GEOG712 Course Project - Assessing the influence of tourists' perceived travel environment and their travel behavior on travel satisfaction using structural equation models (SEM): a case of Qinghai-Tibet Plateau

GEOG712 Course Project - Assessing the influence of tourists' perceived travel environment and their travel behavior on travel satisfaction using structural equation models (SEM): a case of Qinghai-Tibet Plateau

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A Thesis Submitted to the School of Graduate Studies in the Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy

Hope in 2025 you can code more, better, and with confidence.

—Haoran

McMaster University
Doctor of Philosophy (2024)
Hamilton, Ontario (School of Earth, Environment and Society)

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Lay Abstract

This r project `TravelBehaviorQinghai` is created by first-year PhD student Haoran Xu to produce a model paper for the final course project of "GEOG712 - Reproducible Research Workflow", taught by Dr. Antonio Paez at McMaster University, Canada.

Abstract

The study probes into how factors as travel behavior and perceived travel environment can influence tourists' travel satisfaction on Qinghai-Tibet Pleateau. The single-group SEM analysis conducted in this model peper revealed mixed effects across different pathways. Perceived tourist attraction environment significantly influenced travel satisfaction, while perceived road environment had no notable direct effect. Mediating effects showed that better tourist site conditions led to longer daily travel distances, whereas worse road conditions reduced travel distance. Travel modes exhibited minimal direct effects on satisfaction, with walking positively contributing and car driving by others showing the largest negative impact. Regarding travel behavior, frequency of travel to the Qinghai-Tibet Plateau had a minor positive effect on satisfaction, although insignificant, and daily travel distance showed no direct association.

Acknowledgements

I would like to thank Dr. Huaxiong Jiang and my undergrad fellows in old days for helping me with research design and questionnaire distributing. I would also like to thank Dr. Antonio Paez for teaching this course and guiding me throughout the whole semester to learn from scratch about R and Github. With limited coding experiences before, I had been exposed to a lot of new ideas and thoughts on doing research itself. Mostly importantly, I am glad that I got to have the chance to build my own coding space little by little through detailed instructions, and that I could have little more confidence in coding skills instead of anxiety and upset. Anyways, this course surely would shed a very important light in my subsequent years of pursuing a PhD and a possible academic career.

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Declaration of Authorship

I, Haoran Xu, declare that this thesis titled, *GEOG712 Course Project - Assessing the influence of tourists' perceived travel environment and their travel behavior on travel satisfaction using structural equation models (SEM): a case of Qinghai-Tibet Plateau* and the work presented in it are my own. I confirm that:

I did most of the research.

Also the writting.

Sometimes I cried.

But mostly I had fun.

Preface

This r project `TravelBehaviorQinghai` is created by first-year PhD student Haoran Xu to produce a model paper for the final course project of "GEOG712 - Reproducible Research Workflow", taught by Dr. Antonio Paez at McMaster University, Canada.

The paper is titled "Assessing the influence of tourists' perceived travel environment and their travel behavior on travel satisfaction using structural equation models (SEM): a case of Qinghai-Tibet Plateau", and stems from a half-way done research project in collaboration with Dr. Huaxiong Jiang starting from Jun, 2022 from Beijing Normal Universtiy, China.

The project paused since March of 2023 due to lack of time and energy investment. Therefore, I am taking the chance of this course project to review and re-arrange the previous work I had done nearly two years ago. Main work I did for this course project include:

- developing an r package called "TravelBehaviorQinghaiData" using existing data in Excel format, transforming it into reproducible, open-sourced, and well-cleaned .rda format data.
- using r package lavaan to reproduce the Structural Equations Modeling (SEM) method, which was previously constructed and performed in a commercial software called mplus.
- first time writing a model article in r studio using latex syntax, in which I practiced several r packages such as `tidyverse`, `kableExtra`, and `macdown`, a template for writing a McMaster graduate thesis.

Citing format: Xu, H. (2024). TBQTSEM: a model paper of "Assessing the influence of tourists' perceived travel environment and their travel behavior on travel satisfaction using structural equation models (SEM): a case of Qinghai-Tibet Plateau". `https://github.com/Horan517/TBQTSEM`

Chapter 1

Introduction

1.1 Introduction

Subjective well-being is the psychological assessment of people's lives, including their emotional response to incidents and cognitive perceptions on life quality (Diener, 2000). The shift of well-being assessment from merely evaluating objective elements (wealth etc.) to incorporating multiple subjective indicators of assessment occurs in recent times as previous methods fail to determine the quality of life (De Vos, 2019; McCabe & Johnson, 2013).

The relationships of tourism and SWB has been an emerging interest for many scholars to dig into. There are firm evidence that indicates tourism generally contributes to social tourists' well-being (McCabe & Johnson, 2013). Scholars often use two-step surveys to explore the effect outdoor travel has on well-being improvement. Whilst another line of research focuses on the intrinsic mechanisms of the relationship, probing into how possible factors of tourism like built environment and travel behavior affect trip satisfaction and its internal interaction effects (Carneiro & Eusébio, 2019). While among the varied indicators of detecting respondents' SWB, satisfaction is an effective factor to represent people's perceived subjective feeling towards a either short or long activity (Chen, Fan, Cao, & Khattak, 2019).

This study digs into the relationships between travel satisfaction and other factors such as travel modes, travel frequency, travel distance and tourists' perceived tourist attraction environment and road environment. The core research questions is: what kind of factors would greatly impact local and non-local tourists' travel behavior and their travel satisfaction on Qinghai-Tibet Plateau.

Chapter 2

Data & Methodology

2.1 Study Area and Data Collection

The study area, Qinghai-Tibet Plateau, or referred to as Tibetan Plateau, is situated in the western region of China and characterized by its high altitude averaging over 4,000 meters. Due to its low population density and an extremely alpine climate, it exhibits a unique set of travel behavioral patterns for local residents or outside tourists. Furthermore, in recent years, the plateau has witnessed rapid infrastructural development invested by Chinese government, and a significant surge in tourist influx (Gao & Sun, 2021). Despite this growth, scholarly investigations into travel behaviors, satisfaction levels, and the broader implications of these developments on local and visiting populations remain scant.

The questionnaire-collecting process started both online and on-site in July of 2022. The online questionnaires were written on the cover page that only those who had ever been to Qinghai-Tibet Plateau were qualified to fill out them. Then followed by was the on-site questionnaire-distributing process along with the Second Tibetan Plateau Scientific Expedition and Research Program during late July to early August. To specifically target at tourists while considering the convenience of conducting investigation, we mainly chose four touristic sites to collect questionnaires along the expedition route. Eventually, we collected 729 on-site questionnaires, which were acquired mostly in four sites - Qinghai Province Museum in Xining City, Qinghai Lake Scenic Area, Dachaidan Emerald Lake Scenic Area, Mani Stone Mound Scenic Area in Yushu City (Figure 2.1). With a total number of 830 questionnaires, 16 were filtered out due to a lot of missing answers, leaving 814 eventually entering modeling phase, with an validity rate of 98.07%.

2.2 Variables

The survey was originally designed in the contexts of assessing smart transportation within the Qinghai-Tibet Plateau, which contains multifaceted aspects spanning from travel behavior, travel perceptions to technology adoption and usage. This study focuses

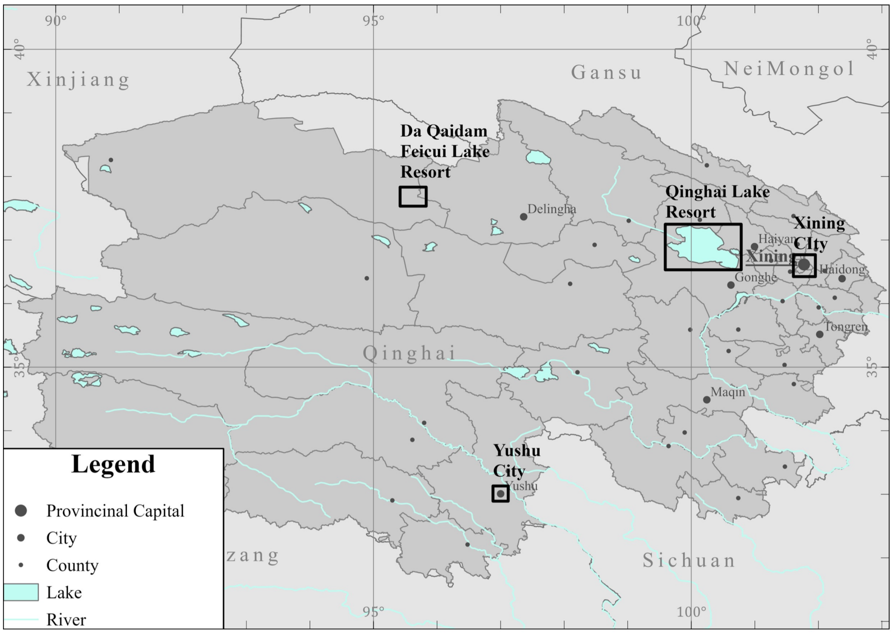

FIGURE 2.1: Sampling Locations on the Qinghai-Tibet Plateau

only on several key dimensions, which are tourist travel behavior, their perceived travel environment, travel satisfaction, and their socio-demograpical characteristics.

The complete questionnaire (originally in Chinese and translated in English) alongside with data cleaning and re-digitalizing is stored in `TravelBehaviorQinghaiData` package.

Specifically, socio-demograpical variables include gender, age, residence, personal monthly income, education level, profession, household size and ownership of driving license. Travel behavior variables in this model include frequency of traveling to Qinghai-Tibet Plateau in the past year and average daily traveling distance during the trip people were having when filling the questionnaire. Travel expectation and travel satisfaction are also measured, using a 5-point Likert scale ranging from strongly agree (value = 5) to strongly disagree (value = 1). Lastly, travel environment variables include two latent variables - people's perceptions of the environment of tourist attractions and the environment of roads along the trip, with the first consisting of 6 questions and the latter consisting of 5 questions.

2.3 Methodology

Structural Equation Model (SEM) was used in the study to entangle the complex relationships across different variables. According to Bollen (1989), SEM is able to simultaneously estimate the causal relationships among a set of observed variables based on a specified model. In addition, SEM can calculate the indirect effects between two

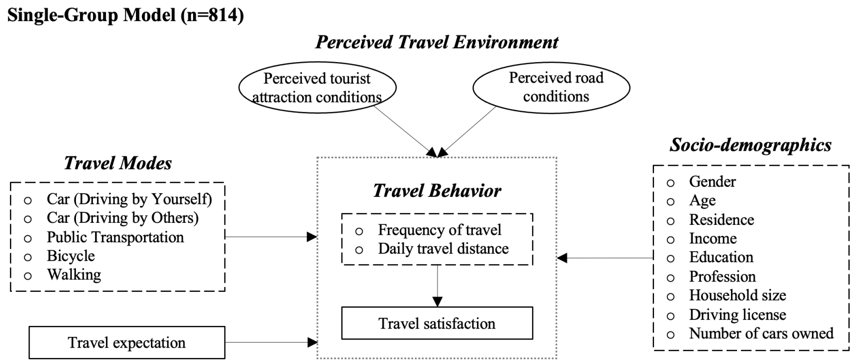

FIGURE 2.2: Conceptual Framework

variables, mediated by other intervening variables (Hayes, 2009), which would help unravel the mediating effects of perceived travel environment had on travel satisfaction through travel behavior.

2.4 Model Construction

The conceptual framework of SEM model is shown in Figure 2.2. Both direct and indirect pathways are drawn and measured, but only one model - a single-group model consisting of all observations, is measured in this model paper. A multi-group modelling approach (setting residence as a grouping variable) was previously used to compare the differences between local tourists and non-local tourists in the project. But in this model paper due to time constraints I did not incoporate the multi-group modelling analysis.

2.5 Modeling

Below, confirmatory Factor Analysis (CFA) model and Structural Equation Modeling (SEM) model are respectively defined and measured.

```r
# Define the CFA model
cfa_model <- "
# Measurement model
tourist_envi =~ ta_envi1 + ta_envi2 + ta_envi3 + ta_envi4 + ta_envi5
  + ta_envi6
road_envi =~ r_envi1 + r_envi2 + r_envi3 + r_envi4 + r_envi5
"

# Fit the model
fit_cfa <- cfa(cfa_model, data = TBQT, missing = "ml")
```

```r
# Model summary
cfa_summary <- summary(fit_cfa, fit.measures = TRUE, standardized = TRUE)
```

```r
# Define the SEM model
model <- "
# Measurement model
tourist_envi =~ ta_envi1 + ta_envi2 + ta_envi3 + ta_envi4 + ta_envi5
  + ta_envi6
road_envi =~ r_envi1 + r_envi2 + r_envi3 + r_envi4 + r_envi5

# Structural model
frequency_travel ~ tourist_envi + road_envi
  + self_drive + other_drive + pub_trans + bicycle + walking
  + exp_lvl
  + gender + age + residence + income + edu_lvl
  + profession + household_size + dri_lic + num_cars
daily_d ~ tourist_envi + road_envi
  + self_drive + other_drive + pub_trans + bicycle + walking
  + exp_lvl
  + gender + age + residence + income + edu_lvl
  + profession + household_size + dri_lic + num_cars
sati_lvl ~ tourist_envi + road_envi
  + self_drive + other_drive + pub_trans + bicycle + walking
  + exp_lvl
  + frequency_travel + daily_d
  + gender + age + residence + income + edu_lvl
  + profession + household_size + dri_lic + num_cars

# Correlations
r_envi1 ~~ r_envi2
exp_lvl ~~ tourist_envi
ta_envi1 ~~ ta_envi2
ta_envi5 ~~ ta_envi6
"

# Fit the model
fit_sem <- sem(model, data = TBQT, estimator = "MLR", std.lv = TRUE, missing = "ml")

# Model summary
sem_summary <- summary(fit_sem, fit.measures = TRUE, standardized = TRUE, modindices 

mi <- modindices(fit_sem, sort = TRUE, maximum.number = 20)
```

As all of the variables in the model are categorical variables (either binary, categorical or ordinal), `lavaan` package only need to maintain the types of these categorical variables as `numeric` to deal with exogenous categorical variables. For endogenous variables, the ideal way is to set it as `ordered`, however, since the Full Information Maximum Likelihood method of dealing with missing value cannot deal with categorical variable. Therefore, I prioritized using Maximum Likelihood with Robust Standard Errors (MLR) estimator with setting `missing = "ml"` to deal with missing values.

For iterations, as the iterations control is already built into the `lavaan` package, it will automatically iterate until convergence. Regarding bootstrapping strategy, it helps to deal with data non-normality problem and to test indirect effects by estimating bias-corrected confidence intervals (CI). This method should be tested with trials, yet due to time constraints, it is not included in this model paper.

Chapter 3

Results

3.1 CFA Results

Confirmatory Factor Analysis (CFA) is performed at first to detect if the model can build "perceived tourist attraction environment" and "perceived road environment" as two latent variables. The method models how a set of observed variables relates to one or more latent variables.

According to CFA results (3.1), model fit is relatively acceptable. The significant Chi-Square test ($p < 0.001$) is not unexpected given the large sample size ($n = 814$). The SRMR (0.040) indicates a good fit, and the CFI (0.926) and TLI (0.905) are close to the acceptable threshold of 0.90, suggesting a moderately acceptable fit overall. However, the RMSEA (0.094) exceeds the typical cutoff of 0.08, meaning that there could be refinements about constructing the two latent variables.

Regarding loading estimates, Table 3.2 shows that the observed variables load strongly onto their respective latent variables, indicating good measurement. For the "perceived tourist attraction environment" latent variable, standardized loadings range from 0.601 to 0.723, with `ta_envi2` ("I think there is a large variety of scenic views along the route"), `ta_envi3` ("I think the attractions I visited are well-known"), and `ta_envi4`

Table 3.1: CFA model fit results: Travel Environment variables

Index	Value	Standard
Chi-Square	352.57	-
Degrees of Freedom	43	-
P-value (Chi-square)	<0.001	> 0.05
CFI	0.926	>= 0.90 (acceptable)
TLI	0.905	>= 0.90 (acceptable)
RMSEA	0.094	< 0.08 (acceptable)
P-value RMSEA <= 0.05	0	> 0.05
SRMR	0.04	< 0.08 (acceptable)

(“I think the scenery along the route is unique”) showing the strongest relationships. Similarly, for the perceived road environment latent variable, loadings are consistently high as well, ranging from 0.686 to 0.888, with `r_envi4` (“The level and capability of traffic management along the route affected this trip”) and `r_envi3` (“The availability of roadside service facilities (e.g., shops, parking lots, gas stations) affected this trip”) being the most strongly associated indicators.

TABLE 3.2: Standardized coefficients of the measurement models

Latent Variable	Observed Variable	Coeficient	S.E.	t-statistic
Perceived Tourist Attraction Environment	ta_envi1	0.674	0.000	NA
	ta_envi2	0.715	0.077	17.335
	ta_envi3	0.691	0.079	16.261
	ta_envi4	0.723	0.075	17.249
	ta_envi5	0.637	0.087	15.041
	ta_envi6	0.601	0.086	14.449
Perceived Road Environment	r_envi1	0.686	0.000	NA
	r_envi2	0.775	0.056	20.648
	r_envi3	0.823	0.059	20.499
	r_envi4	0.888	0.061	21.456
	r_envi5	0.814	0.065	20.511

Note:
S.E. represents for standard error.
All loadings of observable variables except the first one of each latent variable are statistically significant ($p < 0.001$).

Table 3.3: SEM model fit results

Index	Value	Standard
Chi-Square	492.814	-
Degrees of Freedom	246	-
Chi-Square/df	2.003	< 5.0 (acceptable)
P-value (Chi-square)	< 0.001	> 0.05
CFI	0.955	>= 0.90 (acceptable)
TLI	0.942	>= 0.90 (acceptable)
RMSEA	0.036	< 0.08 (acceptable)
90% CI RMSEA (Lower)	0.031	-
90% CI RMSEA (Upper)	0.041	-
P-value RMSEA <= 0.05	1	> 0.05
SRMR	0.042	< 0.08 (acceptable)

Note:
CFI = comparative fit index;
TLI = Tucker Lewis index;
RMSEA = root mean square error of approximation;
SRMR = standardized root mean square residual.

The covariance between the two latent variables (standardized = 0.136) is significant (p = 0.001), suggesting a moderate correlation. This indicates that individuals who perceive tourist attractions favorably also tend to rate road environments positively. And later in SEM model the two latent variables that have residual correlations are linked with ~~ symbol.

3.2 SEM Results

The Structural Equation Modeling (SEM) model demonstrates a good overall fit in Table 3.3. The Chi-Square/df ratio of 2.003 is within the acceptable range (< 5), indicating a reasonable relative model fit. While indices as CFI (0.955) and TLI (0.942), exceed the threshold of 0.90, suggesting a strong fit. The RMSEA of 0.036, with a 90% confidence interval of [0.031, 0.041], is well below the acceptable limit of 0.08. Additionally, the SRMR of 0.042 meets the recommended standard (< 0.08). These results collectively indicate that the hypothesized model aligns well with the observed data.

According to the overall single-group SEM results that considered all observations (Table 3.4), the overall effects between different pathways are mixed.

Table 3.4: SEM model results

Sections	X.	Trip.frequency	Daily.traveling.distance	Travel.satisfaction
Travel Environment	Tourist environment	-0.008	0.114***	0.448***
	Road environment	-0.003	-0.069**	-0.003
Travel Modes	Car (Driving by Yourself)	-0.028	0.247***	-0.033
	Car (Driving by Others)	-0.022	0.127**	-0.074
	Public transportation	-0.028**	-0.138***	-0.046
	Bicycle	0.001	0.019	-0.004
	Walking	0.024	-0.095***	0.053*
Travel Expectation	Travel expectation	-0.035	0.025	0.166***
Travel Behavior	Frequency of travel	NA	NA	0.063
	Daily travel distance	NA	NA	-0.013
Socio-demographics	Gender	-0.012	-0.063**	0.06*
	Age	-0.037	-0.016	-0.08**
	Residence	0.75***	-0.202***	-0.166***
	Income	0.015	0.082*	0.039
	Education level	-0.017	0.051	-0.006
	Profession	0.046*	0.034	0.039
	Household size	0.027	0.016	-0.012
	Owing driving licence	0.004	0.097**	0.015
	Number of cars	-0.024	0.028	0

Note:
All results are standardized.
***: Significant at the 0.01 level (p-value < 0.01)
**: Significant at the 0.05 level (p-value < 0.05)
*: Significant at the 0.1 level (p-value < 0.1)

3.2.1 The effects of perceived travel environment on travel satisfaction

The results showed that perceived tourist attraction environment had a direct effect on travel satisfaction (0.448) while perceived road environment (-0.003) showed no such significant correlations. The better perceptions people had over the quality and other characteristics of tourist attractions, the higher satisfactory levels they tended to possess during the trip. Though, in terms of perceived road environment, the associations were weak.

Considering the mediating effects, perceived travel environment affect travel satisfaction through travel behavior. It shows that, better tourist site conditions (0.114) led to farther daily travel distance while worse road conditions (-0.069) caused people to travel less. Meanwhile, there existed no associations was obtained between travel environment and trip frequency.

3.2.2 The effects of travel modes on travel satisfaction

Different levels of tourists' travel satisfaction were observed in five different travel modes, despite the relationships being mostly not significant. Walking (0.053) is the only travel mode that contributed to leveling up satisfaction, while the other four (i.e., car driving by yourself, car driving by others, public transportation, and bicycle) all resulted in not significant lower satisfaction, with car driving by others (-0.074) lowering the most.

Regarding the influence travel modes exerted on travel behavior, daily travel distance was generally more associated with travel modes compared to trip frequency. Car, either driven by yourself (0.247), car driven by others (0.127), both significantly caused tourists to travel longer distance, while the former has bigger influence than the latter. Meanwhile, public transit (-0.138) and walking (-0.095) both significantly discouraged tourists from traveling farther. For the effects of travel modes on travel frequency, public transportation (-0.028) is associated with lowering people's intentions of traveling. While for other travel modes, driving by car will lower travel frequency while walking will boost it, though none of them are significant, meaning that there exist no mediating effects towards travel satisfaction either.

3.2.3 The effects of travel behavior on travel satisfaction

In terms of travel behavior, our study only considered two variables - tourists' trip frequency to Qinghai-Tibet Plateau and their daily travel distance during the trip. The results showed that higher frequency of travelling to Qinghai-Tibet Plateau had a direct positive effect (0.063) on tourist travel satisfaction, despite the correlation being not significant. This could indicate that as tourists travel to Qinghai-Tibet Plateau more times their satisfactory levels would steadily improve. However, the associations between daily travel distance and travel satisfaction were not significant. This might result in the gradient setting of daily traveling distance in the questionnaire (distance categorized as <10 km, 10-50 km, 50-100 km, 100-200 km, >200 km). However, based on the simple statistical analysis of the average tourists' satisfactory levels under different distance

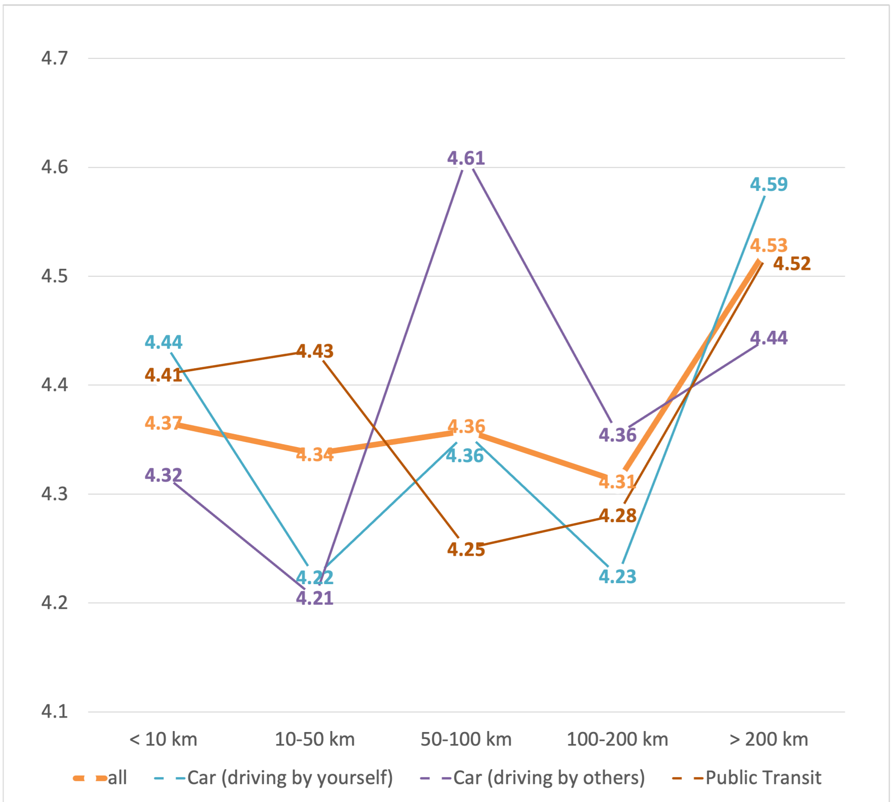

FIGURE 3.1: Travle satisfaction by gradient travel distance levels

gradients, it was found that distance-satisfaction relationship might follow a U-shaped pattern as shown in Figure 3.1.

For the single-group scenario, within the 200 kilometers range, tourists' satisfactory levels fluctuated and slightly decreased (from 4.366 for <10 km to 4.312 for 100-200 km) as they traveled longer distance. However, the pattern displayed a drastic surge of satisfactory levels when travel distance exceeded 200 kilometers. The possible cause for the decrease could be attributed to increasing fatigue of sitting or driving during daily travelling. While for the surge, it is speculated that the beauty and uniqueness of natural landscapes of Qinghai-Tibet Plateau had positive effects on travelers' eyes and moods, which would first offset the tiredness brought by means of transport and then improve tourists' satisfactory levels. This pattern was also observed in studies of (Ettema et al., 2011), who theorized that the positive relationships between distance and satisfaction could be ascribed to the inner vales contained activities in travel (e.g., admiring scenery, listening to music, having fun, etc.). Furthermore, considering the huge area of Qinghai-Tibet Plateau and the percentage of people traveling in cars (62.3%), the 200 kilometers could be an important distance demarcating point, where visual contentment gained along the road would prevail over physical fatigue thus leading satisfactory levels to rise.

3.2.4 Effects of travel expectation and socio-demographics on travel satisfaction

The results showed that travel expectation had a significantly positive effect (0.166) on travel satisfaction only directly. The highly anticipated travel with big expectations before traveling tended to result in higher levels of satisfaction. However, as travel expectation does not has dierect influence over travel bahvior, there seems to be no mediating effects on travel satisfaction.

In terms of socio-demographics, both direct and indirect effects demonstrated high heterogeneity in different paths. The binary exogenous variable residence, which reflected different sources of tourists (0 for non-local, 1 for local), proved to be an important factor that influenced both travel satisfaction and travel behavior. Local people generally had lower satisfactory levels over the course of their whole travel experience compared to non-locals (-0.166). The cause for this might stem from people's different travel intentions. Taking planned travel time for example, 49.3% non-local people planned to travel longer than a week, while the majority local people (85.0%) only planned one-week travel or even shorter. Further, there could exist hidden factors (i.e., varied subjective well-being levels) that account for the results, regarding income, profession, education, etc. Simultaneously, local people significantly travel more frequently and within shorter distance, which can be regarded as supplementary evidence of different travel intentions.

For other socio-demographic characteristics, women (0.06) and younger people (-0.08) had higher levels of travel satisfaction, and people who have higher income, better education and more flexible professions also tended to be more satisfactory, though the latter paths were not significant. Considering the effects on travel behavior, those who have inflexible professions (0.046) tend to travel more frequently, while men (-0.063) and people with higher income (0.083), as well as owning a driving license (0.097) would travel longer distance.

Conclusion

The study probes into how factors as travel behavior and perceived travel environment can influence tourists' travel satisfaction on Qinghai-Tibet Pleateau. The single-group SEM analysis conducted in this model peper revealed mixed effects across different pathways. Perceived tourist attraction environment significantly influenced travel satisfaction, while perceived road environment had no notable direct effect. Mediating effects showed that better tourist site conditions led to longer daily travel distances, whereas worse road conditions reduced travel distance. Travel modes exhibited minimal direct effects on satisfaction, with walking positively contributing and car driving by others showing the largest negative impact. Regarding travel behavior, frequency of travel to the Qinghai-Tibet Plateau had a minor positive effect on satisfaction, although insignificant, and daily travel distance showed no direct association.

The innovative highlights of the study would be using SEM modeling to comprehensively incorporate all relevant factors that could impact travel satisfaction. While it focused on the perspectives of tourism traveling instead of work commuting, a travel activity that has been well researched and concentrated on. Meanwhile, the study supplements the vacancy of similar travel behavior related studies conducted on a plateau area, as most focuses on cities of low altitude.

There are also some aspects this article can be further improved: 1) if conducting follow-up survey or new survey projects targeted at travel satisfaction, the more standardized and official survey scale, such as Satisfaction with Travel Scale (STS) by Ettema et al. (2011), could be used; 2) objective and measurable traveling time, distance, and road infrastructure geo-spatial data could be calculated and added into this study, however, it is true that such data might not be easy to obtain due to harsh natural environments and governments' privacy concerns; 3) Could further dig into the dynamic intersecting influences between variables by performing multiple-group models using variables such as residence, profession, or travel modes.

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