Information support of stakeholder cooperation: technology for formation of a digital footprint of companies

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Abstract. The paper presents a tool for the formation of a digital footprint of companies focused on supporting the processes of strategy with the further search for potential stakeholders, the formation of proposals for cooperation and establishing contacts with them. The world-class head Hunter recruiting company was chosen as the object of the study, its REST API was considered as a data source. The architecture of the system, which provides the ability to collect and store relevant information. It secures the monitoring the digital footprint of personnel needs (vacancies) of companies. Implementation of the proposed tool for the formation of a digital footprint is carried out within the framework of interaction between universities and the business community in the process of formation of professional competencies of students. An interactive map with data on profession vacancies has been developed, which allows supporting the processes of stakeholder interaction.

1. Introduction
Information plays a fundamental role in the future economy of the country. Taking into account the growth of traffic volume by 27.87% (from 1464 to 1872 exabytes per year) in the period 2017–2018 and its increasing projected values to 4752 exabytes per year [1], the principal component of any business is interaction with stakeholders aiming the goal achievement. Indeed, the published research results show a reduction in the life cycle of companies and the positive dynamics of the tempo metrics of successful companies [2]. It is indicated that their age, size, reputation and current sales do not guarantee survival in the future [3]. The authors [4] discuss the fundamental need for systematic work on business development and the business environment [5,6], modeling scenarios of interaction with stakeholders with tracking changes in dynamics [7], mixed types of interaction based on relations with each group [8], the application of the theory of fuzzy sets [9], the need for proactive management [10] based on the use of end-to-end technologies of the digital economy [11].

Despite the fact that various aspects of the interaction of stakeholders and their groups have been discussed for a long time, one of the decisive phases is the phase of strategy with the further search for potential stakeholders, the formation of a proposal for cooperation and establishing contacts with them, is poorly described. The formation of a digital footprint of companies of interest is one of the solutions of the problem. We define the digital footprint as information intentionally or unintentionally left in the digital space with the further possibility of its source identification. It is proposed to use one of the peculiarities of the digital footprint namely if the information was entered it is almost impossible to remove it and it becomes publicly available.
Thus, it is necessary to develop a tool for the formation of a digital footprint of companies, which will allow to collect and accumulate public data on potential stakeholders. This requires the development of appropriate technology and its software realization.

2. Methodology

Development of technological processes requires specification of the application. Implementation of the proposed tool for the formation of a digital footprint is carried out within the framework of interaction between universities and the business community in the process of formation of professional competencies of students. Training of future specialists should be focused on the needs of companies. Taking into account the need to provide personnel for the digital economy, the development of technology for the formation of a digital footprint of personnel needs of companies and its software implementation will allow to organize the educational process at a higher level. Head Hunter, a world-class recruitment company, has been selected as an object under investigation. Its REST API (Representational State Transfer Application Programming Interface) was considered as a data source.

The architecture of the future system, which provides the ability to collect and store relevant information, is formed to monitor the digital footprint of personnel needs (vacancies) of companies. In this study, the problem of modeling the structure of functional subsystems with the subsequent visualization of the digital footprint is solved, and the technology is developed and implemented in the form of several programs.

The structure of the functional subsystems is determined at the level of task groups for the implementation of the digital footprint of companies including creation of a platform to accommodate your digital footprint (creating a website, placing a site on hosting, creation of domain), the platform for the subsystem of data collection, storage and visualization (Figure 1).

![Figure 1](image)

**Figure 1.** The logical structure of the relationship of functional blocks of the system for formation of the digital footprint of companies.

The structure is divided into six basic blocks:

- site block assuming the style definition of the website, the choice of colors, determining the layout of the pages, the description of the block content, compatibility with various browsers and devices;
• hosting block provides the storage of the site on the server, the rights of the website administration, implementation of backup system, reporting errors in the case of failures of the website, domain name registration, obtaining access to the site by domain name;
• databases (DB) work unit provides a remote connection to DB, creates DB for the site, creates tables in DB, records data on the vacancies in the table, deletes outdated data and records new ones;
• unit work with REST API Head Hunter forms a request to REST API, receives a result on the request, records the result of the request to a variable;
• block getting information for visualization creates an interactive map of Russia regions displaying information on vacancies of a certain profession, creates diagrams with the most popular competencies for vacancies of a certain profession.
• digital footprint information visualization unit to forms a request to the database, retrieving data from the database.

The logical structure of the relationship of the functional blocks of the system of formation of the digital footprint of companies includes the following elements:
• the site block is located on the hosting server (Hosting block);
• database work unit creates a database which is stored on the hosting;
• unit of work with REST API Head Hunter provides the data to write to database work unit;
• block of getting information for visualization requests the data for updates from the database stored on the hosting;
• digital footprint information visualization unit receives the data from a block of getting information for visualization;
• hosting block creates domain name for website access of users.

Thus, the system of formation of the company’s digital footprint is a set of tools aimed at collecting, processing, storing and displaying information. The choice of information which will be further used, depends on the task assigned to the system. Almost any work with a digital trace can be reduced to the presented logical model, making minor changes according to the chosen subject area.

Information flows of the digital footprint formation system can be classified according to the following features:
• by relation to the digital footprint formation system: incoming, outgoing and internal information flows.
• by degree of openness: public and non-public information.
• by subject area: information for interested persons, including graduates, students, and University professors.

In addition, the system includes functions for storing data with a time stamp on which they were relevant, and the ability to change the structure of the data if necessary.

The software implementation of the technology of forming a digital footprint of companies required the use of several programming languages; query and markup languages in table 1.

Thus, the schematic diagram of the software implementation of the digital footprint involves the sequential realization of two stages: the creation and configuration of the system (deployment, filling data), as well as work with data (updating data) and their visualization. The collected, accumulated and stored data in the system are placed in the hosting storage (in the built-in file system), or in the database created on the hosting by the user.

The final result of the system is the data on vacancies clustered and stored in the database. Built-in visualization tools allow the most current data at the current time to be displayed.
| Block name                                           | Language | Functional                                                                 |
|-----------------------------------------------------|----------|-----------------------------------------------------------------------------|
| Site block                                          | HTML     | Description of the logical structure of the site and its blocks             |
|                                                     | CSS      | General description and description of individual block locations          |
|                                                     | JavaScript | Connection of modules and scripts, data conversion to the required form |
| The unit works with the REST API Head Hunter        | Python   | Sending a request to REST API hh.ru and getting data on vacancies           |
| The database work unit                              | Python   | Connecting to the database and running queries                             |
|                                                     | SQL      | Creation of databases and tables, their filling and clearing               |
| The block getting information for visualization     | PHP      | Connecting to the database and getting the latest information on the site  |
| The digital footprint information visualization unit| PHP      | Calling the data acquisition block                                         |
|                                                     | JavaScript | Displaying the map and data on the mp                                    |
|                                                     | HTML     | The logical structure to display on the site                               |
|                                                     | CSS      | Description of of the map and the possibility of increasing or decreasing it|

3. Results and summary

Thus, the website development using HTML, CSS, JS, and software implementation for the visualization of digital trace using JS, HTML, CSS, and PHP allowed us to obtain an interactive map of the Russian Federation with the display of relevant data regarding the number of vacancies of a particular specialty in the regions of the Russian Federation, the level of salaries and the demand of professional competences of potential candidates (Figure 2).

![Figure 2. An interactive map with the data on vacancies of the system analyst.](image-url)
Figure 2 shows the offer for vacancies of the system analyst in Moscow (412 places), the average salary (94023 rubles a month), and also the most demanded competences such as SQL, UML, BPMN, development of specifications.

The presented interactive map is currently created for several professions:
- system analyst;
- business analyst;
- web developer;
- web designer;
- 1C programmer;
- IT project Manager;
- Internet marketer.

These jobs for the software implementation of the digital footprint were chosen according to the following criteria:
- formation of professional competencies for future work should be provided by the current training plan of the program 38.03.05 – Business Informatics faculty of business Novosibirsk state technical University;
- the professional standard for the chosen workplace should be present in the database of the Association of computer and information technology enterprises of Russia.

The proposed version of the interactive map will be beneficial for all stakeholders of the educational process. The state, graduates and their parents (acting as investors in the education of children), as well as junior students have the opportunity of professional orientation and self-determination. Graduates who have already chosen their future profession, as well as senior students can form their own professional educational trajectory through the formation of competencies relevant to the region of the proposed location. The teaching staff of the University will be able to improve the educational process based on requirements for a potential employee, personal characteristics (qualities and abilities), relevant tools, as well as the functional work activities and its context. This will have a positive impact on the reliable provision of the region with really necessary personnel.

Regarding the issues of strategy of universities, the search for potential stakeholders, the formation of proposals for cooperation and subsequent contacts, the proposed interactive map will allow to choose the most promising professions. These professions will allow to purposefully form the required professional competence of teachers (and, consequently, somewhat later, of students) and to carry out technological modernization of the educational process, thereby ensuring the competitiveness of universities in the world market of educational services.

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