Transportation Research Part A 141 (2020) 398–409

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Explanatory variables underlying the route choice decisions of tourists: The case of Geiranger Fjord in Norway

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A R T I C L E I N F O

Keywords:
Route choice
Tourist
Path size correction logit
Scenery road

A B S T R A C T

The tourism industry is rapidly growing, and the massification of certain areas is jeopardising the environment. Certain roads in protected areas or near tourist attractions are experiencing an increase in traffic volumes, leading to higher pollution and noise levels and greater discomfort in the travel experience. To recommend measures intended to ensure a sustainable tourism industry without compromising the environment, it is necessary to obtain further knowledge regarding tourists' travel behaviour as it may differ from that of other travellers, i.e., tourists might choose a route based on variables other than time and cost, such as landscape or tourist attractions.

Using Geiranger Fjord in Norway as a case study, tourist route choice preferences were observed and analysed. In total, 60 routes from 12 different origins were observed based on 408 responses collected through a tourist survey administered in the summer of 2018. These data were combined with information regarding road features and the locations of tourist attractions. A path size correction logit model was selected to estimate the significant variables in the choice of one route over other routes. The results showed that tourists selected their routes mainly based on the travel time, road scenery (water bodies and forests), sightseeing places among first-time visitors, and outdoor activities among those living outside of Norway. In addition, the tourists preferred local roads, and 'caravan' tourists were more attracted to roads with fewer facilities. The findings of this study show that tourists' route choice behaviour differs from that of other travellers. Policymakers should consider these differences to enhance transport systems. Further research should focus on incorporating these findings into a transport model to simulate tourists' travel patterns and quantify changes in traffic volumes due to different sustainable measures.

1. Introduction

Tourism might affect the natural environment (Holden, 2008) as it might generate pollution and cause ecological damage (Zhong et al., 2011). Simultaneously, tourism may influence the tourist experience as an increase in traffic volumes might reduce traveller satisfaction (Manning et al., 2014). However, tourism and the environment might be able to co-exist if adequate measures are implemented to avoid the massification of places and establish a well-designed transportation system (Pettebone et al., 2011). Manning (2011) proposed managing the visitor capacity to avoid irreversible impacts on national parks, maintaining the quality of tourists' experience. Regarding road capacity, understanding tourists' movement patterns is necessary before analysing different measures, such as route deviations, which could be used to alleviate traffic volumes by spreading tourists along different roads or areas.

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https://doi.org/10.1016/j.tra.2020.09.023
Received 29 November 2019; Received in revised form 25 September 2020; Accepted 27 September 2020
Available online 10 October 2020

Unfortunately, research concerning tourist travel behaviour is scarce (Denstadli and Jacobsen, 2011); moreover, this behaviour might be difficult to capture as the patterns are non-repetitive (Hasnat and Hasan, 2018).

The following two types of studies investigate tourist movement patterns in the literature: studies focusing on tourists' routes to or from their main destination and studies focusing on intra-destination movement patterns. These two decision processes differ because they correspond to different stages of a trip (Karl et al., 2015). The latter has attracted greater attention from researchers as it directly influences micro destination management (Lew and McKercher, 2006). In contrast, the former is directly associated with route choice, which is the fourth step of traditional transport models (Ortúzar and Willumsen, 2011). In this step, traffic volumes are allocated to all potential road paths per origin destination until convergence is reached.

This article focuses on tourist route choice preferences as these preferences might differ from those of other travellers. An improved understanding of tourist route choice preferences could provide a better overview of tourist traffic in both hotspots and their surrounding areas, thus supporting the use of holistic, sustainable measures.

Tourists might regard travel as a benefit (Chavas et al., 1989; Page, 2005). Tourists might prefer detours to visit certain places and enjoy sightseeing, even if these places are remote (Zhong et al., 2019). Alivand and Hochmair (2015) studied nearly 100 routes selected by tourists and found that the travel time was approximately 90% longer than the corresponding fastest route. A greater range of vehicle types were found in scenic routes as these were used by tourists (Briganti and Hoel, 1994). Denstadli and Jacobsen (2011) analysed the motives underlying the route choice in scenic roads and found that in addition to road scenery, tourists placed significant weight on natural and cultural attractions, facilities, and outdoor activities. Sun and Lee (2004) identified landscape, especially water bodies and forests, as a relevant attribute in tourists' route choice; furthermore, the road type and certain points of interest were also important, while restaurants were not found to be important. The presence of scenic roads along a route was significant for tourists and travellers on long and overnight trips (Eby and Molnar, 2002). However, only time and money are commonly included as factors in the decision process (Ortúzar and Willumsen, 2011).

This article contributes by providing empirical quantitative evidence of tourists' route preferences and differentiates them based on trip and socioeconomic features, which is lacking in research conducted in this field.

The selected case study is Geiranger, a small village with approximately 250 inhabitants in the western part of Norway. Geiranger is located at the head of the Geiranger Fjord, which is listed as a UNESCO World Heritage Site. This village is one of the best Norwegian tourist destinations due to its spectacular scenery (Visit Norway, 2019a). The total number of visitors to Geiranger in 2018 exceeded one million, with over 30% of tourists visiting in July (Yttredal et al., 2018). These numbers are constantly increasing. The total number of visitors to Geiranger has increased by 19% since 2014, representing an annual increase of approximately 5%.

In the summer of 2018, a survey was conducted among tourists in Geiranger, and in total, 915 responses were collected; however, only 408 responses were further analysed in this article as these corresponded to tourists who freely chose their route. A path size correction logit (PSCL) model was estimated with this sample to observe the significant variables driving tourists' route choice. The

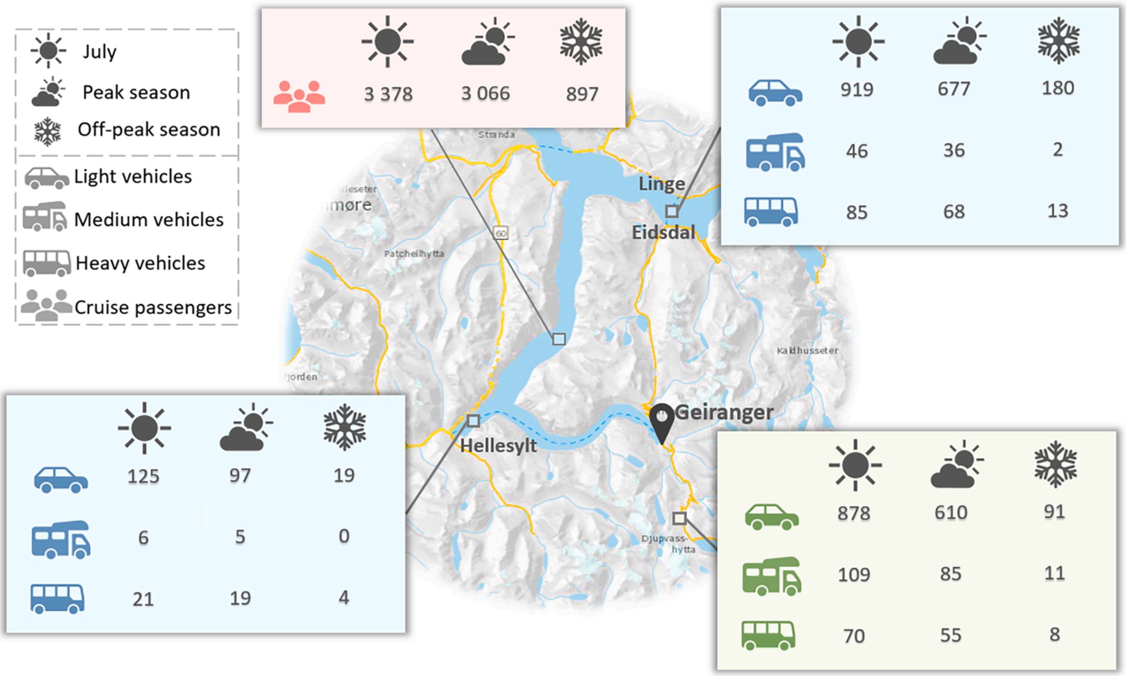

Fig. 1. Average daily traffic (light, medium, and heavy vehicles) and number of cruise passengers in July, the peak season (June-August) and the off-peak season (September-May) in 2018 on the land and sea access to Geiranger village (one way) (modified after Babri and Díez-Gutiérrez (2019), background map modified after Statens vegvesen (2019)).

model included route features, trip characteristics and socioeconomic features and accounted for spatial correlation among the routes.

Section 2 describes the case study in greater detail. The methodology, including a description of the data and method employed, is reported in Section 3. The results are presented in Section 4, followed by a discussion in Section 5. The conclusion and policy implications are presented in Section 6.

2. Case study

Geiranger can be reached by either land or sea. A county road provides access to Geiranger from the south and the north. The southern access is generally only open between May and October due to snow and weather conditions in the winter. The northern access includes the Eidsdal-Linge car ferry, which is located 30 km from Geiranger centre and has an on-board time of approximately 12 min and a ticket fee of approximately 10€ (for a car including the driver). This ferry is operated year-round with frequencies that vary from 4 departures per hour during the peak season (June-August) to 2 departures per hour during the off-peak season (September-May). The western access includes the Hellesylt-Geiranger car ferry, which is in operation between April and October with 8 departures per day during the peak season and half of that frequency during the off-peak season. The duration is approximately 60 min with a ticket fee of approximately 60€ (for a car including the driver). In addition, Geiranger port receives several cruises from May to October, especially during the peak season, and is the second most important tourist port in the country (Stranda Port Authority, n.d.).

Fig. 1 depicts the average daily traffic of light, medium and heavy vehicles on the accesses to Geiranger village during the different seasons in 2018 (vehicles less than 5.6 or 6 m long are considered light for road or ferry counts, respectively; medium vehicles are between 5.6 and 7.5 or between 6 and 8 m long, and heavy vehicles are more than 7.5 or 8 m for road or ferry counts). The average daily traffic is estimated according to the time periods during which the road, ferry, or cruises are in operation. The counting stations in the north and west are located at the ferry quays, while in the south, the counting station is located on the road. In addition, Fig. 1 shows the average daily number of cruise passengers. Previous studies have shown that approximately 55% of these passengers pre-book a bus to visit sightseeing places around the village (Svendsen et al., 2014); this traffic might not be captured by the mentioned

Table 1
Socio-economic features.

Variable	N	%
Gender		
Male	244	60%
Female	164	40%
Age		
Under 18	16	4%
18–24	39	10%
25–34	100	25%
35–44	68	17%
45–54	94	23%
55–64	65	16%
65–75	22	5%
Over 75	0	0%
No answer	4	1%
Maximum education level		
Primary (middle school)	28	7%
Secondary (high school)	105	26%
Bachelor's degree	118	29%
Master's degree or higher	142	35%
No answer	15	4%
Employment		
Full time	303	74%
Part time	22	5%
Student	36	9%
Unemployment	7	2%
Retired	32	8%
No answer	8	2%
Country of residence		
Norway	131	32%
Germany	57	14%
Sweden	57	14%
Netherlands	24	6%
France	20	5%
USA	16	4%
Belgium	12	3%
Switzerland	12	3%
Spain	12	3%
Denmark	8	2%
Great Britain	4	1%
Other	53	13%

counting stations as these stations are situated beyond the reach of the bus routes.

The traffic during the peak season, especially in July, led to overcrowding at locations in the village and surrounding destinations. These locations include viewpoints along the road, generating queues and congestion at certain times of day.

Table 2
Trip features.

Variable	N	%
Travel party		
Family/friends with children	267	65%
Family/friends without children	81	20%
Alone	25	6%
No answer	35	9%
Transport mode		
Electric car	5	1%
Hybrid car	50	12%
Diesel car	147	36%
Petrol car	117	29%
Caravan	70	17%
Motorbike	11	3%
Bike/walking	8	2%
Route motivation		
Scenery	177	36%
Visiting other places along the way	132	27%
Fastest	66	13%
Shortest	58	12%
Private reasons	18	4%
Others chose the route	16	3%
More flexible (no ferries)	13	3%
Cheapest	5	1%
Safest	5	1%
Lower traffic	5	1%
Overnight place the previous/posterior night to Geiranger		
Oslo	25	6%
Bergen	15	4%
Trondheim	21	5%
Molde	30	7%
Ålesund	123	30%
Åndalsnes	79	19%
Stryn	58	14%
Grotli	24	6%
Runde	10	2%
Førde	8	2%
Voss	6	1%
Sogndals	9	2%
Overnight days in the Geiranger area		
No overnight stay	95	23%
1 day	146	36%
2 days	96	24%
3 days	36	9%
4 days	12	3%
5 days	7	2%
6 days	6	1.5%
1 week	2	0.5%
1–2 weeks	5	1.3%
2–3 weeks	2	0.5%
3–4 weeks	1	0.2%
Geiranger as the main attraction		
Yes	271	66%
No	137	34%
First time in the area		
Yes	268	66%
No	140	34%
Willingness to pay an entrance fee (N = 315)		
No willingness to pay	48	15%
Up to 20 €	149	47%
Up to 40 €	65	21%
Up to 60 €	31	10%
Up to 80 €	22	7%

3. Methodology

3.1. Data

The data used in this study were collected through a random intercept survey of tourists on a total of 20 weekdays in July and August of 2018 at seven locations around Geiranger. The locations included areas in the north, west and centre of Geiranger. Tourists travelling to/from south of Geiranger were assumed to be covered by those in the centre.

The survey was designed as a self-completed questionnaire in several languages. Two or three interviewers randomly approached tourists at the locations to engage them in the survey as no reward was offered for participation. The tourists could complete the survey on-site through a PDA or use a QR code to complete the survey at another more convenient time. However, participation with the code was very low. To encourage tourist participation in the survey, the maximum time to complete the questionnaire was 10 min. Therefore, the tourists answered different sets of questions depending on whether they were on their way to Geiranger, in the village, or on their way out. The former two groups responded to questions related to the location of their accommodation the night before arriving at Geiranger (origin) and the trip to the village. The third group completed a questionnaire concerning the trip out of the village and the location of their accommodation on the final night of their stay in Geiranger (destination).

The questionnaire was divided into the following three main parts: (1) socioeconomic information of the respondents; (2) a description of the trip to/from Geiranger, including the origin or destination, transport mode, route choice, and route motivation; and (3) a description of mobility within Geiranger village, i.e., transport mode, length of stay and attraction points visited (for further information regarding the survey, see Babri and Díez-Gutiérrez (2019)).

In total, 408 questionnaires were further analysed in this study as these corresponded to tourists who freely chose among different routes to/from Geiranger.

3.1.1. Socio-economic features

Table 1 describes the variables of the respondents associated with the socio-economic characteristics, including the number in the sample (N) and the corresponding percentage (%).

Of the respondents, 60% were male. The distribution of the age range of the respondents was consistent with the demographic shares, while the maximum education level was slightly higher than the population average, with 35% of the respondents having a master's degree or above. Income was not included in the questionnaire, although income could be related to the education level. Almost 75% of the respondents were working full time.

Regarding the country of residence of the respondents (including only countries with more than 5 respondents), following Norway, which represented more than 30% of the respondents, Germany and Sweden had the second largest shares of tourists, followed by the Netherlands and France.

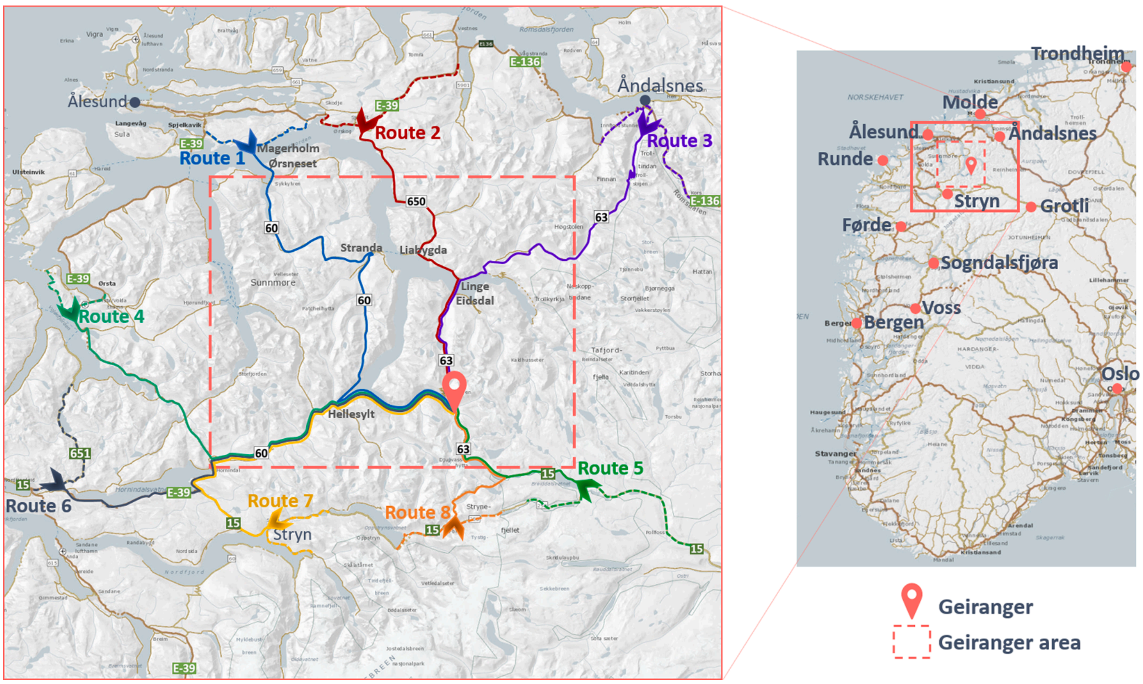

Fig. 2. (a) Routes in the Geiranger area. (b) Origins/destinations (background map modified after Statens vegvesen (2019)).

3.1.2. Trip features

Table 2 describes the variables of the respondents associated with the trip features, including the number in the sample (N) and the corresponding percentage (%).

Tourists travelling alone represented 6% of the respondents, while those travelling with family and/or friends were in the majority. Of these tourists, 65% were travelling with children, and 20% were travelling without children.

Most tourists travelled by car (78%), hybrid and electric vehicles represented only 12% and 1%, respectively; 17% were travelling by caravan, while motorbike, bike and walking jointly represented only 5% of the respondents.

All respondents were asked to state their reason for selecting their route to/from Geiranger in a multiple-choice question. Most tourists chose their routes due to the scenery of the route (36%) or because it was convenient to visit other places along the way (27%); in contrast, 13% chose the fastest route, and 12% selected the shortest route.

Regarding the overnight place stayed at the previous or posterior night when visiting Geiranger, 30% of the tourists stayed at Ålesund, almost 20% of the tourists stayed at Åndalsnes and almost 15% of the tourists stayed at Stryn. These three locations are also popular destinations for tourists. Of the surveyed tourists, 77% stayed overnight in the Geiranger area, and the average number of nights stayed was 1.7; 66% stated that Geiranger was their main attraction, and 66% reported that it was their first time in the area.

Price sensitivity was captured by a willingness-to-pay question in which the respondents faced the choice of whether they would continue visiting Geiranger if they had to pay various road tolls to obtain access. To avoid a long questionnaire, this question was asked of those travelling out of or into Geiranger, who represented 77% of the sample (N = 315). Of these respondents, 47% were willing to pay 20€, 21% were willing to pay 40€, 10% were willing to pay 60€, and only 7% were willing to pay 80€ or more.

3.1.3. Route features

In the proximity of Geiranger area, eight routes were selected based on the roads with greater differences in traffic volumes between summer and winter to identify those most used by tourists, represented on the left side of Fig. 2. The tourists drove to/from Geiranger from/to twelve different locations as presented on the right side of Fig. 2.

The respondents were asked about their route to/from Geiranger from/to the place they stayed at overnight the previous/posterior day. Thus, the route was applicable to a unique day; in the case of multi-day trips, only the day travelling to/from Geiranger was considered. The tourists were presented a map similar to that shown in Fig. 2(a) and asked to select an arrow on the road corresponding to one of the eight routes in the Geiranger area. Thus, the respondents did not select the entire route from/to the origin/destination but only the access road to the local area. The entire route to/from the local area from/to the origin/destination was assumed based on the road network, travel times, and attraction points on the roads. Some tourists might have taken short detours; however, this was considered minor given the lack of a dense road network. The assumed route was validated against the places visited on the way and the origin/destination stated in the survey.

Eight routes from/to each of the twelve origins/destinations were enumerated based on these locations and the travel times. From these potential 96 routes, only those selected by the tourists in the survey were further included in the analysis. In total, 60 routes were observed.

The travel times of the potential routes were estimated based on Google Maps (Google, n.d.), and the values are presented in Table 3. The other route features, including the mean, minimum, and maximum values of each route with regard to all origins/destinations, are described in Table 4.

The route data, including the characteristics of the road, travel distance (km), travel cost (€), road width (m) and speed limit (km/h), were obtained from the Norwegian national road database (NVDB, 2019).

The number of attractions along the routes was obtained from Visit Norway (2019b). The points close to the road within a buffer of approximately 2 km were considered. These points included cultural sites, natural sites, outdoor activities, facilities (accommodations and restaurants), tourist information centres, and sightseeing places. The latter mainly include viewpoints and certain activities intended to explore the scenery (such as fjord safaris and helicopter trips).

The data related to the natural features of the road surroundings, such as rivers, springs, lakes, glaciers, oceans (including fjords), and forests, were obtained from databases provided by the Norwegian Mapping and Cadastre Authority (Kartverket, 2019). A buffer of 500 m on each side of the road segments of each route was created to estimate the percentage of the road where these natural features could potentially be seen. For modelling purposes, these percentages were translated to units between 1 and 100.

Table 3
Travel time (in minutes) of each route and origin/destination.

	Oslo	Bergen	Trondheim	Molde	Ålesund	Åndalsnes	Stryn	Grotli	Runde	Førde	Voss	Sogndals.
Route 1	–	–	500	275	200	260	315	380	285	–	–	–
Route 2	505	560	395	175	135	155	260	–	230	–	–	–
Route 3	450	–	390	225	220	160	–	340	–	465	–	485
Route 4	660	–	550	325	235	310	–	–	200	–	–	–
Route 5	380	450	340	–	–	280	–	50	–	–	360	260
Route 6	590	455	–	–	295	365	–	–	260	270	430	280
Route 7	575	455	–	–	–	–	140	205	–	260	420	270
Route 8	–	400	–	320	240	305	90	–	200	215	375	225

Table 4
Road features (mean, min, and max from the different origins/destinations).

	Travel distance (km)			Travel cost (€)			Road width (m)			Road speed (km/h)		
	Mean	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
Route 1	247	114	492	140	125	157	7.58	7.28	7.85	64	59	67
Route 2	264	108	544	29	10	53	7.83	7.06	10.02	69	62	74
Route 3	311	82	481	23	10	43	7.57	6.39	10.22	71	68	76
Route 4	309	142	653	141	116	169	8.08	7.43	9.75	66	61	72
Route 5	304	33	418	7	0	33	7.84	6.68	10.85	76	69	82
Route 6	284	178	531	136	125	149	7.33	6.92	7.82	68	63	72
Route 7	261	73	530	123	116	139	7.18	6.80	7.75	69	65	72
Route 8	257	69	486	13	0	43	7.57	6.92	8.02	70	66	74
	Tourist information points (number)			Cultural attractions (number)			Natural attractions (number)			Outdoor activities (number)		
	Mean	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
Route 1	6	4	9	8	4	16	12	10	17	78	50	111
Route 2	5	3	8	8	2	22	10	7	20	90	46	207
Route 3	6	2	12	10	3	22	19	12	27	134	72	197
Route 4	6	4	9	11	5	24	16	12	25	87	39	202
Route 5	8	1	13	13	2	22	21	4	34	129	29	205
Route 6	9	4	17	11	5	25	14	11	18	96	47	181
Route 7	10	4	17	10	4	23	14	10	19	121	51	213
Route 8	7	3	13	6	2	14	11	6	17	101	47	195
	Facilities (number)			Sightseeing places (number)			Water bodies (%)			Forest (%)		
	Mean	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
Route 1	60	39	123	59	46	80	29%	26%	34%	43%	35%	48%
Route 2	89	46	236	53	37	79	22%	13%	27%	49%	41%	54%
Route 3	122	57	222	70	52	100	16%	6%	23%	50%	44%	57%
Route 4	86	32	226	64	42	88	28%	17%	32%	42%	36%	46%
Route 5	147	31	226	54	33	63	14%	10%	20%	42%	18%	53%
Route 6	78	38	161	57	42	76	28%	19%	36%	43%	39%	49%
Route 7	84	34	166	59	44	77	27%	20%	33%	43%	38%	49%
Route 8	80	42	140	57	39	79	23%	17%	26%	40%	33%	44%

3.2. Method

As mentioned above, this article further considered the tourists' route choices. The estimated model was a route choice model as the final destination was pre-defined; however, the routes might have been influenced by activities or places along the route. Several variables, such as sightseeing places and outdoor activities, were included in the model to cover the significance of these activities and places.

The route choice modelling is divided into the following two stages: choice set generation and choice selection from a set.

The choice set of each individual must be defined to fulfil the requirements of individual choice behaviour theories (Ben-Akiva and Lerman, 1985). This choice set should include a finite number of alternatives. However, in the context of route choice modelling, the set might be massive and possibly consist of hundreds of potential alternative routes in dense network areas. The choice set must be carefully formed as it influences the choice probabilities and model specifications (Prato and Bekhor, 2007; Bliemer and Bovy, 2008). There are different choice set generation techniques (see Prato (2009)). A misspecification of the choice set might lead to biased model results (Williams and Ortúzar, 1982). In fact, Bliemer and Bovy (2008) showed that irrelevant alternatives within the choice set might cause attractive routes to be modelled as less attractive. This effect should be avoided as it might lead to models with poor robustness.

Nevertheless, in this study, the tourists did not state their route alternatives but only the chosen route. It was assumed that the tourists could choose among all potential routes from/to their origin/destination as described in Section 3.1. Given the lack of a dense infrastructure network in the area, this assumption was not considered to introduce major bias to the model estimations. A minor limitation was that small rural roads were not considered in the estimation of the choice sets, although only negligible detours are excluded from the choice set. Another assumption was that all routes were available to all individuals; however, this might not have always been the case as some tourists might have been unaware of all alternatives. In the questionnaire, the tourists stated why they chose their route, and those who answered that there were no other alternative routes were removed from the sample.

After defining the choice set, a route choice model is used to identify the significant variables affecting the route choice decision and quantify the probabilities of selecting different alternatives. The alternatives might be correlated as some road segments could be included in several routes. Incorporating this correlation into the models reduces biased results.

Route choice models are divided into the following three types: 1) logit structure, including a deterministic correction for the correlation in a multinomial logit (MNL) model (C-logit, path size logit (PSL), and PSCL); 2) generalised extreme value (GEV) structure, which is characterised by explicit modelling of the correlation through assumptions in the stochastic term (paired combinatorial logit, cross-nested logit, and generalised nested logit); and 3) non-GEV structure, which is an open-form expression allowing for correlation in the stochastic term and taste variation or correlation of unobserved factors (Multinomial Probit and Logit Kernel) (Prato, 2009).

The logit structure is the most common in the transport modelling literature (Frejinger and Bierlaire, 2007; Sobhani et al., 2019). Logit models are based on the random utility theory, which postulates that individuals associate a preference index with each alternative, which is denoted as utility. The individual is assumed to choose the alternative that maximises his or her utility according to the utility maximisation rule (Ben-Akiva and Lerman, 1985). Despite their simple structure, these models were used in this article because greater model complexity is not directly correlated with model quality.

MNL models feature the property of independence of irrelevant alternatives (IIA), implying that the probability of choosing one alternative over another alternative should not change if more alternatives are added to the choice set. However, this property is violated in route choice due to overlapping road segments across route alternatives. The C-logit model, which was proposed by Cascetta et al. (1996), represents the first deterministic correction by including a commonality value for each alternative that is directly proportional to the overlap with other routes in the choice set.

PSL models preserve the features of the MNL model but include an additional component in the utility function to account for the spatial correlation among alternative routes; these models were first proposed by Ben-Akiva and Bierlaire (1999) and further developed by Ramming (2001). This component, which is a heuristic approximation, i.e., not based on a well-founded derivation, reduces the utility of each alternative according to the level of correlation with the other alternative routes. Although in Frejinger and Bierlaire (2007), the PSL performed worse than C-logit, the opposite is typically the case (Prato, 2009). PSL has been widely applied to route choice models in the literature and shows good performance (Daamen et al., 2005; Prato and Bekhor, 2007; Dalumpines and Scott, 2017; Liu et al., 2019), even for the tourists' choices (Alivand et al., 2015).

The PSCL model provides a more intuitive understanding of the spatial correlation as a reduction in the utility is related to the length of the common links weighted by the number of routes using them (Bovy et al., 2008). PSL and PSCL models exhibit similar performance, although PSCL models are slightly better for predictions (Bovy et al., 2008). Therefore, a PSCL model was further used in this article. The probability of a route alternative is given by equation (1) based on the formulation described by Bovy et al. (2008).

$$P_k = \frac{\exp(V_k + \beta_{PSC} {*} PSC_k)}{\sum_{l \in C} \exp(V_l + \beta_{PSC} {*} PSC_l)} \tag{1}$$

where k is a given alternative among all alternatives (l) within the choice set (C), V represents the systematic utility of an alternative, PSC is the path size correction of the route, and β_{PSC} is a parameter to be estimated. The path size correction is defined in equation (2).

$$PSC_k = -\sum_{a \in R_k} \frac{L_a}{L} \ln \sum_{l \in C} \delta_{al} \tag{2}$$

where a is a given road segment within the total route segments (R), L_a represents the length of the segment, δ_{al} is the number of alternative routes including the road segment, and L is the length of the whole route.

The route choice model was estimated using BIOGEME, which is a Python package developed by Bierlaire (2018).

The criteria for selecting or rejecting a variable in the model were based on several conditions. The microeconomic conditions must be satisfied, which was verified by estimating the derived utility with respect to the observed variable. The parameter significance was also assessed based on the robustness of the t-test. The null hypothesis that the parameter equalled zero with a confidence interval greater than 90% should be satisfied. Some variables, such as the number of facilities, might have been perceived differently by different types of tourists, such as car or caravan tourists. Thus, the correlations between the parameters of the same variable were estimated based on the robustness of the t-test. The null hypothesis that the parameters were equal should be rejected at a confidence level greater than 90%; otherwise, the variable was perceived equally by all types of tourists.

In addition, the correlations between the parameters of some variables were tested based on the robustness of the t-test. The null hypothesis that the parameters were equal should be rejected at a confidence level greater than 90%. In the case of collinearity,

Table 5
Estimated results of the PSCL model.

Parameter	Value	Std. Error	*t*-test	Sig.
Correlation among the paths (PSC)	1.380	0.313	4.44	***
Travel time	−0.0132	0.001	−8.67	***
Cost × (willingness to pay up to 20€)	−0.0002	0.0001	−1.11	
Width × (scenery as the route motivation)	−0.685	0.180	−3.37	***
Forest	0.023	0.011	1.88	*
Water bodies	0.057	0.019	2.84	***
Sightseeing places × (first-time tourists)	0.0357	0.008	4.58	***
Outdoor activities × (Norway as the country of residence)	−0.0163	0.006	−3.34	***
Facilities × (travelling with a caravan)	−0.0254	0.010	−2.74	***
Number of observations	408			
Initial Log-likelihood	−695.3574			
Final Log-likelihood	−537.0067			
Rho-square	0.228			
Adjusted rho-square	0.215			

Significant at the *90%, **95%, and ***99% confidence levels.

different models of each variable were estimated, and the best model was selected.

The criteria used to compare two models to select the best one depended on whether the models were linearly related in terms of the parameters. The former was based on the likelihood-ratio test to reject the null hypothesis that the two models were equal. The latter was based on the rho-square test; comparing each model to the share market, the best model holds a higher value.

4. Results

Several models were tested by combining different variables, including tourist, trip, and route features, and different interaction effects. These interaction effects were estimated by multiplying the variable by a dummy variable with a specific tourist feature. Table 5 shows the results of the selected PSCL model.

The parameter in the model accounting for the correlation among the routes was significant and presented a confidence level greater than 99%.

The travel time parameter was significant with a confidence level greater than 99%. Several models were tested to observe potential heterogeneity in time perception depending on socioeconomic and trip features, such as tourists travelling with children, first-time tourists, tourists staying overnight, tourists seeking the fastest route, etc. Nonetheless, none of the features presented significant differences with respect to time perception. The travel time and distance were correlated at the 95% confidence level. Thus, a different model replacing the travel time with distance was tested, although the performance of the latter model was worse (rho square of 0.213 against a rho square of 0.215).

The cost parameter was significant at the 75% confidence level among tourists with a high price sensitivity, who are defined as those willing to pay up to 20€ as a toll for entering Geiranger. Given the low value of the confidence level, cost could be considered insignificant for the route choice, even though the microeconomic expectations were satisfied. Additional models were tested to observe other possible cost heterogeneities with respect to different tourist features, but these models performed poorly. Education level was not a significant variable in this analysis.

The parameter representing the width of the roads along the routes was studied with different tourist features. The route motivation was found to be a trigger for the differences in perception, especially among the tourists choosing a route due to its beauty, henceforth called 'scenery' tourists. The width parameters of the 'scenery' tourists and 'non-scenery' tourists were not correlated at a confidence level greater than 95%. The width parameter was significant only among 'scenery' tourists at the 99% confidence level. The parameter was negative, suggesting that 'scenery' tourists preferred narrower roads, i.e., local roads where the scenery is closer.

The parameter related to water bodies had significant effects on the route choice among all types of tourists at the 99% confidence level. No type of water body was significant when analysed separately, suggesting that tourists value the presence of all water bodies along the route. The analysis tested whether 'scenery' tourists valued water bodies more highly by including two parameters in an additional model (water bodies for 'scenery' and 'non-scenery' tourists), but both parameters were correlated at a confidence level higher than 95%. Therefore, scenery could be a secondary reason motivating the route choice of 'non-scenery' tourists. The forest parameter was significant at the 90% confidence level.

The parameter associated with sightseeing places was significant only among 'first-time' tourists at the 99% confidence level. These tourists were travelling to the area for the first time. The analysis also examined whether tourists who considered Geiranger their main attraction point would not consider other sightseeing places along the way and obtained a non-significant result. Some sightseeing places were glaciers, lakes, or waterfalls; however, the parameters of the sightseeing places and water bodies in the model were not correlated at a confidence level larger than 95%. This finding might be explained by the units considered as the variable of the sightseeing places referred to the total number of places along the route, while the variable of water bodies referred to the percentage of the route where these could be seen. Moreover, sightseeing places include other points of interest, such as viewpoints, quaint villages, or activities exploring nature.

The parameter of outdoor activities was significant at a confidence level greater than 99% among tourists residing in Norway. This parameter was negative, suggesting that among these tourists, the presence of outdoor activities reduced the attractiveness of the route.

Facilities along the route were further observed. The parameter was negative and significant among tourists travelling by caravan at the 99% confidence level. In contrast, car tourists did not regard facilities as a significant parameter in their route choice.

Other variables related to route features, cultural and natural attractions, and tourist information points were tested without showing any significance in the route choice in the sample. In addition, potential differences between tourists who were on their way in or out of Geiranger were observed, although these differences were not significant at a confidence larger than 95%.

5. Discussion

The results showed that the travel time was important for the tourists in the sample. The time that tourists spent on their holidays might be predefined in advance, and thus, spending more time reaching the main destination reduces the time spent at the main destination; nevertheless, the drive might also be an attraction (Chavas et al., 1989; Page, 2005). Travel costs were not significant, suggesting that other factors were more important in their decision-making process regarding the route choice. A potential explanation is that a road toll close to the main destination might be unattractive but trivial when compared to the cost of the total trip.

Tourists are different; some tourists might prefer to visit historical towns, bustling cities, relaxing spots, or the wilderness. Therefore, their preferences regarding the accessibility of holiday attractions are also diverse (AlKahtani et al., 2015). Similarly, their preferences for selecting one route over another route differ; however, in the observed sample, the tourists regarded scenery, forests and water bodies as important in their route choice. Some tourists stated that scenery was a main motivation for their route choice. Among the 'scenery' tourists, the road features were also included in the decision-making process as these tourists preferred local roads probably to experience the surrounding nature, and these roads might also have had less traffic. In addition, the speed limit and average speed on these roads might be slightly lower to avoid the phenomenon of 'tunnel vision', reducing the ability to view road surroundings (Rogé et al., 2004).

The evaluation of the destination of first-time tourists is based on external sources (Fakeye and Crompton, 1991), while repeat visitors' evaluations are based on previous experiences (McKercher and Wong, 2004). The perception of a tourism destination on the second and subsequent trips to the same area might also differ from that on the first trip as tourists might become attached to the destination and exhibit environmental awareness and protective behaviour (Su and Swanson, 2017; Joo et al., 2019). Thus, the route choice process might differ between first-time and repeat visitors (McKercher et al., 2012). The results reported in this article support this view as only 'first-time' visitors considered sightseeing places when selecting their route to Geiranger. On subsequent visits, tourists might have already explored their sightseeing places and, thus, chose their routes without considering the locations of these places. This article did not consider the timing of visits to sightseeing places. However, some researchers have shown that the value of visiting different points of interest might vary over the course of the day (Zheng et al., 2017); for example, certain scenery might be more spectacular at sunset.

Outdoor activities around the country resemble one another; thus, residents of Norway may have already experienced such activities. Consequently, these tourists did not consider the locations of these activities when selecting a route likely because these tourists were not particularly concerned with experiencing these activities again during their travel to/from Geiranger. In addition, the perception of tourist attractions might differ across nationalities (Marques et al., 2018).

In contrast to the findings reported by Denstadli and Jacobsen (2011), the presence of facilities along the road was not an important decision factor among tourists travelling by car or motorbike in the studied sample. This discrepancy could be explained by differences in the analysis as the survey considered in this article did not directly ask about the importance of such facilities; instead, this variable was estimated with the logit model. In contrast, the 'Caravan' tourists considered the location of facilities when choosing their route. These tourists preferred roads with fewer facilities, suggesting that this type of tourists might prefer wilder roads. Some tourists were motivated to visit nature-based destinations, such as Norway, to seek anonymous places and experience nature (AlKahtani et al., 2015). In addition, these roads might allow 'caravan' tourists to park their vehicles freely in parking spots outside campsites without paying parking fees.

Measures to restrict tourist growth in Geiranger have been discussed (Halpern, 2007). Incorporating the results of this article into a transport model might help decision makers select the most appropriate measures. Simple models have already shown good performance in non-dense network areas (Díez Gutiérrez et al., 2017).

Nonetheless, these findings are extracted from a reduced sample, limiting the potential to draw conclusions from these data. The validity of these results might be ensured internally by triangulation of data sources as the phenomenon is observed from multiple perspectives (Knafl and Breitmayer, 1989). Thus, further research should incorporate data, such as traffic counts and the number of tourists staying overnight in different origins/destinations. In addition, potential bias due to assumptions related to the choice set could be partially overcome by directly asking tourists about the alternative routes considered in their route choice decision-making process. Moreover, the sample corresponded to a specific place; thus, some tourist types might not be captured, and hence, transferring the conclusions to other areas could be a source of bias. In this article, external validity is discussed by comparing the results with previous studies in different areas.

Further research could focus on including external factors in the model, such as weather conditions as water bodies along the route may be less attractive on rainy days than sunny days. Nevertheless, given the weather variation along the location within each route and the time during the day, to introduce this variable in the model, the collection of other data should be performed to monitor the location and time (GPS data) in addition to the survey. These location data along with road counts could provide information regarding potential crowding experience, which might affect the answers regarding the route motivation.

6. Conclusion

According to the results, tourists selected their routes mainly based on the travel time, road width, road scenery (water bodies and forests), sightseeing places, outdoor activities, and facilities. The dissimilarities among the tourists were reflected in the importance assigned to the abovementioned variables. Sightseeing places were only relevant for first-time tourists, while outdoor activities reduced the attractiveness of the route among tourists residing in Norway. 'Scenery' tourists preferred local roads, and 'caravan' tourists were more attracted to roads with fewer facilities.

The findings reported in this article show that tourists' route choice behaviour differs from that of other travellers. These differences should be considered by policymakers when proposing plans to enhance transport systems. Further research should focus on incorporating these findings into a transport model to simulate tourists' travel patterns and quantify changes in traffic volumes due to different sustainable measures.

Acknowledgements

This research was funded by the Norwegian Research Council through the SUSTRANS project (www.sustrans.no), project number 267887. The authors would like to thank Dina Margrethe Aspen, Else Ragni Yttredal and Solveig Meland for their contribution to the data collection.

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