

“Accessibility Passports” Service in Information Environment for Persons with Disabilities

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Abstract – The paper describes development process of information environment for persons with disabilities. Introduction gives a base understanding of the project idea. The first section of the main part describes common infrastructure architecture. Services are divided on government and public. The public part is presented by various services, based on the information collected by government service. Government service is presented by information system “Accessibility passports”, which in details is described in second section of main part. The “Accessibility passports” is a service for initial collection of data about accessibility of the social infrastructure facilities for people with disabilities. In the last section of the main part presented a mathematical method for measuring level of accessibility of the social infrastructure facilities for people with disabilities. Method is based on probability theory and provide possibility for formal ranging of the social infrastructure facilities according to the level of accessibility for persons with limited mobility.

Keywords – *Social Services, Location Based Services, Theory of Probability.*

I. INTRODUCTION

The United Nations Convention on the Rights of Persons with Disabilities reaffirms that all persons with all types of disabilities must enjoy all human rights and fundamental freedoms. In particular it states that “... community services and facilities for the general population are available on an equal basis to persons with disabilities and are responsive to their needs...” [1].

Presently the infrastructure of even some main cities in Russia is not friendly for persons with disabilities. Selection of a route to socially significant facilities is challenging for a disabled person, and information on using services of this facility is inaccessible. Consequently a person with some restrictions sooner decides against visiting the social infrastructure facilities, and it means that he can’t fully participate in the life of the community.

In order to increase the accessibility of facilities for the general population for persons with disabilities, a multiple stage development of social infrastructure is proposed, presented as a set of interrelated services of social orientation. The eventual result for the society will be such services as:

- “Accessibility Map”: a geographical map of the Region with its socially significant facilities, containing information on the accessibility of the services offered by a facility for people with various disabilities.
- “Social Navigator”: a route planning service adapted for abilities of persons with various restrictions.
- “Social Network”: a network aimed to begin a dialogue between persons with disabilities, social institutions, and government institutions responsible for inclusion of persons with disabilities into the life of the society.
- ...and other.

But the further development of the public services is impossible without a preliminary stage: collecting data on socially significant facilities. In order to manage this task an information system “Accessibility passports” has been developed. It allows the monitoring of the accessibility of the social facilities under the unified criteria. When creating so called “accessibility passport” the facility is bound to the geographical coordinates, is described on the given form, and the accessibility of the facility is estimated according to a specified set of criteria, with automated output of the general evaluation of its accessibility for persons with various mobility restrictions.

The system “Accessibility passports” is meant to be used by government institutions, and the data in the system is not directly available for use in functioning of public services. In relation to that a program agent is used, which transfers the summary of the required data on the facilities in the form of geo-tags to the system Geo2Tag. Geo2Tag permits data access to the social facilities in the

given coordinate areas for using this information in route planning, forming search query answers, displaying the data with the use of exterior cartographic services.

The initiative of the proposed development mainly belongs to the Ministry of Healthcare and Social Development of the Republic of Karelia, which emphasizes its relevance and social significance.

II. COMMON PROGRAM ARCHITECTURE

The described project is multistage and includes development of a set of applied services with various target audience. The specific nature of the subject field implies that the development of the final public services is impossible without a preliminary stage, at which data on the current situation in the sphere of the accessibility of the social infrastructure for persons with disabilities is collected. For this purpose the information system “Accessibility passports” is developed for the local government authorities to fulfill the specified task. The data collected in this system will serve as an information basis for creating various public services: the accessibility maps of socially significant facilities, the social navigator etc. The basic principle of the information interaction of the developed services is presented in the Fig. 1.

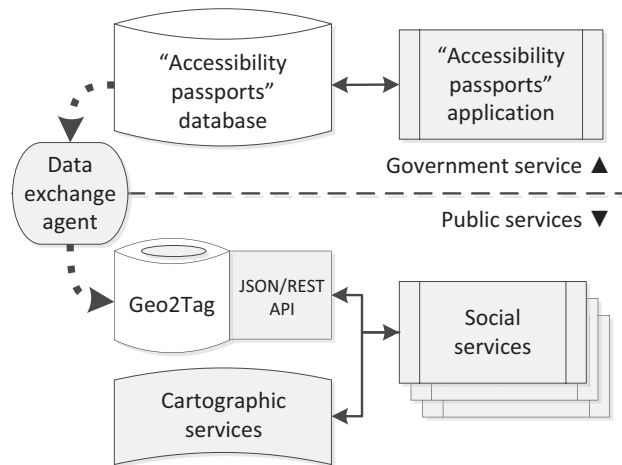


Fig. 1. Common program architecture

The information system “Accessibility passports” is independently separated in the common architecture and is presented by a service for the local government authorities. Two main modules can be distinguished in the system: a data bank, presented by a relational database and a web-application. The application has a wide arrange of functions, required for monitoring the degree of accessibility of the social infrastructure facilities. Besides that, the “Accessibility passports” allows drawing up report documentation, analyzing collected data, thereby covering a number of the functions fulfilled by the respective government branches. The full description of

the information system “Accessibility passports” is given further in this article.

The database contains a significant set of data on every inspected social infrastructure facility. Only part of this information is required for functioning of the public services. These data are uploaded by specifically developed program agent to the system Geo2Tag. Geo2Tag platform was described in detail at works [2, 3]. This particular data sample from the initial set of data forms the basis for the public services.

Social applications are developed with the use of the data on the social infrastructure facilities stored in the system Geo2Tag in the form of geo-tags and the software of the public cartographic services. These applications will allow persons with disabilities to browse information on the accessibility of the social infrastructure facilities, search for more convenient facilities, plan optimal routes etc. Samples of social medical services are described in [4, 5, 6].

Therefore the general dataflow may be presented in the form of the following scheme (see Fig. 2): the workers of the Ministry monitor the accessibility of the social infrastructure facilities via the system “Accessibility passports”; the program agent transfers the critical data to the Geo2Tag server; the geotagged data are used for delivery of the information services to people.

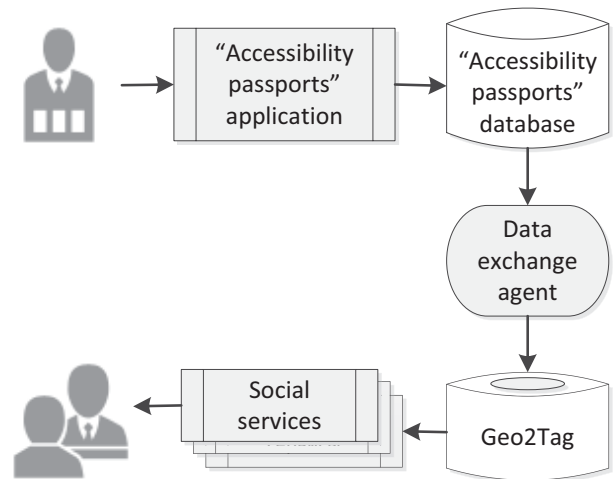


Fig. 2. General dataflow

III. INFORMATION SYSTEM “ACCESSIBILITY PASSPORTS”

A. “Accessibility passports” architecture

The program architecture of “Accessibility passports” service is divided into three parts: application part, framework part and data storage (see Fig. 3). Relational database or multiplicity of Geo2Tag geo-tags can be used as data storage in different situations. Framework part contains reusable program modules that can be used in future in development of application services for

information environment for persons with disabilities. Application part contains program code of specific information service, in particular, “Accessibility passports” service.

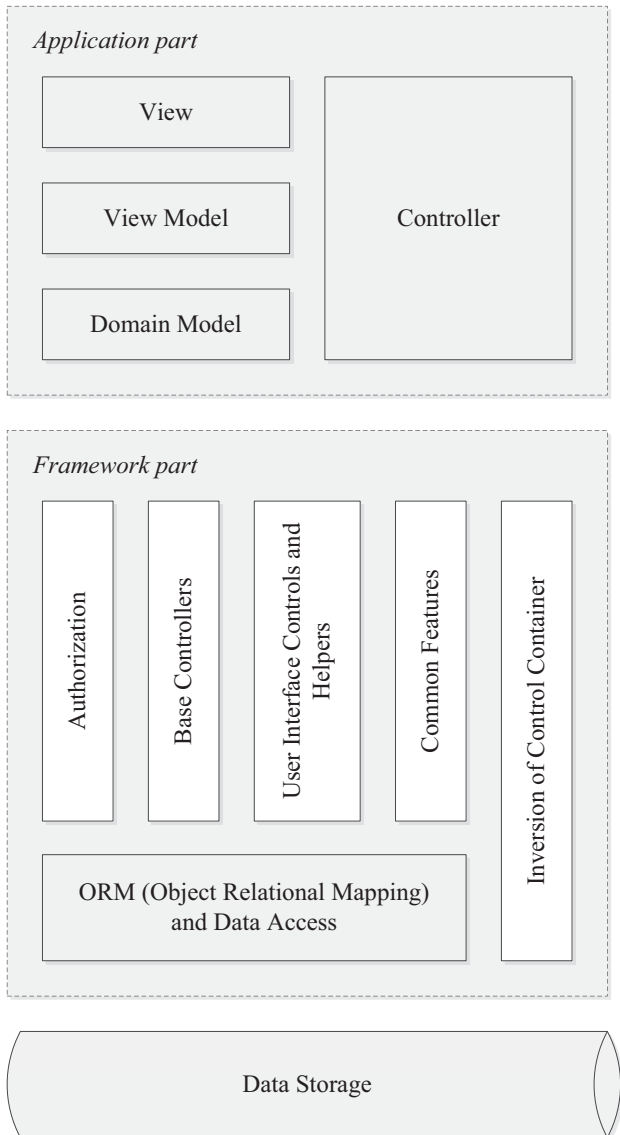


Fig. 3. “Accessibility passports” architecture

In the structure of framework part we can name following major program modules:

- *Object Relational Mapping (ORM) and Data Access.* ORM allows to separate program logic from specific implementation of data storage, and to make it easier to change data storing technology if it is necessary. The NHibernate open source ORM library was used in our development. NHibernate automatically bind business logic classes with their representation in data storage. Data access is realized through

repository objects, with no possibility for direct connection. Using of repository pattern makes unit testing easier and allows develop applications without binding to specific technology of data storing.

- *Authorization.* In authorization module common methods of user authentication are realized. Two ways of authentication are available: first, with registration of account in unified user register for all services in information environment for persons with disabilities and, second, authentication via OAuth protocol with account credentials from most popular social networks. Second way makes it easier to get access to social services, because most of Internet users have an account in some social network.
- *Base Controllers.* Framework part contains base class of controllers, which specific implementation is realized in application part. Base controllers provides helper reusable methods and allows to organize application services program code in a same style.
- *User Interface Controls and Helpers.* For developing user interface in framework part set of user input controls is realized. For example: ComboBox, AutoComplete, StringInput, NumericInput, DialogWindow, etc. User controls are realized in a same style and provide several visual themes. This allows design information services in a same style, but at the same time to maintain their individuality.
- *Common Features.* Framework part contains classes and methods, that extends existing classes of Microsoft .NET Framework and simplify services design. For example, methods of extended string formatting, getter- methods for business objects descriptions, data verification methods, etc.
- *Inversion of Control Container.* Framework part include module, that implement extended version of Castle Windsor – inversion of control (IoC) open source library. Inversion of control is a software design pattern that provides minimal connectivity of program components via using a dependency injection. Framework part provides infrastructure for using IoC in application services design.

Application part architecture combine such software design patterns as MVC (Model-View-Controller) and MVVM (Model-View-ViewModel) [7, 8]. Following modules compose the structure of application part:

- *Controller*. The logic part of application is implemented in controllers. Controllers has access to all other structure elements: Model, ViewModel and View. Controllers modifies Model, control mapping process from Model to ViewModel, initialize View building, process user input, etc.
- *Model*. Model represents a description of object from subject area as classes. Class model developed in most simple way in accordance with POCO (Plain Old CLR Object) principle and doesn't include any metadata. Model hasn't any logic, model doesn't bind to any other structure element of application part architecture.
- *ViewModel*. ViewModel represents modified Model for transmission to View. ViewModel includes restricted or, on the contrary, extended set of Model properties, includes metadata for View generation. In some cases ViewModel can combine data from different Model at the same time.
- *View*. View includes program methods of generation graphic user interface (GUI) using ViewModel data. View methods must be able to generate GUI, provide interactive features using JavaScript, and transmit user input and requests into controllers.

“Accessibility passports” service is developed in strict accordance with given architecture. In the design of application part for “Accessibility passports” Microsoft ASP.NET MVC 4 framework was used.

B. “Accessibility passports” description

The information system “Accessibility passports” is a service of initial collection of data on the current level of the social infrastructure facilities convenience in terms of accessibility for people with disabilities. Some views of interface design are presented on Fig. 4. The system is developed in cooperation with and specifically for the Ministry of Healthcare and Social Development of the Republic of Karelia. The system is targeted to automate the process of survey of the social infrastructure facilities, initiated by the federal government in the framework of the government program “Living Together”.

The central element of the system is the document “Accessibility Passport”. Apart from the functions of working with the document, the system has the following functions:

- maintenance of additional reference books;
- generation of printed forms of the documents;
- producing registry and report documentation.

The accessibility passport is a multiblock document, depicting the data on accessibility of the inspected facility for various groups of persons with disabilities, general information on the facility, description of the routes to the facility, description of the ways of modification of the facility and the ways of increasing the level of the accessibility of offered services. An important function for consequent implementation of the social services is the function of geolocation of the facility using the functionality of public cartographic services.

The accessibility passport has three-stage life cycle, which is matched in the system with so called stages of the document. Initially the document is at the stage “New”. At this stage the facility is inspected and the document is filled in, introducing modifications to the document at other stages is impossible. Upon completion of filling in the data, the document is transferred to the stage “Approved”. Usually the transfer to the stage “Approved” is accompanied with signing the paper copy of the document “Accessibility passport” and sending it to the relevant ministry. The approved document is examined by a worker of the relevant ministry for correctness, after that it is either returned for rework (stage “New”), or is transferred to the stage “Agreed”. The “Agreed” stage is the final stage in the life cycle of the accessibility passport, and only these documents are used for making registry of the accessibility passports and other reports.

In order to provide the described scheme of working with the document, a three-stage access differentiation system is implemented in the system. The following groups of access are specified:

- 1) The organization level. The users of this group can input the facilities which belong to their organization to the system, fill in their accessibility passports, as well as transfer created passports to the stage “Approved”.
- 2) The ministry level. The users of this group have all the rights of the users of the organization level in relation to the organizations subordinate to their ministry. Besides that the users of this group can create new organizations subordinate to their ministry and transfer the accessibility passports of the facilities of the relevant organizations to the stage “Agreed”.
- 3) The administrator level. The users of this group use all the functions of the system without restrictions.

IV. METHOD OF EVALUATION OF ACCESSIBILITY

The main feature of the information system “Accessibility passports” is the ability to automatically output the evaluation of the level of accessibility of the social infrastructure facility on the basis of the evaluation



Fig. 4. Interface design of the information system “Accessibility passports”

data of a limited set of indirect criteria. This task aroused in relation to the necessity of formal ranging of the social infrastructure facilities according to the level of accessibility for persons with limited mobility. It is obvious that the evaluation of the level of the accessibility can't be done subjectively, but should be done on the

basis of unified formal rules. These rules were extended to a mathematical model making it possible to do an evaluation of accessibility of a facility in general for each of the category of persons with disabilities on the basis of evaluating simple accessibility criteria.

Let us denote M – a set of all the criteria collectively stipulating the accessibility of the facility of the social infrastructure for disabled persons. Such criteria are notably “the width of the doorway”, “availability of a lift” etc. Let us denote K – a set of categories of disabled persons: “moving on a wheelchair”, “hearing-impaired” etc.

Let Ω_{ij} be an accidental event consisting in the fact that for the category of disabled persons j the significant accessibility criterion is i ($i \in M, j \in K$). Let us assume that this event can be either certain or impossible [9]:

$$\mathbb{P}(\Omega_{ij}) = \begin{cases} 1, & \text{if criterion } j \text{ is significant} \\ & \text{for category } i; \\ 0, & \text{otherwise.} \end{cases} \quad (1)$$

It means that the criterion either determines accessibility of the facility for disabled persons, or it does not. For example, the criterion “availability of a ramp” determines accessibility of the facility for the disabled persons on wheelchairs, and is not significant for hearing-impaired. The decisions of the significance of various criteria, as well as the list of the criteria, are accepted by the specialists of the Ministry of Healthcare and Social Development of the Republic of Karelia in dialogue with the social organizations of disabled persons.

Let us denote X_{ij} as an accidental event that determines the possibility of a disabled person of the category j gaining access to the facility in accordance with the accessibility criterion i ($i \in M, j \in K$). The probability of this event $x_{ij} = \mathbb{P}(X_{ij})$ corresponds to the accessibility evaluation of the social infrastructure facility for disabled persons of the category i given the accessibility criterion j ($i \in M, j \in K$). These evaluations are done by the designated person, inspecting the facility by strictly specified regulations, developed by the specialists of the Ministry of Healthcare and Social Development of the Republic of Karelia.

Let us introduce to consideration conditional probability $\mathbb{P}(X_{ij}|\Omega_{ij})$ of a disabled person of category j gaining access to the facility given the criterion i under the condition that the given significance of criterion i for the category of disabled persons j ($i \in M, j \in K$).

$$\mathbb{P}(X_{ij}|\Omega_{ij}) = \begin{cases} 1, & \text{if } \Omega_{ij} \text{ impossible event} \\ x_{ij}, & \text{otherwise} \end{cases} \quad (2)$$

Using the introduced notations, accessibility of the social infrastructure facility F_j for the category of disabled persons j can be calculated by the following formula:

$$F_j = \prod_{i \in M} \mathbb{P}(X_{ij} | \Omega_{ij}) \quad (3)$$

The coefficient of accessibility of the social infrastructure facility F_j takes the value in the interval [0; 1] and is a production of conditional probabilities of a disabled person of the category j getting to the facility with the given values of the significance of the accessibility criteria.

Let us note that the set of criteria can be also divided into subsets in accordance with structural-functional zones of the facility: “entrance to the building”, “surrounding area” etc. The evaluation of accessibility can be done by the selected subsets, by the same algorithm is used for the whole set of criteria. Thus the offered model allows evaluating the facility not only as a whole, but by their structural-functional components as well.

V. CONCLUSION

At the present time the information system “Accessibility passports” is developed and put into operation under the auspices of the Ministry of Healthcare and Social Development. As it was said before, this system is the key instrument for collecting data and consequent development of the whole information environment for persons with disabilities on its basis. At this stage of development, the main difficulty is making strategically correct decisions regarding the program architecture of information environment and the technologies applied. In particular, from the standpoint of program architecture the following decisions have been made:

- Logical division of the social services and the system “Accessibility passports” on the program level and the data level. It allows if necessary manually divide spheres of functioning of the public services and the government service.
- Using object-relational mapping (ORM) in the development of all the applications of the system in order to abstract business logic of the applications from the specific implementation of the database.
- Loosening of the coupling of the program components of all the applications at the expense of applying inversion of control template and using the relevant frameworks. This architectural feature assists in maintenance of the information environment and development of additional services [10].

Among the exterior program systems engaged in the development it is important to distinguish the Geo2tag platform. The software features of the Geo2Tag platform are planned to be used for storing and manipulating the data of the social infrastructure facilities. “Geo-tag” Ceo2Tag allows extracting up to 1 Kb of associated data on the facility which is enough for data storing required for creation of the social services.

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