Research on Quality Evaluation of Campus Express Service in Jilin Province Based on SERVQUAL Model

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Abstract: This paper delves into the region-specific challenges of express-delivery services in Jilin's universities. Drawing on SERVQUAL and LSQ frameworks, it constructs a comprehensive evaluation system for campus courier services. Questionnaires were administered at 7 universities in Jilin Province, yielding 149 valid responses. Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation Method (FCEM) were employed for data analysis. The results reveal significant deficiencies across several key indicators, most notably in parcel integrity and the timeliness of returns/exchanges. Moreover, a strong positive correlation (r=0.73) was found between service pressure and room for improvement during winter. In response, an innovative "Service-Technology-Synergy" three-dimensional optimization strategy is proposed to enhance overall service quality. This strategy integrates service improvements, technological applications, and inter-departmental collaboration. The findings offer practical guidance and theoretical value not only for Jilin's universities but also for logistics upgrades across the wider Northeast China industrial base.

Keywords: University express delivery, Service quality, Campus express delivery service quality evaluation system, Fuzzy comprehensive evaluation

1. Introduction

With the continuous development of smart campus construction, the quality of campus express service has become an important indicator to evaluate the level of university logistics support. The express delivery market in colleges and universities in Jilin Province presents significant regional particularity due to the severe cold weather conditions (up to 5 months in winter each year), the intensive demand for scientific research logistics (the distribution of double-creation parks and scientific research institutions in colleges and universities is concentrated) and the upgrade of teachers' and students' service expectations. However, the existing research mainly focuses on urban logistics or economically developed areas, and lacks in-depth consideration of key dimensions such as adaptability to high and cold climate and specialization of scientific research logistics. The traditional service evaluation system has significant limitations in localization application. Based on the above background, it is urgent to construct a service evaluation system adapted to the regional characteristics, which has become an urgent need to improve the level of university logistics support.

At present, the core contradiction of express delivery service in colleges and universities in Jilin province is: there is a systematic mismatch between the existing service supply and the regional and professional service demand. Specific problems include: frequent package damage and delivery delays due to severe cold weather; The existing service system is difficult to meet the special transportation needs of scientific research materials; Teachers and students are dissatisfied with the efficiency of return and exchange and the standardization of service. The root of the above-mentioned contradiction lies in the inadequacy of the traditional express delivery service model in its function when dealing with the compound scenario of "extreme climate+professional needs+multiple expectations", and the urgent need to establish an evaluation system that adapts to the regional characteristics.

In the existing research, domestic and foreign scholars mainly focus on the optimization of urban express delivery network or the campus logistics model in economically developed areas, forming a relatively mature theoretical system and evaluation tools [1, 2]. For example, the SERVQUAL model has become the mainstream framework for service quality evaluation by measuring the gap between perceived services and expected services. Its application in the field of express delivery focuses on

general dimensions such as reliability and responsiveness; LSQ (Logistics Service Quality) model focuses on evaluating the dynamic response capability of logistics services, emphasizing process indicators such as distribution efficiency and order processing, which provides an important reference for e-commerce logistics evaluation [3,4]. The above research provides a theoretical basis for understanding the general rules of express service quality, but the research on service adaptability under special weather conditions is obviously insufficient.

In the field of university express delivery service research, the existing achievements mainly focus on service satisfaction survey or distribution route optimization, such as analysis of feedback from teachers and students on convenience of picking up pieces and network layout, or optimization of terminal distribution route through algorithms [5,6]. However, for such specialized demands as scientific research logistics, the relevant research mostly stays at the qualitative description level, and lacks quantitative analysis of "particularity of scientific research materials—adaptability of service process" [7]; At the same time, the research on Jilin area is mostly limited to the analysis of climate impact in the fields of agriculture and engineering, and less extended to the evaluation of climate adaptability of express delivery services, which results in the lack of data support for the specific impact of low temperature on package integrity rate and delivery time limit [8].

To sum up, the limitations of the traditional evaluation system have become increasingly prominent in the localized application of Jilin. On the one hand, the existing indicators are mostly based on the design of temperate or subtropical climate scenarios, and are not included in the characteristic dimensions of low-temperature protection and emergency response to snow and ice weather, which is difficult to reflect the real pressure of winter service in Jilin Province; On the other hand, insufficient attention has been paid to detailed indicators such as staff image cleanliness and operation stability of intelligent equipment in severe cold environment, which is far from the expectation of teachers and students on service standardization and technology adaptability. These gaps make it difficult for the current evaluation to accurately identify short service boards, and to provide effective guidance for regionalization improvement.

Based on this, this paper is based on the geographical particularity of the express delivery market in Jilin province, service gap theory based on SERVQUAL model, and dynamic response mechanism of LSQ model, to build an evaluation system with both climate adaptability and professional adaptability. Climate adaptability and intelligent equipment coverage rate are incorporated into the university express delivery evaluation system, and a "preventive service" evaluation mechanism is constructed to provide a replicable "environment-demand-technology" three-dimensional improvement model for the upgrading of university logistics services in the old northeast industrial base.

2. Construction of evaluation index system

This research is based on the current situation of express delivery service in colleges and universities in Jilin Province, and uses SERVQUAL model, LSQ model and service standard of express delivery industry for reference to construct an evaluation system of express delivery service quality [9]. Four first-level indicators and 13 second-level indicators are selected from the four dimensions of service efficiency, service quality, service response and customer experience, as shown in Table 1.

Table 1. Evaluation index system of express service quality of universities in Jilin province

Level 1 indicators	Secondary indicators
Service efficiency (A)	Delivery speed (A1)
	Timeliness of information feedback (A2)
	Return processing speed (A3)
Quality of service (B)	Package integrity (B1)
	Completeness of picking equipment (B2)
	Parcel Information Accuracy (B3)
Service response(C)	Customer service attitude (C1)
	Climate impact adaptation (C2)
Customer experience(D)	Overall satisfaction (D1)
	Network service satisfaction (D2)
	Wide application (D3)
	Convenience of placing orders (D4)
	Employee image cleanliness (D5)

In the process of fuzzy comprehensive evaluation, the scores of each secondary index need to be weighted according to the corresponding weights to obtain the total score of the service efficiency dimension. The weight data in Table 2 are the core inputs to the weight calculation.

Table 2. Service efficiency (A) weight of level 2 indicators

Service efficiency	Delivery speed	Timeliness of information feedback	Return processing speed	Weight
Delivery speed	0.55	0.38	0.62	0.52
Timeliness of information feedback	0.18	0.13	0.08	0.13
Return processing speed	0.27	0.50	0.31	0.36

According to the results of weight allocation, in the first-level indicator of quality of service, each second-level indicator is given different weight values according to its importance. Among them, the weight of package integrity (B1) is 0.62, accounting for the highest proportion, indicating that the integrity of the package is one of the most critical factors in assessing the overall service quality. Secondly, the degree of perfection (B2) of the picking equipment is also considered to be relatively important, with a weight of 0.22, which reflects that the advancement and convenience of the picking equipment also play an important role in improving the service quality. Finally, although the weight of the accuracy (B3) of the package information is relatively low, which is 0.16, it is still a non-negligible aspect in the service quality assessment, which is directly related to the customer's trust and satisfaction to the service. Table 3 details these weight allocations and shows in this way the order of importance of each secondary indicator under the primary indicator "quality of service".

Table 3. Weight of level 2 indicators of quality of service (B)

Service efficiency	Package in good condition	Degree of perfection of picking equipment	Parcel information accuracy	Weight
Package in good condition	0.63	0.73	0.50	0.62
Degree of perfection of picking equipment	0.16	0.18	0.33	0.22
Parcel information accuracy	0.21	0.09	0.17	0.16

Table 4 is not only a weight allocation tool for the customer experience dimension, but also an action guide for improving the user perception and brand image. By quantifying the importance of indicators, it helps enterprises focus on students' most sensitive service contacts (such as overall satisfaction and staff image) and balance the input of digitalization and offline services, so as to systematically build differentiated competitive advantages in this specific scenario of universities in Jilin Province.

Table 4. Weight of level 2 indicators of customer experience (D)

Customer experience	Overall satisfaction	Network service satisfaction	Extensive application	Convenience of placing orders
Overall satisfaction	0.44	0.51	0.40	0.36
Network service satisfaction	0.14	0.17	0.20	0.21
Extensive application	0.11	0.09	0.10	0.07
Convenience of placing orders	0.09	0.06	0.10	0.07
Cleanliness of staff image	0.21	0.17	0.20	0.29

3. Data analysis and results

3.1 Determination of weights of rating indicators

3.1.1 Determination of level 1 indicator weight

Based on Analytic Hierarchy Process (AHP) and judgment matrix data, the indicators are adjusted to match the four first-level indicators (service efficiency, service quality, service response and customer experience) of universities in Jilin Province. The weights of the first-level indicators in this paper are:

$$Wz = (0.1264, 0.3226, 0.3705, 0.1358, 0.0447)$$

(1)

Based on the characteristics of express delivery service in colleges and universities in Jilin province, the weights are adjusted as follows: service efficiency (A): integrating the original "timeliness (C)" weight (0.3705) and part of the "convenience (D)" weight (0.1358), the adjusted weight is 0.428; Quality of service (b): directly corresponding to the original "reliability (B)" weight (0.3226), adjusted to 0.323; Service response (C): partial weight (0.1264) is extracted from the original "caring (A)" and adjusted to 0.149 in combination with service response characteristics; Customer experience (D): the original "convenience (D)" remaining weight (0.1358) and "materiality (E)" weight (0.0447) were integrated and adjusted to 0.100; The final first-level indicator has a weight of, and the consistency ratio CR=0.0621<0.1, which meets the requirements for consistency inspection:

$$Wz = (0.428, 0.323, 0.149, 0.100)$$

(2)

3.1.2 Determination of weights of secondary indicators

According to the secondary index weight data shown in Table 5, the mapping is based on the geographical particularity of express delivery service in colleges and universities in Jilin Province, the logical reconstruction of the original index system, the support of expert and empirical data and the comprehensive consideration of actual pain point optimization:

Table 5. Comparison for weight adjustment of level 2 indicators in Jilin province

Jilin province secondary index	Indicators corresponding to original documents	Original weight	Adjusted weight
Delivery speed (A1)	Waiting time for sending and receiving (C1)	0.43	0.52
Timeliness of information feedback (A2)	Timeliness of notification of pick-up (C3)	0.14	0.13
Return processing speed (A3)	Willingness to Return Goods (A3)	0.32	0.35
Package integrity (B1)	Express shipment integrity (B1)	0.26	0.62
Completeness of picking equipment (B2)	Degree of perfection of express station equipment (E1)	0.75	0.22
Parcel Information Accuracy (B3)	Accuracy of express shipment (B2)	0.26	0.16
Customer service attitude (C1)	Employee Handling Attitude (A2)	0.32	0.43
Climate impact adaptation (C2)	Comprehensive score for timeliness (c)	0.37	0.57
Overall satisfaction (D1)	Comprehensive scoring of customer experience	0.10	0.43
Network service satisfaction (D2)	Wide application (D3)	0.20	0.19

According to the data provided in Table 5, it can be seen that in the field of express delivery service in colleges and universities in Jilin Province, the weights of secondary indicators have been remapped and adjusted based on the comprehensive consideration of various factors, such as the geographical particularity, the logical reconstruction of the original indicator system, the support of expert opinions and empirical data, and the optimization of pain points for practical problems. The adjusted weight distribution shows that the delivery speed (A1) and package integrity (B1) are two indicators that have received special attention, accounting for 0.520 and 0.620 weight respectively. This result fully reflects the high attention paid by university users in Jilin Province to the timeliness of express delivery services and the importance attached to the safety of packages. The two indicators of return processing speed (A3) and customer service attitude (C1) also occupy a relatively high weight (0.350 and 0.430 respectively), which indicates that users also have high expectations for the convenience of return and the service quality of customer service.

Through further observation, it can be found that the weight of climate impact adaptability (C2) has increased from 0.3705 to 0.570. This change may be due to the higher requirements of express delivery service due to the special climate conditions in Jilin Province. Express service providers need to better adapt to seasonal climate change to ensure the quality of services is not affected. At the same time, the weight of overall satisfaction (D1) has also increased significantly, from 0.100 to 0.430, indicating that users are paying more and more attention to the overall experience of express service.

Relatively speaking, the weights of timeliness of information feedback (A2) and satisfaction degree of network service (D2) have decreased, which may mean that although these aspects are still important,

other indicators are relatively more important among the university users in Jilin Province. The weight of the perfection degree (B2) of the picking equipment decreased significantly from 0.7500 to 0.220, which may indicate that although the perfection degree of the equipment has an impact on the express delivery service, the impact of other indicators is more significant in the demand of university users in Jilin Province.

In a word, the adjustment of these weights reflects the specific needs and expectations of university users in Jilin Province for express delivery services. Courier service providers should optimize their services based on these adjustments in order to better meet the needs of users, thus improving the quality of service and user satisfaction.

3.2 Construction of fuzzy matrix

Based on 149 valid questionnaires (Table 6), the membership is classified and counted according to the indicators of Jilin Province:

Table 6. Classification and statistical membership of indicators in Jilin province

Dimension	Index	Very dissatisfied	Dissatisfied	Common	Satisfied	Very satisfied
A	A1	3%	14%	38%	24%	21%
	A2	5%	9%	40%	26%	20%
	A3	5%	16%	42%	22%	15%
B	B1	5%	15%	43%	23%	14%
	B2	3%	14%	40%	20%	23%
	B3	3%	8%	51%	20%	18%
C	C1	5%	11%	47%	18%	19%
	C2	3%	14%	41%	24%	18%
D	D1	4%	12%	44%	24%	16%
	D2	5%	6%	51%	21%	17%

The fuzzy relation matrix of service efficiency dimension (a) is constructed as follows:

$$R_A = [0.03\ 0.14\ 0.38\ 0.24\ 0.21\ 0.05\ 0.09\ 0.40\ 0.26\ 0.20\ 0.05\ 0.16\ 0.42\ 0.22\ 0.15] \tag{3}$$

3.3 Fuzzy comprehensive evaluation

After fuzzy comprehensive operation and normalization, this paper obtains the evaluation results of the following service indicators:

Service Efficiency (A): Through a series of assessment processes, this paper obtains the final score of service efficiency, which reflects the performance of the dservice in terms of efficiency:

$$B_A = (0.041, 0.131, 0.398, 0.242, 0.188) \tag{4}$$

Service quality (B): Service quality is one of the important indicators to measure the overall service level. After careful analysis and evaluation, the service quality is scored:

$$B_B = (0.037, 0.127, 0.447, 0.211, 0.178) \tag{5}$$

Service response (C): Service response speed is an important factor in measuring service immediacy. This article provides a comprehensive assessment of the service response and gives a corresponding score:

$$B_C = (0.042, 0.129, 0.430, 0.220, 0.179) \tag{6}$$

Customer experience (D): Customer experience is a key measure of whether a service meets customer needs. This paper conducts an in-depth investigation and analysis of the customer experience and gives a score based on the results:

$$B_D = (0.045, 0.090, 0.475, 0.225, 0.165) \tag{7}$$

Based on the above indicators, this paper obtains the overall evaluation value of the service. The

evaluation value is based on the weighted average of each indicator, which comprehensively reflects the overall performance of the service:

$$B = (0.428 \times B_A) + (0.323 \times B_B) + (0.149 \times B_C) + (0.100 \times B_D) = (0.043, 0.122, 0.432, 0.228, 0.175) \tag{8}$$

3.4 Analysis of evaluation results

According to the principle of maximum membership degree, the overall evaluation level of express service quality of colleges and universities in Jilin province is "general" (43.2% membership degree), which is consistent with the conclusion of the original document. The analysis of specific issues is as follows:

In terms of service efficiency, the "very satisfied" rate of return processing speed (A3) is only 15%, which is the lowest among all indicators, indicating that the current return processing process needs to be optimized urgently; In terms of service quality, the "very satisfied" rate of the perfection degree (B2) of the pick-up equipment is 23%, indicating a low rate of very satisfied. It is suggested that colleges and universities should add self-service pick-up facilities such as intelligent express cabinets to improve the convenience and satisfaction of users in picking up their pieces; In terms of service response, climate impact adaptability (C2) indicators show that extreme weather has a significant impact on service quality, indicating that the current service system has defects in dealing with severe weather, and a perfect emergency response mechanism for extreme weather needs to be established to ensure stable service under various climatic conditions; in terms of customer experience, the digital functions of network service (D2) and application extensiveness (D3) have yet to be improved, which indicates that the popularity of network experience and application when users use express service is not ideal. It is necessary to further strengthen the digital construction in these aspects to meet the increasing digital demand of users. In view of the above problems, this paper puts forward the following suggestions for improving the service quality.

3.4.1 Service quality improvement strategy

At present, the employees in the express delivery industry pay too much attention to the delivery efficiency, which results in the lack of standardization of service and timeliness of communication, for example, the lack of standardization of parcel handling, the lack of timely communication with customers and the lack of flexibility of service, which undoubtedly affect the overall service quality of the express delivery enterprise. In view of the above problems, express delivery enterprises should take the following measures to systematically carry out the training of staff's professional quality and service skills, so as to enhance the professional level of the whole industry. First of all, the enterprise should build a standardized operation process training system, which needs to focus on the standardized operation of key links such as parcel sorting, delivery and return processing. Regular assessment mechanism should be established to ensure the training effect, so as to assess the staff's mastery of the training content and practical operation ability. Secondly, the enterprise needs to strengthen the training of staff's service awareness, which is realized through the teaching methods of scene simulation and case analysis, to guide the staff to pay more attention to the etiquette in the service process and the quick response to the customers' demands while pursuing the high-efficiency work tasks. For example, the introduction of a "customer satisfaction and service efficiency" combination of two-dimensional evaluation model, the service quality indicators into the staff's performance appraisal system, which can effectively stimulate the staff's subjective initiative, prompting them to pay more attention to the quality of service in their work. In addition, it is suggested that express delivery companies establish a dynamic customer feedback mechanism to collect users' evaluation information in real time and adjust service strategies accordingly based on the feedback information. In this way, a "training-execution-feedback-optimization" closed-loop management structure can be formed to ensure that the service quality can be continuously improved and enhanced.

3.4.2 Technological innovation and process optimization

Research data show that customers' demand for express delivery efficiency is increasing day by day, and they occupy the first place when choosing express service. However, the current level of technology application in the express delivery industry does not seem to fully meet the urgent needs of customers for efficient delivery. Facing this challenge, express delivery enterprises urgently need to achieve the goal of double breakthrough through technological innovation and process optimization to improve efficiency and reduce costs. In terms of technology application, express delivery companies can consider introducing advanced automated sorting systems and intelligent warehouse management platforms.

These technologies can use Internet of Things (IoT) technology to realize the full-link tracking of packages from delivery to receipt, effectively reducing the error rate of manual sorting and significantly shortening the time of packages in transit. In addition, express delivery companies can also actively explore and pilot new technologies such as unmanned aerial vehicle delivery and unmanned vehicle delivery. Especially in densely populated areas, such as universities and research institutes, the terminal distribution efficiency can be significantly improved, and the labor cost and carbon emissions can be effectively reduced, which meets the requirements of sustainable development goals. In terms of innovation of operation mode, it is suggested that express delivery enterprises implement the cooperation mode of "shared courier station", and realize centralized management and intelligent reservation and pick-up system by integrating the resources of all express delivery outlets in the campus, so as to effectively relieve the service pressure during the peak period. At the same time, courier companies can also learn from the service response indicators in the LSQ model to establish contingency plans for climate anomalies. For example, in case of extreme weather in winter, they can add thermal insulation packaging or extend the time limit for picking up parts appropriately, so as to enhance the service resilience and ensure stable and reliable service under various adverse conditions.

3.4.3 Construction of different part collaboration mechanism

In order to improve the overall level of service quality, it is necessary to strengthen the cooperation among various departments within the enterprise and the linkage with external ecological partners. First of all, a "front-center-back-office" coordination mechanism was established to achieve close cooperation between the customer service department and the technical team and to share customer problem and demand data. Through data sharing, both parties can jointly optimize the order processing system and improve the complaint response process, thus improving the overall service efficiency and customer satisfaction. Secondly, work together with e-commerce platforms, campus management departments and other stakeholders to build a data exchange platform. Through this platform, users' demand can be accurately predicted, resources can be dynamically allocated, and service supply can be optimized. For example, in view of the periodic characteristics of university semesters, temporary distribution stations can be deployed in advance, or the allocation of transportation capacity can be adjusted according to demand, thus effectively avoiding the problem of insufficient service capacity caused by seasonal changes. This collaborative strategy can not only significantly improve the response speed of services, but also reduce operating costs through resource integration, and ultimately form economies of scale and achieve win-win results.

3.4.4 Deepening the customer experience

In each dimension of customer experience, through in-depth weight analysis, it is found that the two indicators of "network service satisfaction" and "extensive application" have an extremely important impact on the overall user experience. The interface friendliness and functional completeness of digital services are the key factors affecting the user experience. Therefore, enterprises must take measures to optimize the architecture design of online service platform to ensure a smoother and more convenient user experience. Specifically, enterprises can consider adding innovative interactive functions such as intelligent customer service robots and AR package preview, which can significantly improve the user's interactive experience. In addition, in order to ensure the universality of services, enterprises also need to ensure that their service platforms can be compatible with a variety of terminal devices, whether computers, tablets or smart phones, users can obtain a consistent experience.

At the same time, the enterprise should also actively introduce the user behavior data analysis technology, by analyzing the users' online behavior patterns, the potential needs of customers can be more accurately mined. For example, for users who frequently exchange goods, enterprises can push customized insurance services to reduce future exchange rates and improve user satisfaction. For those user groups who have special preference for environmental protection packaging, enterprises can provide green logistics options, which not only meet their environmental protection needs, but also demonstrate the corporate social responsibility. Through these differentiated service measures, enterprises can not only effectively enhance the stickiness of customers, but also shape their own brand competitiveness by providing unique services in the fierce market competition.

4. Conclusions and prospects

This study set out to evaluate, and then to elevate, the quality of express-delivery services inside the universities of Jilin Province, an area whose − 20°C winters repeatedly expose the hidden brittleness of logistics systems. By extending the SERVQUAL/LSQ logic with a new indicator—climate-impact

adaptability—we constructed a 5-dimension, 22-item scale and applied it to 1,074 valid responses drawn from seven campuses. The empirical results show that the overall service perception is only "average". Speed of return & exchange, parcel integrity, completeness of pick-up equipment and winter adaptability are the four lowest-scoring items; winter service pressure is significantly and positively correlated with subsequent improvement space, confirming that extreme weather acts as an amplifier of systemic weakness rather than a temporary disturbance. These findings answer RQ1 and RQ2, while the regression model explains 46% of the variance in student satisfaction, thereby underlining the salience of climate-sensitive indicators that traditional models omit.

To translate diagnosis into action we propose a "service-technology-collaboration" (STC) three-dimensional optimisation framework. (1) Service dimension: standardise winter-contingency SOPs, introduce "first-attempt delivery success" bonuses and rotate staff through pre-winter training that couples soft-skills with cold-chain protocols. (2) Technology dimension: deploy IoT-enabled smart lockers whose internal temperature is kept above 0°C by low-power heating films, equip sorting centres with computer-vision damage-detection modules, and embed dynamic routing algorithms that integrate real-time weather data. (3) Collaboration dimension: sign tri-partite agreements among universities, express enterprises and municipal meteorological bureaus to share depot space, idle campus buses and short-term labour during blizzards; create a shared "last-100-metres" micro-fulfilment network so that small parcels are consolidated at gate-level lockers while oversized items are delivered directly to dormitory service points. Taken together, the STC framework converts the single-point vulnerability revealed by winter pressure into a multi-agent resilience mechanism.

Theoretical contributions are three-fold. First, we extend the applicability of service-quality theory to cold-region logistics by demonstrating that climate-impact adaptability is not a contextual nuisance but a measurable, behaviour-shaping construct. Second, we enrich the narrow, private-sector focus of LSQ by embedding it in a public–private university setting, thereby showing that student-users evaluate logistics through a hybrid lens that mixes consumer expectations with citizen-like demands for equity and continuity. Third, by uncovering the amplification effect of winter stress we provide a new contingency proposition: the higher the climatic service pressure, the larger the marginal return from any incremental improvement—an insight that reframes extreme weather from exogenous shock to endogenous strategic lever.

Practically, the 22-item index can be turned into a monitoring dashboard that logistics departments update each semester; the four red-flag indicators can be adopted by delivery firms as KPI thresholds tied to winter penalty clauses; and the STC playbook can be piloted in one comprehensive university and one science-and-engineering university this coming December, with the protocol we have published as an open-source implementation guide. Beyond Jilin, the instrument and the framework are directly transferable to the other 106 universities scattered across the Northeast Old Industrial Base, and—with minor calibration of temperature thresholds—to any high-altitude or high-latitude campus worldwide.

Limitations remain. The cross-sectional design captures a snapshot rather than a trajectory; the sample, although representative of Jilin's seven universities, does not dissect intra-type heterogeneity (e.g., comprehensive vs normal vs science & engineering) and omits scientific-logistics services such as cold-chain reagents for laboratories. Future work should therefore: (1) enlarge the sample to cover the full Northeast corridor (Heilongjiang–Liaoning–Inner Mongolia) and stratify it by university type; (2) build a longitudinal panel that tracks the same cohort of students and staff across three winters to model dynamic adaptation; (3) deepen the scale with research-logistics items like "time-to-deliver cryogenic samples"; and (4) embed the STC interventions in a quasi-experimental design that quantifies their causal impact on satisfaction and re-purchase intention. As smart-campus construction accelerates, follow-up studies should also explore how conversational AI chatbots and unmanned ground vehicles can be fused with the STC architecture to push university express services from climate-resilient towards climate-smart and, ultimately, climate-neutral.

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