

# DESTINATION MANAGEMENT SUPPORT SYSTEM AND INTELLIGENT DESTINATION GUIDE FOR NATURAL DESTINATIONS

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## Abstract

As a meaningful contribution to digital transformation in the tourism industry aiming to harmonize the needs and preferences of visitors with nature protection, a comprehensive and scalable destination management support system has been designed and developed. It is based on principles of carrying capacity and applies a systemic approach to tourism and destination. In close cooperation with area experts from Broumovsko, Bohemian Paradise, Iron Mountains, and Bohemian Switzerland, multifaceted models of the territories have been constructed, including visitation monitoring time series, paths and routes, and other geographical data. It also includes an extensive interpretative dataset containing geolocalized semantically tagged photos and short texts in several languages, which has been created according to a developed methodology. The system aid participative destination management via readily available visualization of data coming from a variety of sources, including calculated predictions. Using the same models and data, flows of visitors can be influenced via a gamified mobile tour guide application. The main steps involved in implementing the system as well as its main characteristics are briefly described in the paper.

**Key words:** visitor management; carrying capacity; protected areas; software tour guide

## Introduction

Information and communication technologies (ICT) play a growing role in the tourism industry, accelerated in addition to the development of ICT technologies (Buhalis 2019) by social and economic changes, emphasis on the sustainability of tourism, personal development (Marx, Flynn, Kylänen 2021) and also by the impact of the SARS-COV pandemic. The current process is referred to as digital transformation in the tourism industry (Konstantinova 2019, Loureiro, Nascimento 2021). For the sustainability of tourism in natural (and often at the same time protected) areas, it is important to influence the flows, preferences, and behavior of visitors to the area in addition to the regulation and appropriate spatial structure of the tourism infrastructure. This influencing is based on dynamic knowledge of visitor flows and concentration, based on their monitoring (e.g. Shoval, Isaacson 2007; Shoval, Ahas 2016) and modeling of their flows in connection with external factors. In connection with the dynamic concept of carrying capacity (Zelenka, Kacetl 2014; Wang et al. 2020), the creation of a destination management support system (DMSS; not to be confused with destination management system) connected with an intelligent tour guide for mobile devices is a beneficial method. DMSS is a practical implementation of the systemic concept of the destination, based on a dynamic concept of carrying capacity (Pásková et al. 2021) and a systematic description of the natural and cultural resources of the destination, is described in Zejda, Zelenka (2019). This concept was further developed on the basis of research with key actors, verification of suitable methods of simulating the current state of the territory, and experience with its implementation. The intention of the submitted contribution is to briefly describe implementing a destination management support system n intelligent guide for natural areas, including the importance of the involvement of experts for selected areas and to characterize the main outcomes.

## Materials and methods

The creation of DMSS follows the previous research on carrying capacity in tourism (Zelenka, Kacetl 2014; Pásková et al. 2021), analysis of the use of ICT in tourism sustainability (Zelenka, Pásková, Husáková 2015), and analysis of the implementation of participatory management in protected areas (Zelenka, Těšitel, Pásková 2013). Based on the theoretical foundation, the technical concept of DMSS (including the intelligent tour guide) has been conceived. For the experimental implementation of DMSS, territories of Broumovsko, Bohemian Paradise, Iron Mountains, and Bohemian Switzerland have been selected based on their physical characteristics, varied intensity and nature of tourism, their proximity and accessibility from Hradec Králové, and their readiness of their management for cooperation. The actual process of creating DMSS based on the underlying theoretical concepts was subsequently based involved:

\*0 Research in the heritage interpretation methods and approaches;

- \*1 Cooperation with individual geoparks, Nature Conservation Agency of the Czech Republic (AOPK), and destination management agencies, whose experts determined areas suitable for photo documentation (while respecting the interests of nature and landscape protection), created or checked interpretation texts and coordinated the activities of documentation teams;
- \*2 Analysis of territories characteristics including zoning, trails used and usable for tourism, points of interest (top attractivities, often suffering from over-visitation, and actual or potential alternative goals both natural and cultural), visitor monitoring time series, and other characteristics of tourism, conceptual and strategic documents related to the management of visitors in the selected territories;
- \*3 Selection of algorithms, data structures, architectural principles, communication connections, and application of agile software development approaches to implement a comprehensive and scalable DMSS for selected territories;
- \*4 Creation of multifaceted territory models involving known territory characteristics and interpretative data within the developed DMSS followed by user testing and usability testing of both the web administrative interface and the tour guide.

## Results

Research and development involving territory experts, photographers, documentarians, interpreters, translators, statisticians and data scientists, software architects, and developers concluded in the following practical results:

1. An interpretative data set consisting of almost 3000 mostly original photographs has been created, each photography geolocated, semantically tagged, and described, interpretative texts translated into five languages (English, German, Polish, Ukrainian, Russian);
2. Initial multifaceted models of territories have been constructed consisting of trails usable for tourism, visitation time series, interpretative content;
3. A Set of methodological guides covering the whole process of a photo-documentation and interpretation (organizing documentation activities, planning a documentation trip, taking photos and notes in-situ, authoring short interpretative texts, assigning GPS coordinates, semantic tagging, validating, importing, translating) have been created and evaluated;

Namely, comprehensive and scalable DMSS has been developed in the architecture of containerized microservices (Fig. 3) which can run either centrally or in distributed deployments. It has a comprehensive web-based management interface and involves modules for:

- importing and management of photos and textual interpretation and for systematic translation (integrates machine translation, filtering, and full-text search) with status tracking, edit history, role-based approval workflow, and visualizing the coverage of the territory with photographs,
- defining a network of paths that can be used by visitors, namely the mobile guide users (the system calculates the suitable paths between selected points), creating recommended tours over the defined paths that can be actively offered to visitors, temporarily closing a path segment to exclude it from navigation,
- management of visitation time series, including advanced interpolation and predictive algorithms.
- visualization of tracking records received from registered visitors.

On the side of DMSS, a communication API is available to connect a mobile guide application that supports new user registration, provides the app with interpretation data, and receives tracking and telemetry data for analysis. A sample (referential) mobile application of the tourist guide has been developed, tested, and released (Fig. 4). The main function of the application is gamified, geofencing is used to unlock the interpretive details of the places the user has passed by. It allows trail tracking and visualization of recorded trips. The application responds to status changes (foreground, background, off display, offline, online, low battery, etc.) and supports all commonly used Android versions. It adapts its behavior (e.g. frequency of communication with the server) according to the current state to optimize system resources.

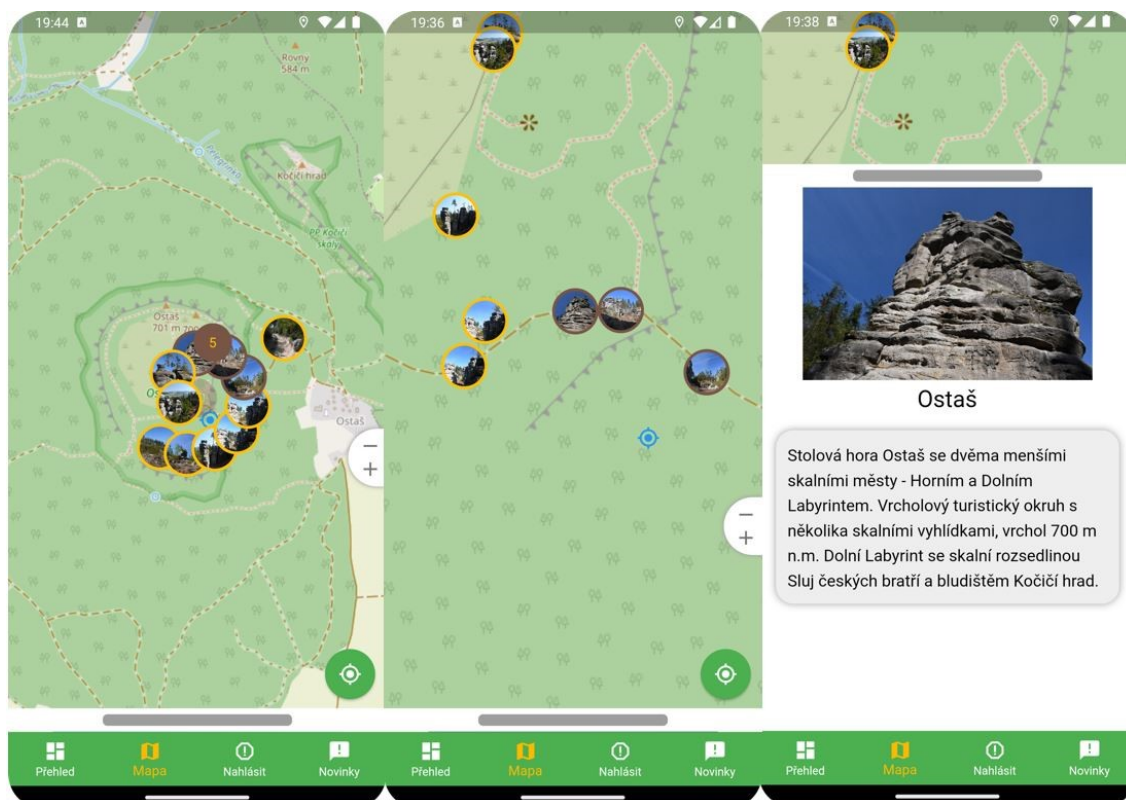


Fig. 3: Interpretation coverage visualization for Broumovsko; sample interpretative description of Ostaš consisting of geolocalized photography, semantic tags, timestamp and connected textual objects; sample of a proposed route with two partial circuits; aided online translation of texts; prediction of visitation in two sample profiles in the Iron Mountains.

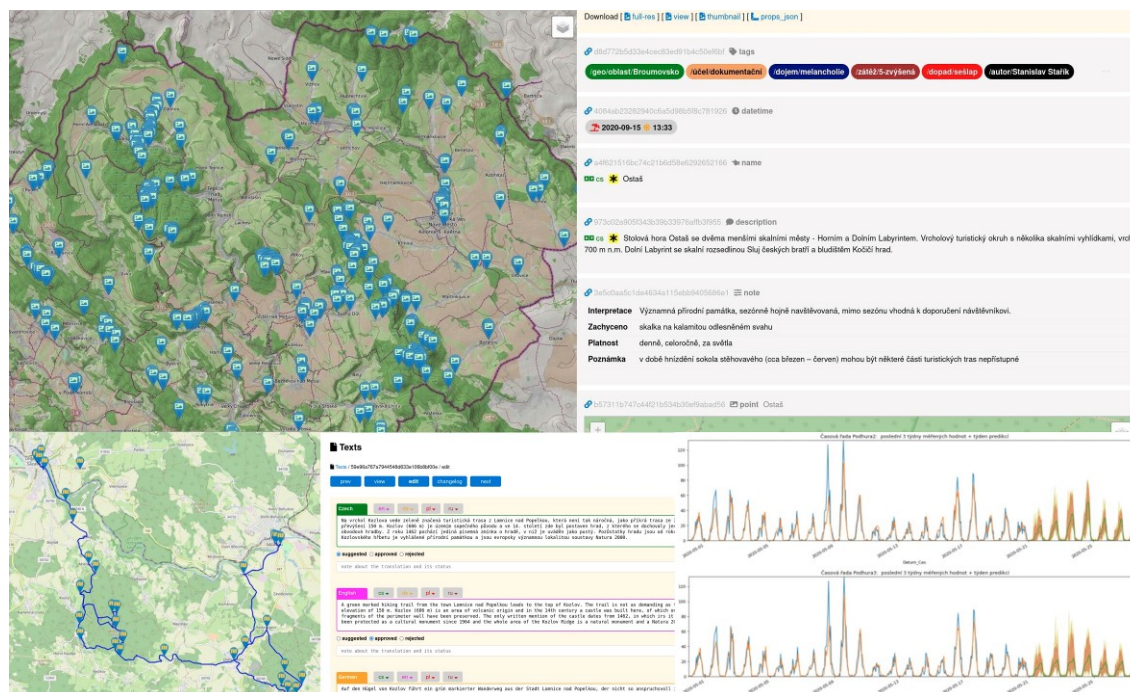


Fig. 4: Surroundings of Ostaš with examples of points of interest covered with photographs and interpretive text displayed in the mobile tour guide application.

## Conclusion

As a practical application of the results of research concerning carrying capacity and systemic approaches to tourism and destination (Zelenka, Těšitel, Pásková 2013; Zelenka, Kacetyl 2014; Zelenka, Pásková, Husáková 2015; Zejda, Zelenka 2019; Pásková et al. 2021), comprehensive, scalable DMSS has been designed and developed. In close cooperation with area experts from Broumovsko, Bohemian Paradise, Iron Mountains, and Bohemian Switzerland, characteristics of tourism including tourism-nature interactions in these territories have been thoroughly analyzed. Informed by the analysis, multifaceted models of involved territories have been constructed. They include visitation monitoring time series, paths and routes, and other geographical data and an extensive interpretative dataset containing geolocalized semantically tagged photos and short texts in several languages. The DMSS aids participative destination management via readily available visualization of available data from a variety of sources, including calculated predictions. Using the same models and data, flows of visitors can be influenced via a gamified mobile tour guide application.

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## Souhrn

Jako praktická aplikace výsledků výzkumu únosné kapacity a systémových přístupů k cestovnímu ruchu a destinaci byl navržen a vyvinut komplexní, škálovatelný systém pro podporu destinačního managementu (DMSS). V úzké spolupráci s odborníky na danou oblast z Broumovska, Českého ráje, Železných hor a Českého Švýcarska byly důkladně analyzovány charakteristiky cestovního ruchu včetně interakcí cestovní ruch-příroda v těchto územích. Na základě této analýzy byly zkonstruovány modely zapojených území. Jejich součástí jsou časové řady z monitoringu návštěvnosti, struktura cest a tras a dalších geografických údajů a rozsáhlý interpretační datový soubor obsahující

geolokalizované sémanticky označené fotografie a krátké texty v několika jazycích. DMSS usnadňuje participativní destinační management prostřednictvím vizualizace dostupných dat z různých zdrojů vč. spočítaných predikcí. Pomocí stejných modelů a dat lze ovlivňovat toky návštěvníků prostřednictvím gamifikované mobilní průvodcovské aplikace.

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