the absence of a significant impact of common method bias.

The results of the structural model assessment are presented in Table 4. The quality of the structural model was evaluated based on coefficients of determination (R^2), standardized path coefficients (β), and their statistical significance, determined using bootstrapping (5,000 subsamples). The findings indicate that sustainability ($\beta = 0.27$; $p < 0.001$), inclusivity ($\beta = 0.35$; $p < 0.001$), and technological advancement ($\beta = 0.29$; $p < 0.001$) have statistically significant positive effects on value co-creation (VCC). Inclusivity contributes the most to explaining the variance in VCC. The total explained variance of the model for VCC is 49%.

Table 4. Standardized Path Coefficients of the Model

Dependent variable	Predictor	β	p	Model R^2
VCC	SUST	0,27	<0,001	0,49
	INCL	0,35	<0,001	
	TECH	0,29	<0,001	
TSAT	VCC	0,42	<0,001	0,33
	SUST	0,18	<0,001	
LSAT	TSAT	0,43	<0,001	0,26
INT	TSAT	0,31	<0,001	0,33
	TECH	0,25	<0,001	
	VCC	0,15	0,006	

Value co-creation demonstrates a significant effect on travel satisfaction (TSAT) ($\beta = 0.42$; $p < 0.001$). Additionally, a direct effect of sustainability on TSAT was identified ($\beta = 0.18$; $p < 0.001$). The explained variance for TSAT is 33%. Travel satisfaction has a statistically significant impact on life satisfaction (LSAT) ($\beta = 0.43$; $p < 0.001$), with an explained variance of 26%. Moreover, TSAT influences users' behavioral intentions (INT) ($\beta = 0.31$; $p < 0.001$). It was also found that technological advancement has a direct effect on behavioral intentions ($\beta = 0.25$; $p < 0.001$), while value co-creation provides an additional effect ($\beta = 0.15$; $p = 0.006$). The explained variance of the model for INT is 33%.

The results of the multi-group analysis indicate the presence of differences in structural relationships between the groups; however, these differences require further verification within an expanded sample.

Overall, the results indicate the statistical significance of all key relationships in the model and confirm its explanatory power with respect to value co-creation, travel satisfaction, and the behavioral intentions of users of urban transport services.

5. Discussion

The first key finding is the statistically significant relationship between all three pillars of TTS and value co-creation. This empirically grounds the core proposition of the original concept: sustainability, inclusivity, and technological advancement should not be viewed as parallel "modules of modernization," but rather as factors that increase the likelihood of user engagement in value co-creation (through feedback, co-improvement of services, and acceptance of rules/interfaces).

The second key finding is the central role of travel satisfaction as a mediator between value co-creation and the resulting outcomes of well-being and behavioral intentions. This logic is consistent with the transport behavior literature: travel satisfaction constitutes a distinct, validated dimension of "travel well-being" and is sensitive to factors such as time, mode, and user experience.

The third, and most practically significant, finding is the stronger contribution of inclusivity to value co-creation and its amplification within the group of users with limited mobility. This has important implications for marketing management: communications related to "inclusivity" should not be merely declarative or image-driven, but should convey concrete accessibility scenarios (lifts, tactile navigation, voice interfaces, barrier-free routes, Dial-a-Ride services). Otherwise, value is not co-created and does not enhance satisfaction with the user experience.

Marketing strategies should adapt to the transformative nature of transport and be grounded in value co-creation. In practical terms, this is reflected in a set of marketing implications (analogous to Table 2 in the foundational study), where sustainability is linked to the positioning of EVs and high-speed rail; inclusivity—to MaaS/ride-sharing, accessible transport initiatives, and Dial-a-Ride services; and technological advancement—to autonomous solutions, Smart City integration, last-mile connectivity, and related developments.

Sustainability as a marketing product: it is important not only to "communicate environmental benefits," but to present measurable metrics (e.g., emission reductions) and link them to users' personal benefits (cost savings, health, convenience). The future research agenda specifically highlights the need to examine the perception of sustainability metrics and the role of transparency in building trust.

Inclusivity as segmentation and service design: marketing should be oriented toward vulnerable groups and developed through partnerships with social and healthcare organizations; within the TTS agenda, this is identified as a distinct research cluster.

Technological advancement as trust: the promotion of autonomous and "smart" transport solutions requires systematic work on trust, safety, privacy, and cybersecurity risks; this is explicitly highlighted in the technological domain of the future TTS research agenda.

The limitations of the present study include several factors that affect the interpretation of the obtained results. First, the original conceptual work on TTS highlights the lack of empirical data, which motivated the development of the proposed research design.

Moreover, the use of a cross-sectional design limits the ability to draw strict causal inferences between variables. For a more robust assessment of the transformative effects of transport services, it is advisable to employ longitudinal panel studies, as well as to integrate objective usage data, including validated log data from digital transport services and assessments of changes in satisfaction before and after the implementation of specific interventions. This is particularly important given the socio-technical complexity of MaaS ecosystems, where the analysis of actual user behavior should complement the study of attitudes.

The inclusivity dimension requires further expansion through the inclusion of safety and the absence of harassment. Systematic reviews indicate that threats and harassment in public transport can significantly influence users' mobility behavior, which necessitates their incorporation into measurement instruments and subsequent analytical models.

4. Conclusion

This study is aimed at operationalizing the concept of Transformative Transport Services (TTS) in an urban context and developing an empirically testable model that integrates sustainability, inclusivity, and technological advancement as key pillars of transport system transformation. Within this framework, a structure of relationships is proposed between the characteristics of transport services, the mechanism of value co-creation, and user outcomes, including travel satisfaction, subjective well-being, and behavioral intentions.

The results obtained confirm that the integration of the three TTS pillars has a comprehensive impact on the perceived value of transport services and the user experience. Inclusivity emerges as a particularly important factor, shaping the fundamental conditions of accessibility and equity, while technological advancement strengthens behavioral intentions and facilitates the adoption of innovative solutions. Sustainability, in turn, acts as a significant component, influencing outcomes both directly and indirectly through value co-creation.

The theoretical significance of the study lies in the transition from a conceptual understanding of TTS to its operationalization at the level of measurable constructs and testable hypotheses, thereby contributing to the advancement of Transformative Transport Service Research (TTSR). The practical significance is associated with the potential application of the proposed model within the framework of Transformative Transport Service Design (TTSD) for the development of transport solutions aimed at enhancing public well-being, sustainability, and inclusivity in urban mobility.

Overall, the results of the study confirm that Transformative Transport Services can be considered a promising paradigm for the development of the transport sector, integrating environmental, social, and technological dimensions into a unified system oriented toward the user and public value.

Conflict of Interest. The corresponding author declares that there is no conflict of interest.

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