INFORMATION FLOWS ENHANCEMENT FOR AIS TOURISM AUTOMATED INFORMATION SYSTEM

Irina Titova, Natalia Frolova

Abstract: *This article put emphasis on the issue of information system efficiency in tourism, as a tool of defining the level of domestic and inbound tourism growth. The necessity of information system development is determined to solve the problem of current tourism functionality; however, the implementation of some automated information system (AIS) cannot be a solution to the obstacle. AIS need to be efficient. Thus, the article provides the way of estimation and enhancement of information flows as an approach to improve information system efficiency.*

Keywords: *automated information systems (AIS), efficiency, information flow, graph modeling, AIS enhancement, information systems in tourism.*

ACM Classification Keywords: *G.2.2 Graph Theory, H.1 Models and Principles, K.4.3 Organizational Impacts*

Introduction

The Russian Federation (RF) has a high tourist and recreational potential There are variety of cultural, historical and entertaining areas here. The immense territory rich in unique natural attractions, but its potential is realized incompletely.

In order to change this situation, a Federal target program for domestic and inbound tourism to 2020 was developed (FTP) [Collection of Legislation, 2011]. This program aims to increase the competitiveness of the tourism market of the Russian Federation, by providing high-quality tourism services. The goal is going to be achieved through the creation of conditions for tourism activities by:

- development of tourist and recreational complex of the Russian Federation;
- improvement the quality of tourism services;
- advancement of national tourism product for domestic and international public.

Specification of the tourism industry realization ways improvement is made by extracting the key areas of support and development of the industry, by determining the methods of tourism enhancement in the country, and also by defining target indicators of FTP efficiency assessment. Tourist conferences, forums and exhibitions have become global events, with the honored participates, including government

officials. The main problems noted during the meetings are the adaptation of domestic tourism to the new realities and prospects of development in new conditions.

International events organized in Russia such as the Winter Olympics in Sochi, the World Championships in Aquatics in Kazan, the World Cup, Summits SCO and BRICS in Ufa, East Economic Forum in Vladivostok, stimulate facilities creation, which has a beneficial effect on the development of domestic and inbound tourism. The current socio-economical and political situation even in greater extent demonstrates the necessity of tourism development in Russia.

development of the industry is becoming based on the FTP. It includes the establishment of information exchange between Federal Agency for Tourism and regional departments. Automated information system (AIS) is one of the most progressive areas and a tool of information support for FTP tasks. AIS takes a role of means of storing, processing data, its visualization and dissemination.

The development of the information system aimed to provide information accessibility for different user groups, including executive personnel, involves the electronic format of the interaction between employees of federal and regional levels. Implementation of the information system is a decision of problems of information availability, reliability and timeliness. Thus, information is essential organization resource.

Information acts as a source for decision-making, because it integrates experience of routine activities.

Providing organization with urgent information is important to decision making quality, in order to make this process and the quality of the decisions worthy and to meet the requirements of current conditions [Shilyaev, 2005]. In other words, information quality should not prevent normal organization work, and, if possible, it should stimulate further development.

Special attention should be given to the question of the information quality estimation especially in the context of the existing information problems of public tourism organizations such as the lack of information unification, its fragmentation and territorial remoteness of interacting organizations. Information - data organized in a manner that it makes sense for a person. In this system, information - some of the key data which is used in reports.

The transformation process from the original row data to the end report through intermediate indicators is determined by information flows. Information flows - are an organized set of interrelated information blocks, which together provide a valuable result for customers. In this subject area information flows take into account the movement of raw data rather than the change of final documents. A valuable result for customers are based on a set of input data, such as agreements, contracts, acts or bank orders.

Z.V. Alferova and V.P. Ezzhaeva note the need for a long and careful analysis of the automation object as the part of information flows structure and information processing. The authors suggest as a research

approach methods based on graph theory because graphs allow to determine correlation between initial and final data [Alferova, 1971].

Implementation of specialized information systems is not a solution to the problem of information support, it is just a tool and technology for management personnel [Belyaev, 2010]. Information system has become a fundamental factor in the development in the case when it is effective.

There are many approaches to determine efficiency. Classical approach to the assessment considers the overall efficiency from the standpoint of three components: institutional, social and economic efficiency [Belyaev, 2010]. Each component is characterized by its objectives: the solution of problems, meet the expectations of employees and the achievement of financial results.

Other researchers consider methods for estimating benefits from the information systems implementation, focusing on two sides - tangible and intangible. First means measurable quantitative indicators (including financial results), second characterizes complex quality indicators (such as loyalty, performance, satisfaction) [Serdenko, 2014]. Thus, organization or information system can be specified as a subject of research.

This article is devoted to the assessment of the information system itself, because its effectiveness directly determines the efficiency of the organization. By efficiency we mean the ability of the system during its operation to produce the effect. In other words, efficiency is the ability of the system to bring some benefit. The greater benefit it creates; the higher efficiency is. The concept of efficiency in this situation is closely correlated with the term "quality". System vulnerability demonstrates low quality of product and, consequently, its low efficiency.

Approach

The tourism automated information system was inspected for efficiency. The problem of data actualization delay has been identified as a result of modeling, supervision, documenting and questioning. It associates with time separation of the data input stage and the conversation stage (Figure 1). The delay in form renewal determined by the duration of calculations.

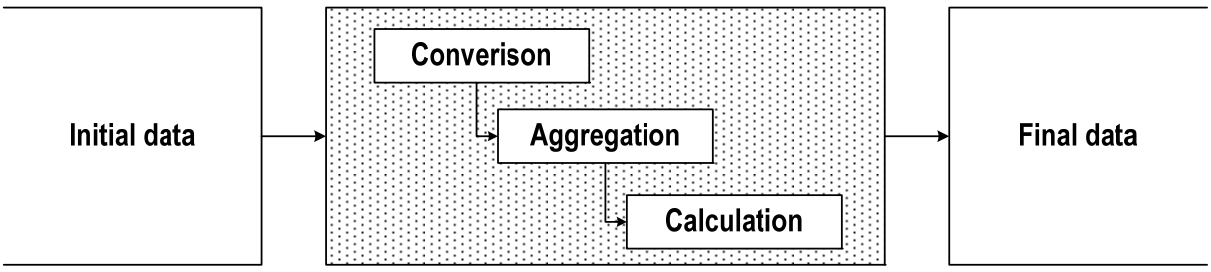

Figure 1. Data transformation

Thus, the process of collecting and reporting data is critical in the system. This process should be analyzed more carefully. A set of initial data becomes a desired form by the processing. Data transformation can include three phases: conversion, aggregation and calculation. Aggregation and calculation stages can be omitted.

Conversion is a data transformation from intial data to some intermediate form (for example cube or report) due to applying filter conditions. Aggrigation is a data summation on the various report's levels (for example, aggregation of regional data to the RF level). Calculation is a mechanism for obtaining new intermediate forms based on previously acquired data.

The data processing is a critical step (operation) for the system. Critical work in the system is defined closely to critical work in the project as a work at critical path. Critical path is a sequence of operations, which influence on the process duration and which define working schedule [Bowen, 1997]. This stage determines data actuality in the system so it is important to realize it effectively. Therefore, found bottleneck of information flow realization should be explored in detail.

Algorithm analysis involves the research of the information flow transformation. The transformation process can be represented by a graph model, implemented by semantic network or directed graph (Mor1). Moreover, this graph will be isomorphic to initial algorithm.

Information graph is a diagram of information flows of the modeled system. It reflects all sequences for this information flow from initial to final data. Using the graph allows you to visualize the structure of the information flow, to apply a standard set of operations defined on graphs.

The task of improving information flows is a decision of graph reduction problem. Graph reduction includes merging and splitting of vertices in a manner that algorihm execution logic is saved, but its complexity is changed.

Bound for the complexity of the graph $\theta(G)$ is carried out by estimation the complexity of the algorithm realized by the graph. The complexity of the algorithm is understood as a quantitative calculation of algorithm elementary operations.

Thus, the challenge of Information flows enhancement is the transformation of original graph to transformed grapg $G \to G'$ in such way that the complexity of transformed graph is less than the original one $\theta(G) < \theta(G')$. If reduced (transformed) graph has the least possible complexity $\theta(G') \to min$, then G' is an optimized graph G.

Information flow model (Figure 1) includes three stages of data processing. Because of this organization, various groups of vertices are required:

- Initial documents, input forms or other data that is entered in the system by users (agreements, bank orders and other).
- Filter conditions are logical expressions that define the rules of data transformation.

- Intermediate documents are some data views (cubes,forms) that contain data for the construction of the final document or calculation methods.
- Aggregation mechanism are the conditions for data aggregation levels (total values).
- Calculation formulas are processes that produce new interm,ediate or final documents.
- Final documents final reports and forms.

Thus, we will use a marked graph $G(V, E)$ with a set of vertices V and a set E of edges.

$V \subseteq V_1 \cup V_2 \cup V_3 \cup V_4$, where

- V_1- set whose elements are the initial, intermediate and final documents (data);
- V_2- set whose elements are the filter conditions;
- V_3 - set whose elements are the aggregation mechanisms;
- V_4 - set whose elements are data calculation formula.

E - set of edges that define the connection of vertices.

Figure 2. shows the structure of information flow for one chief process implemented in automated information system "AIS Tourism".

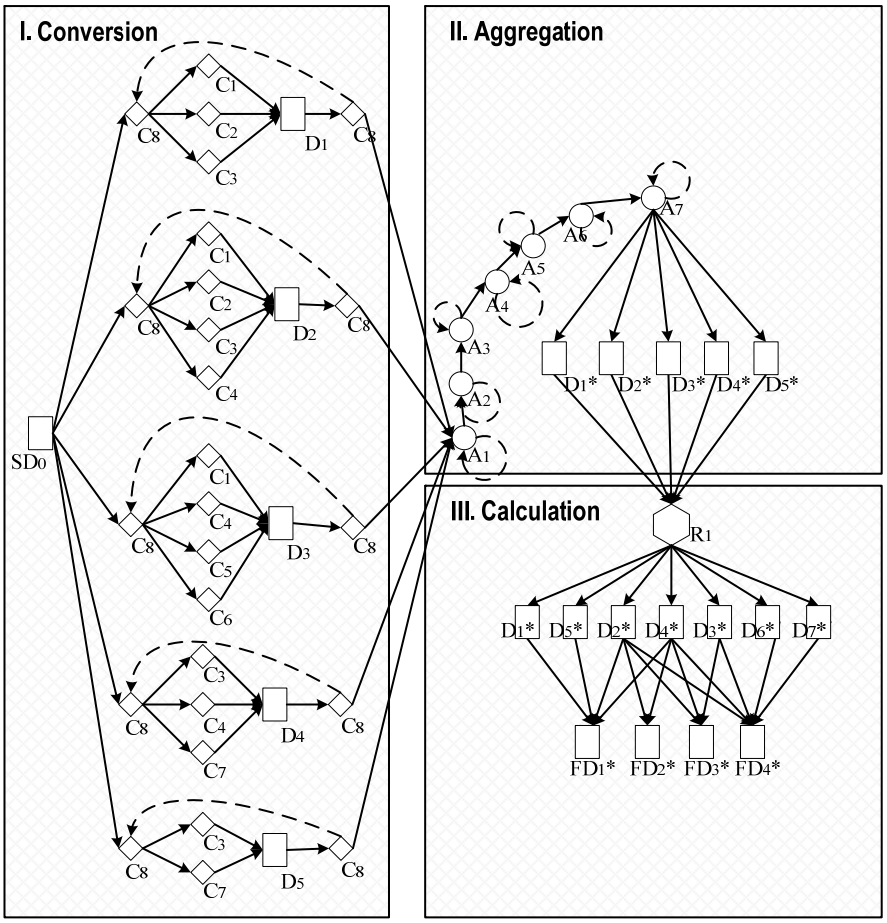

Figure 2. Initial information flow graph

For all vertices are defined symbols on the graph. The compliance of symbols and description is given in the Table 1.

Table 1. Graph description

Symbol	Description
	Initial (SD), intermediate (D) and final documents (FD)
	Filter conditions (C)
	Aggregation mechanisms (A)
	Calculation formulas (R)

This graph has multiple duplicated vertices which characterize additional complexity during the operations execution. Extra activities increase time of algorithm performance. In this way the grothw of input data will increase the speed of algorithm execution because of its polynomial complexity. Graph complexity will be estimated by the amount of elementary operations or vertices.

AIS Tourism consists of n acts and bank orderd. Acts have just one third $p_a \approx \frac{1}{3}n$ of all payment documents and bank orders have last two thirds $p_{bo} \approx \frac{2}{3}n$.

Filter conditions vertices are defined by amount of elementary operations. We will consider following operations as elementary:

- Logic operations (such as and, or, not, xor).
- Relational operators (=, <>, >, <, <=, >=).
- Integer arithmetic.
- Arithmetic (+, -, *, /).

The conversation part has the complexity (1), where k_i is amount of vertices numbered i, a_i is the complexity of vertice numbered i and m is the highest vertice number of filter condition in studied group.

$$A = 5na_8 \sum_{i=1}^{m} k_i a_i \quad (1)$$

As a result, the complexity of the conversion part can be calculated by the formula (2).

$$A = na_8(a_1 + a_2 + a_3) + na_8(a_1 + a_2 + a_3 + a_4) + na_8(a_1 + a_4 + a_5 + a_6) + na_8(a_3 + a_4 + a_7) + na_8(a_3 + a_7)$$

Table 2 includes data that is necessary to estimate the complexity of the graph.

Table 2. Complexity of vertices

Vertice number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Complexity	1	3	5	2	1	1	1	1
Amount of vertices	3	2	4	3	1	1	2	5[1]

The complexity of other stages (aggregation and calculation) we will equate as a constant T. Thus, the complexity of the whole graph will be defined as (3):

$$\theta(G) = A + T \quad (2)$$

Analyzing the graph it was found that there are duplications of vertices with redundant filter conditions, that undermine the effectiveness of the system:

- It increases process time.
- It reduces quality. At the time of performing a long calculation data loss is more likely.
- It reduces system reliability. Long consuming operation has a higher risk of failure;
- System seems to be more complicated.

Graph enhancement can be achived due to reduction of graph based on merging and splitting of vertices. The complexity of operations (vertices) should be taken into account during the reduction process.

First thing that can be done is merging of vertices C8 that control loop operation. Initially there were five loops with the same terminate condition, so it can be simplified by removing needless one (Figure 3).

Figure 3.

[1] Two loop conditions C8 are determined by the same complexity, but on the graph it presents as double vertice.

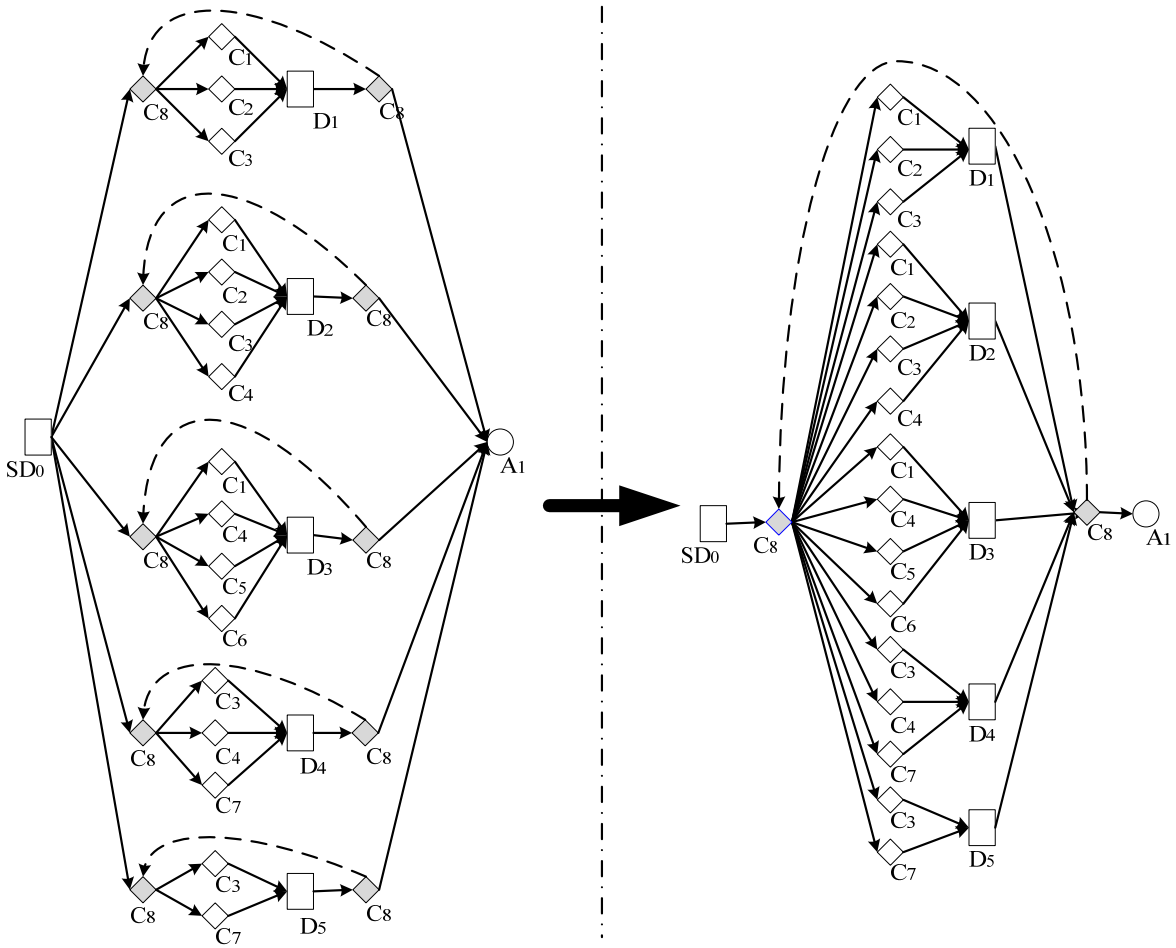

Figure 3. Transformation of vertice C8

Then there are conditions C1 and C7 that consist of opposite facts, it means that if C1 is true then C7 is false. The converse case is also true. So these vertices can be changed by the new vertice C9 with XOR mark. C9 will divide the data set into two groups (acts and bank orders) with success rates p_a and p_{bo}.Generation of new vertice require the creation of new intermediate documents SD1 and SD2 (Figure 4).

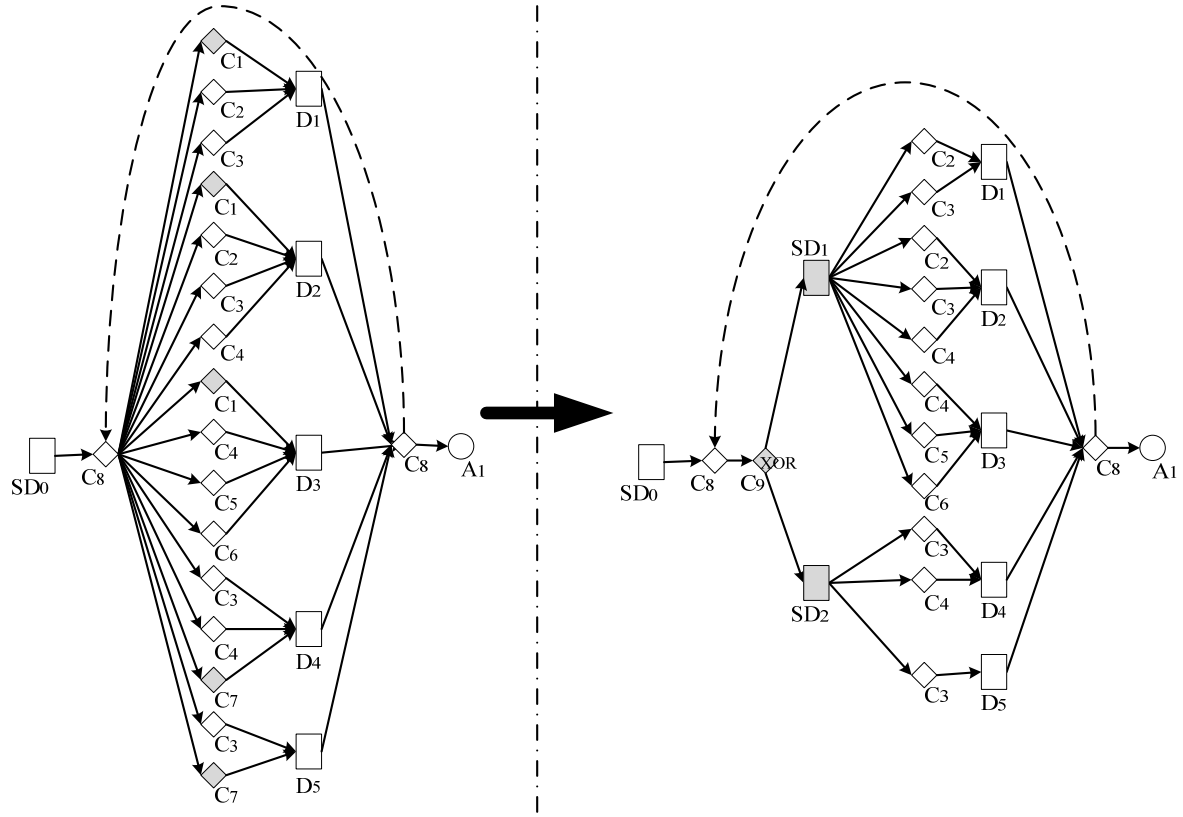

Figure 4. Generation of vertice C9

Each new group (characterized by acts and bank orders) can be implemented in individual reduced loop (Figure 5).

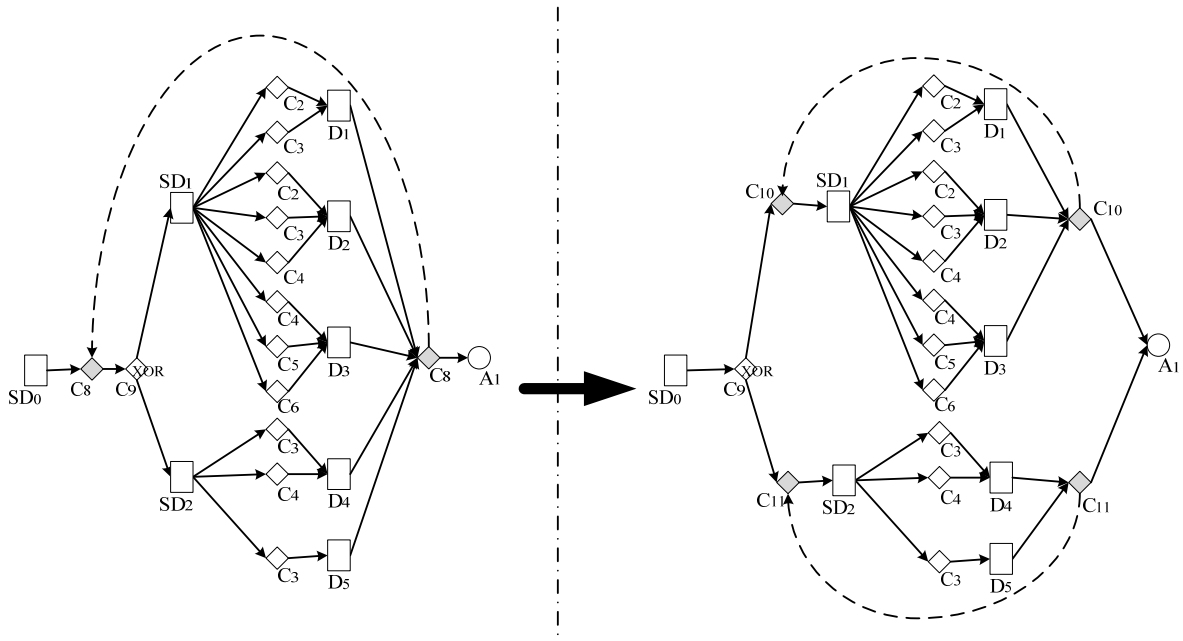

Figure 5. Simplification of C8 loop

After that vertices duplications can be excluded by merging of vertices C2 (Figure 6) and others.

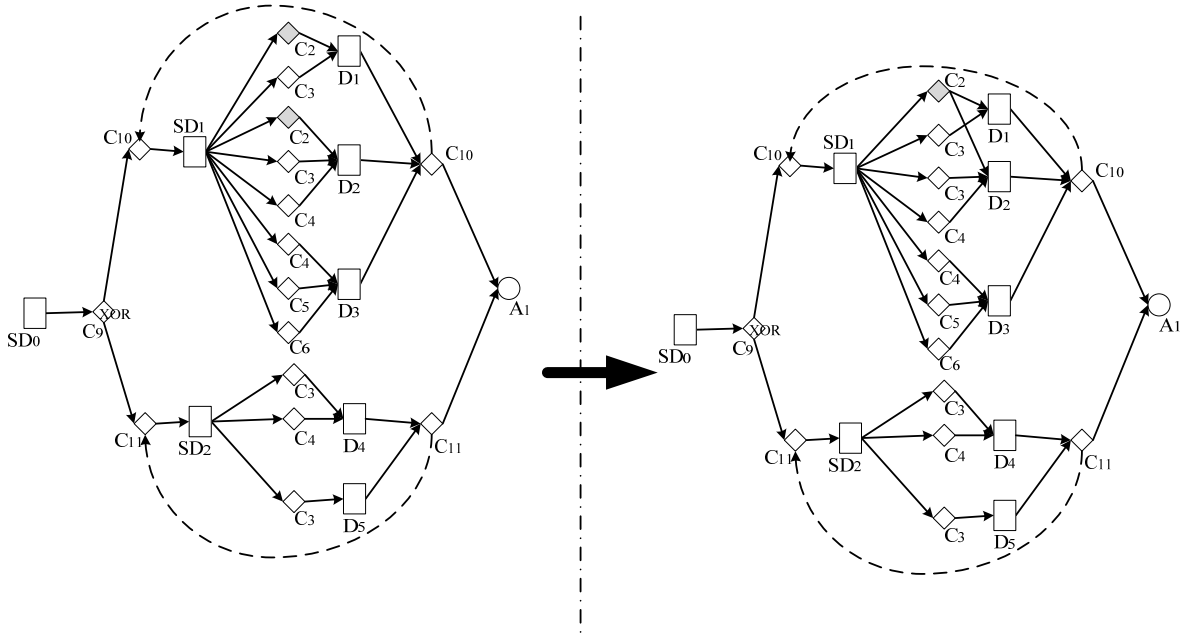

Figure 6. Merging of C2 vertices

As a result, it was received new transformed graph (Figure 7) with complexity (4).

$$\theta(G') = A' + T \tag{3}$$

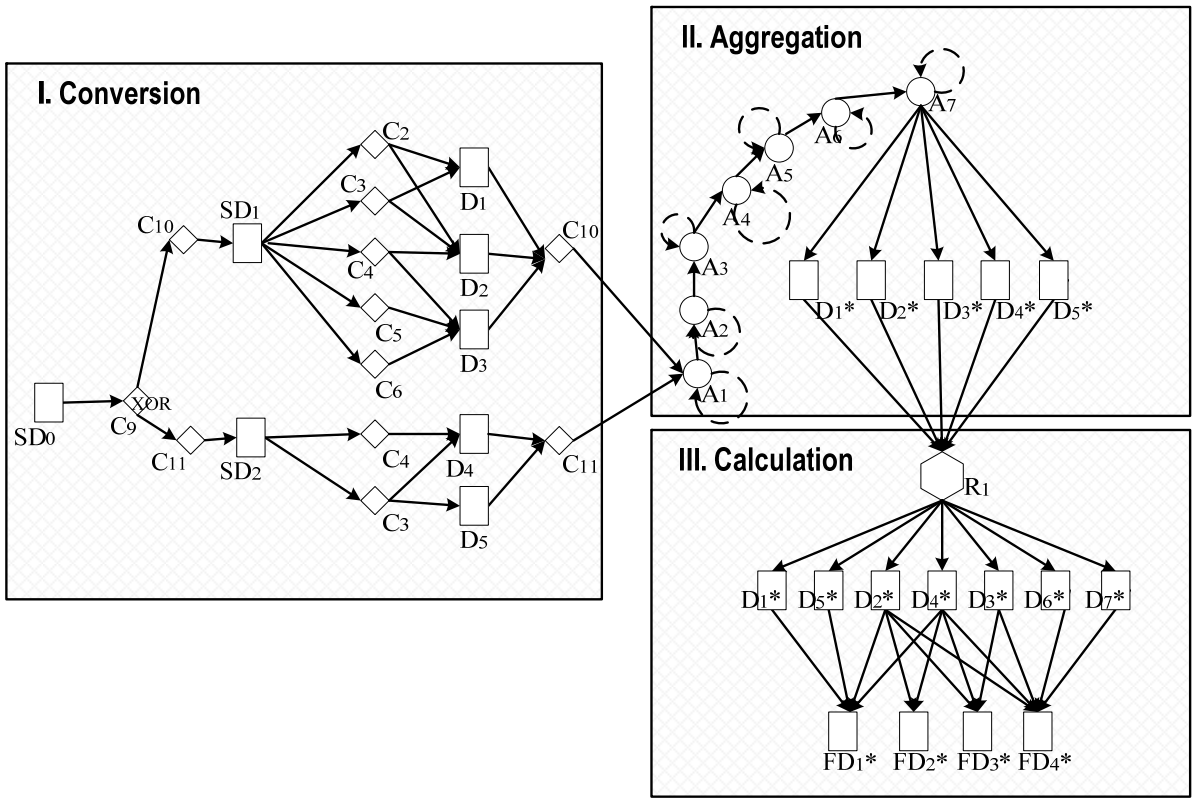

Figure 7. Transformed graph

The complexity of conversion stage of transformed graph G' can be calculated by formula (5).

$$A' = n \cdot p_{bo} \cdot a_{10} \cdot \sum_{i=2}^{6} a_i + n \cdot p_a \cdot a_{11} \cdot (a_3 + a_4) \quad (4)$$

Therefore, the complexity of conversion part of transformed graph is less than original graph complexity $A' < A$, so total graph complexity of transformed graph is also less than original one $\theta(G') < \theta(G)$. Algorithm implemented by the information flow graph can be modernized by transformed graph.

Conclusion

This research represents domain-specific method of estimation and enhancement of information flows for automated information system "AISTourism". The method include three main parts: visualization, analysis or estimation and transformation.

Visualization includes graph modelling for previously defined vulnerabilities of effectiveness of the automated information system. Graph model implements the information flow. Graph realization was choosen due to its opportunity to use basic graph theory rules and its isomorphism to initial algorithm.

Evaluation of information flow model was carried out by applying the theory of algorithms. Improving the implementation of the information flow has been achieved through the transformation of the graph due to the merging and sliting operations.

Bibliography

[Alferova, 1971] Z.V. Alferova. Application of graph theory in economic calculations. Ed. Z.V. Alferova and V.P. Ezzhaeva. M.: Statistics, 1971. 150 p.

[Belyaev, 2010] D.A. Belyaev. Fundamentals of Information Management: supportive notes of lectures. Syktyvkar: Syktyvkar University Publishing, 2010. 64 p.

[Bowen, 1997] H.K. Bowen. Project Management Manual. Boston: HarvardBusiness School Press,1997. 42 p.

[Collection of Legislation, 2011] Collection of Russian Federation Legislation, 22.08.2011, No 34, item 4966.

[Morozov, 1982] V.P. Morozov. Features of design of economic information processing systems based on ES EVM. M .: Finance and statistics, 1982. 150 p.

[Serdenko, 2014] E.S. Seredenko. Cost-effectiveness analysisof information systems. Cand. econ. sci. diss. M., 2014.

[Shilyaev, 2005] A.A. Shilyaev. Information support for the restructuring of the enterprise management system: Cand. econ. sci. diss. Moscow, 2005.

Authors' Information

Irina Titova *– Business Analyst at Prognoz IT-company, e-mail: ir.okulova@gmail.com.*

Major Fields of Scientific Research: information flows, graph modeling.

Natalia Frolova *– Perm State National Research University, Doctor of Physical and Mathematical sciences, Associate Professor, Department of Information Systems and Mathematical Methods in Economics, E-mail: : nvf_psu@mail.ru*

Major Fields of Scientific Research: information flows, graph modeling, *complex system modeling*.