ASSESSMENT OF THE IMPACT OF ACCOMMODATION ACCESSIBILITY ON THE ORGANIZATIONAL AND LOGISTICAL FEASIBILITY OF THE ANCIENT KHOREZM TOURIST ROUTE IN KARAKALPAKSTAN

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Abstract. The article examines the role of accommodation accessibility and service infrastructure in ensuring the organizational and logistical feasibility of a multi-day thematic tourist route. The study is based on the Ancient Khorezm tourist route along the Nukus–Turtkul axis in the Republic of Karakalpakstan. Unlike approaches in which accommodation is considered only as an auxiliary element of the tourist product, the proposed approach treats the availability and accessibility of overnight accommodation as a mandatory constraint in the organization of a multi-day tourist service. The model takes into account daily travel time, duration of site visits, service time, risk-related time, daily segment length, selection of an accommodation facility, and the distance between the final tourist site of the day and the selected overnight location. Empirical

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calculations are carried out for the basic D_1 and extended D_2 formats of the Ancient Khorezm route. The results show that the four-day basic format requires three overnight accommodation assignments, whereas the six-day extended format requires five. The XON, XUMO and BUSTON CITY accommodation nodes ensure the continuity of the route and allow the daily time load to remain within the established limit. The results confirm that accommodation accessibility should be considered as one of the key conditions for the practical implementation and service sustainability of multi-day thematic tourist routes.

Keywords: thematic tourist route, tourist service, accommodation accessibility, multi-day route, service infrastructure, overnight accommodation, logistical feasibility, Ancient Khorezm, Karakalpakstan.

Introduction

The development of thematic tourist routes is increasingly associated not only with the selection of attractive cultural, historical and natural sites, but also with the creation of a complete tourist product that combines transport accessibility, accommodation, catering, excursion services, information support and organizational coordination [1, 2]. For this reason, a thematic route should be considered as a complex tourist service rather than merely as a sequence of attractions.

The problem of route planning has been extensively studied within the Tourist Trip Design Problem and different variants of the Orienteering Problem. Existing studies address the selection and sequencing of tourist sites, time constraints, route length, available transport modes and tourist preferences [3–6]. Recent research also demonstrates the importance of integrating different transport networks and service constraints into tourist trip planning [7]. However, in multi-day routes, the practical feasibility of a tourist service depends not only on the attractiveness and sequence of sites but also on the availability of accommodation at appropriate points of the route.

This issue is particularly relevant to the Republic of Karakalpakstan, where tourist attractions are spatially dispersed and the level of transport and service infrastructure differs considerably between territories. The distance between tourist sites, differences in road conditions and the uneven distribution of accommodation facilities require a direct link between the daily route structure and available service nodes [8].

The Ancient Khorezm route represents a suitable case for such an assessment. The route along the Nukus–Turtkul axis combines archaeological and historical sites located over a large territory. The practical organization of this route requires the distribution of tourist sites by day and their coordination with accommodation facilities, service stops and existing transport conditions [8, 9].

The purpose of the study is to assess the influence of accommodation accessibility on the organizational and logistical feasibility of the Ancient Khorezm multi-day thematic tourist route in Karakalpakstan.

Research Methodology

The methodological basis of the study is the multi-day organization stage of the two-stage two-contour model of thematic tourist service formation. The basic tourist product D_1 includes mandatory and organizationally sustainable sites, whereas the extended product D_2 includes additional sites when favourable time, transport, service, accommodation and risk conditions are available.

For each tourist site i and route day dd, the binary variable z_{id} is used. The variable takes the value 1 when site ii is included in day dd and 0 otherwise. The binary variable w_d indicates whether day d is used in the route. The set of admissible overnight accommodation facilities is denoted by H, and u_{hd} is a binary variable indicating the selection of accommodation facility h for day d.

The duration of a tourist day is determined by the total time load:

$$T_d = T_d^{move} + T_d^{visit} + T_d^{serv} + T_d^{risk}$$

where:

T_d^{move} – total transport movement time on day dd;

T_d^{visit} – time spent visiting tourist sites;

T_d^{serv} – time associated with service stops;

T_d^{risk} – additional time caused by road, organizational and service-related risks.

This representation is important because the actual duration of a tourist day is determined not only by movement between sites and sightseeing but also by service stops and possible time losses caused by infrastructure and road conditions [5–7].

For each route day, the following time constraint must be satisfied:

$$T_d \le T^{max} w_d, \qquad d \in D$$

where T^{max} is the maximum allowable duration of one route day.

The length of the daily route segment is restricted as follows:

$$L_d \le L^{max} w_d, \qquad d \in D$$

where L_d is the total length of movement on day dd, and L^{max} is the maximum allowable daily route length.

A separate block of the model is related to overnight accommodation. For each used route day, except the final day, one admissible accommodation location must be selected:

$$\sum_{h \in H} u_{hd} = w_d, \qquad d = 1, \dots, m-1.$$

This condition links the daily route structure directly to the regional accommodation system.

The selected overnight accommodation facility must also be located within an acceptable distance from the final tourist site of the day:

$$\delta_{ih} \le \delta^{max}$$

where δ_{ih} is the distance between the final tourist site ii of the respective day and accommodation facility h, and δ^{max} is the maximum allowable distance to the overnight accommodation facility.

Equation (5) is important from both organizational and service perspectives. Even if a daily programme is feasible in terms of the number and attractiveness of tourist sites, it cannot be considered fully feasible as a tourist service if the group finishes the programme too far from an available accommodation facility.

The model also takes into account the cumulative daily risk load:

$$\boldsymbol{R_d = \sum_{i \in I} r_i z_{id}}$$

where r_i is the risk load associated with tourist site i and the corresponding transport section.

The following condition must be satisfied:

$$\boldsymbol{R_d \leq R_d^{max} w_d}$$

where $R_d^{\max}$ is the maximum permissible risk load for one route day.

Thus, accommodation accessibility is not assessed separately from the overall route organization. It is considered jointly with daily time, travel distance, service provision and risk constraints.

The objective function of the second stage of the model is written as:

$$\boldsymbol{max\ Z_2 = \sum_{i \in I} \sum_{d \in D} g_i z_{id} - \alpha \sum_{d \in D} \sigma_d - \beta \sum_{d \in D} \lambda_d - \gamma \sum_{d \in D} \eta_d}$$

where:

g_i– integral utility of including tourist site ii in the multi-day tourist service;

σ_d – time overload of day dd;

λ_d – overload related to the length of the daily segment;

η_d – penalty for remoteness or poor accessibility of an overnight accommodation facility;

α, β, γ – significance coefficients of the corresponding penalties.

The presence of η_d in the objective function shows that accommodation accessibility directly influences the selection of a practically feasible multi-day route configuration. Therefore, the route organization problem involves not only maximizing the thematic content of the programme but also minimizing the negative impact of excessive daily load and insufficient access to accommodation.

The empirical basis of the study includes the coordinates of the Ancient Khorezm tourist sites, calculated distances and travel times, normative site-visit times, service times and information on accommodation facilities in the Amudarya, Ellikkala and Turtkul districts [8, 9].

Results and Discussion

The Ancient Khorezm route was evaluated in two organizational formats: the basic tourist product D_1 and the extended tourist product D_2. The basic format is organized as a four-day tourist service, while the extended format requires six days.

The results of the daily calculations are presented in Table 1.

Table 1. Daily parameters and accommodation assignment for the basic and extended formats of the Ancient Khorezm route

Route format	Day	T_d^{move}, min	T_d^{visit}, min	T_d^{serv}, min	T_d^{risk}, min	T_d, min	L_d, km	Overnight accommodation / end
Basic D_1	1	141	240	140	0	521	121.8	XON
Basic D_1	2	201	225	140	40	606	113.7	XUMO
Basic D_1	3	231	90	140	20	481	152.42	BUSTON CITY
Basic D_1	4	213	30	140	0	383	181.0	End of route
Extended D_2	1	141	240	170	0	551	121.8	XON
Extended D_2	2	182	255	170	0	607	99.3	XUMO
Extended D_2	3	46	180	170	40	436	28.69	XUMO

Route format	Day	T_d^{move}, min	T_d^{visit}, min	T_d^{serv}, min	T_d^{risk}, min	T_d, min	L_d, km	Overnight accommodation / end
Extended D_2	4	111	160	170	0	441	75.1	BUSTON CITY
Extended D_2	5	73	230	170	0	473	44.03	BUSTON CITY
Extended D_2	6	233	90	170	20	513	231.0	End of route

Source: compiled by the author based on tourist-site coordinates, the calculated distance and travel-time matrix, normative site-visit times, service times and accommodation data [8, 9].

As can be seen from Table 1, the basic format requires three overnight accommodation assignments: XON after the first day, XUMO after the second day and BUSTON CITY after the third day. The fourth day completes the tourist programme and therefore does not require another overnight accommodation assignment.

The extended format creates a higher dependence on the accommodation system. It requires five overnight stays: XON after day 1, XUMO after days 2 and 3, and BUSTON CITY after days 4 and 5. This means that the extended tourist product not only increases the number of days but also increases the importance of stable accommodation availability along the route.

At the same time, the accommodation nodes perform an organizational function. They divide the long route axis into practically feasible daily segments and prevent the tourist group from completing the daily programme in an area without an appropriate service base.

The results also demonstrate that the selected accommodation structure is compatible with the daily time constraints. The maximum daily time load in the basic format is 606 minutes, while in the extended format it is 607 minutes. Both values remain below the established limit of:

$$T_d \leq 630$$

The basic format has an average daily time load of 497.75 minutes, whereas the extended format has an average daily load of 503.50 minutes. Despite the considerable increase in the number of tourist sites in the extended format, the difference in average daily load remains relatively small due to redistribution of tourist sites between additional route days.

For a clearer interpretation of the role of accommodation infrastructure, the principal characteristics of the two formats are summarized in Table 2.

Table 2. Accommodation-related characteristics of the basic and extended tourist-service formats

Indicator	**Basic format D_1**	**Extended format D_2**
Number of route days	4	6
Number of overnight accommodation assignments	3	5
Accommodation nodes used	XON, XUMO, BUSTON CITY	XON, XUMO, BUSTON CITY
Average daily time load, min	497.75	503.50
Maximum daily time load, min	606	607
Dependence on accommodation system	Moderate	High
Organizational and logistical sustainability	High	Medium / conditionally high
Service potential	Moderate but sustainable	High under favourable conditions

The comparison shows that accommodation accessibility has a different significance for the two route formats. The basic tourist product has a simpler organizational structure and lower dependence on accommodation facilities.

Therefore, it can be considered more sustainable under limited service or transport conditions.

The extended product creates greater opportunities for involving additional heritage sites in tourism circulation and for increasing the duration of tourists' stay in the region. At the same time, this format requires a more stable service environment because disruption in the availability of XUMO or BUSTON CITY would affect several consecutive days of the programme.

This finding is particularly important for regional tourism planning. Accommodation facilities should not be assessed only according to their total capacity. Their **location in relation to the daily route structure** is equally important. An accommodation facility becomes a functional service node when it enables the tourist programme of one day to be completed and provides a feasible starting point for the following day.

From an economic-service perspective, this linkage also affects the possibility of commercializing the route. A multi-day tourist product with an unstable accommodation structure increases organizational uncertainty and may require additional transfers, unplanned travel time or changes to the tourist programme. In contrast, coordination of tourist sites with accommodation nodes contributes to the predictability of the service and creates conditions for the inclusion of the route in standard tour-operator packages.

The results therefore indicate that accommodation accessibility should be treated as an integral element of logistical connectivity rather than as a secondary tourism-infrastructure characteristic. This corresponds to the concept of a thematic route as a complex tourist service in which transport, accommodation, catering, excursion services and other components operate as a single system [1, 2].

Conclusion

The study has shown that the organizational and logistical feasibility of a multi-day thematic tourist route depends significantly on the accessibility and spatial coordination of overnight accommodation facilities.

The proposed approach incorporates accommodation directly into the mathematical structure of multi-day route organization through the variables u_{hd}, the distance parameter δ_{ih}, the maximum admissible distance δ^{max}, and the accommodation-accessibility penalty η_d. Therefore, accommodation is considered not as an auxiliary element of the route but as one of the mandatory conditions for sustainable tourist-service provision.

The empirical assessment of the Ancient Khorezm route demonstrates that the basic four-day format can be organized using three overnight accommodation assignments at XON, XUMO and BUSTON CITY. The extended six-day format requires five overnight assignments and therefore has a higher dependence on the stability and accessibility of the accommodation system.

The calculated daily time loads do not exceed the established limit of 630 minutes. The maximum value is 606 minutes for the basic format and 607 minutes for the extended format. This confirms that the selected accommodation nodes make it possible to divide the Ancient Khorezm route into organizationally feasible daily segments.

The results also show that the extended tourist product has greater economic-service potential because it increases the duration of tourists' stay and, consequently, creates additional demand for accommodation, catering, local transport, excursion services and related services. However, this potential can be realized only when the accommodation infrastructure is sufficiently accessible and stable.

Thus, when developing multi-day thematic routes in regions with spatially dispersed tourist attractions, it is advisable to assess not only the total availability of accommodation facilities but also their position within the daily route

structure. The proposed approach can be applied by tourism authorities, tour operators and regional service providers when developing and evaluating multi-day cultural and thematic tourist products in Karakalpakstan and other regions with similar infrastructure conditions.

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