THE INFORMATIONAL SYSTEM FOR THE COLLABORATIVE LOGISTICS NETWORKS

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ABSTRACT: *This paper presents an informatic system designed for collaborative logistic networks. The informational system is composed of structured informational modules that can easily be modified in order to facilitate the testing of the different algorithms that are being used. The informational system has two components, in the form of web application modules, which are connected to the user-specific modules (THE CLIENT WEB APPLICATION) and to the server-specific modules (THE SERVER WEB APPLICATION), respectively. These two modules operate the transmission of information, the demands of the client and the offers generated by the server. The designed informational system has been tested in actual operating conditions, by co-optating ten EMSs from the Bihor county area. Some of the elements considered positive by the users, in the testing period, were: usability, the automatic assignment of a motor vehicle according to the characteristics of the product, the automatic route generation, the selection of goods according to the cluster "route" of the system.*

KEY WORDS: *collaborative logistics networks; logistic system; informational system; web application modules; the client web application; the server web application; the user interface.*

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1. THE STRUCTURE OF THE INFORMATIONAL SYSTEM FOR THE COLLABORATIVE LOGISTIC SYSTEM

In order to be efficient, a logistic system has to be accessible and user friendly. From the users group, the SMEs is the most important category.

A well designed logistic system:

- can cause a dramatic decrease of the costs of commodity transports, with positive consequences for both operators and clients
- produces added value, in terms of improving the quality levels of the services provided to the end-users, as the punctuality, reliability, sustainability, awareness and transparence are improved, so that the competitiveness of the operators and that of the system users is increased
- brings benefits to society, which positively affects the congestion and pollution levels through an attentive selection of the possible methods of solution, and also through a better use of the available transport capacity. Hence it brings positive contributions not only to efficiency, but also to safety, security, friendly environment and sustainability.

The informational system for the collaborative logistics networks has two components, in the form of web application modules, which are connected to the user-specific modules (THE CLIENT WEB APPLICATION) and to the server-specific modules (THE SERVER WEB APPLICATION), respectively.

The structure of the informational system for collaborative logistic system is represented in *Figure 1.*

The parameters that are monitored in the informational system are the following:

- The load
- The intermodal transportation
- The fleet of vehicles
- The route
- The transporters
- The costs
- The duration.

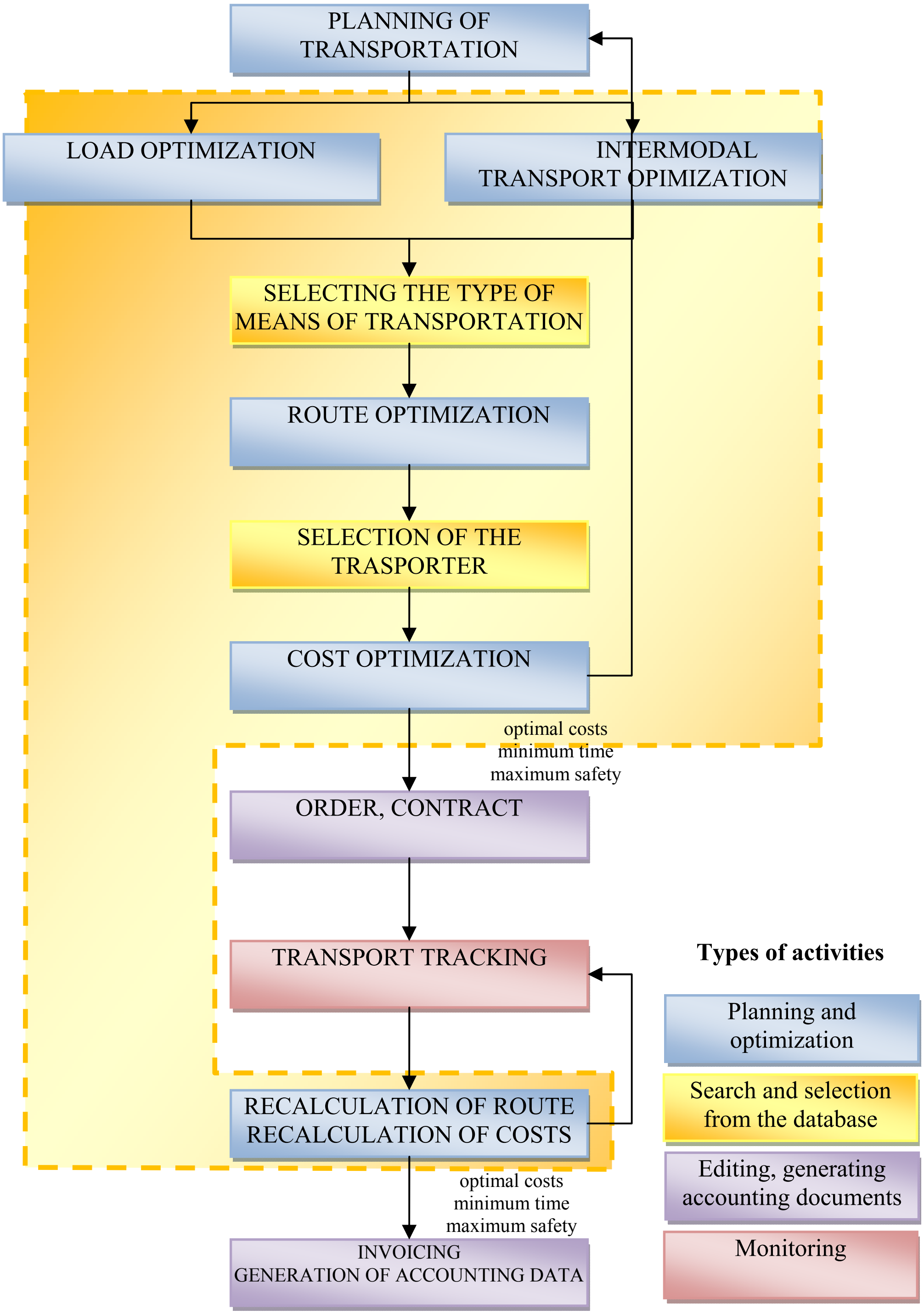

Figure 1. The Structure of the Information System

2. THE INFORMATIONAL SYSTEM

The general diagram of the designed informational system is presented in *Figure 2*.

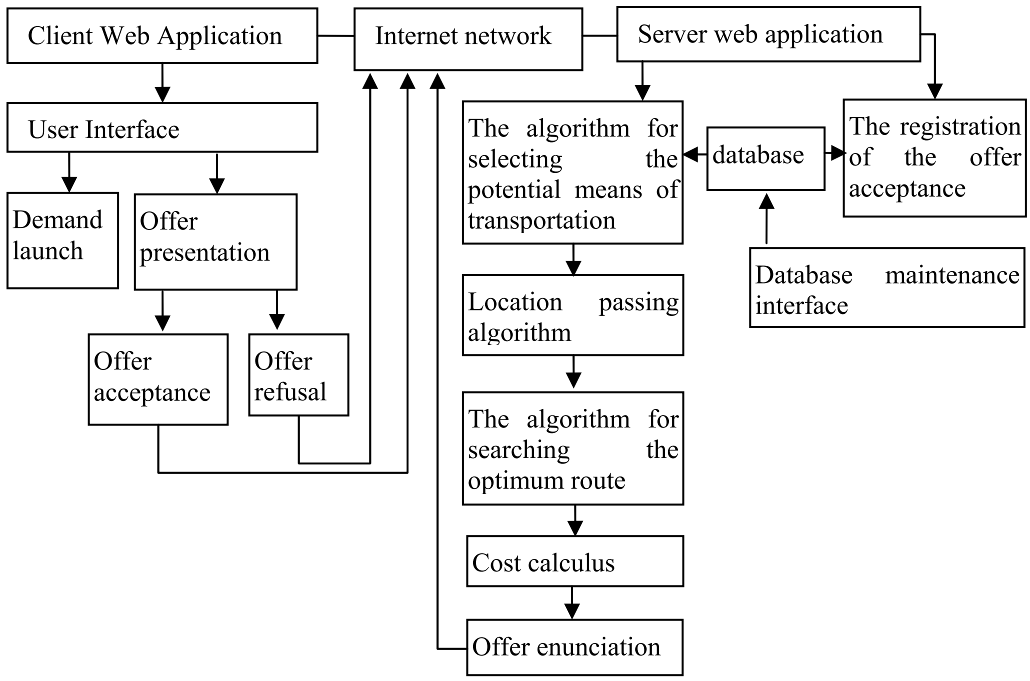

Figure 2. Schematic diagram of the informational system

The informational system is composed of structured informational modules that can easily be modified in order to facilitate the testing of the different algorithms that are being used.

The main component of the informational system consists of two web application modules that are to be connected to the user-specific modules (THE CLIENT WEB APPLICATION) and to the server-specific modules (THE SERVER WEB APPLICATION), respectively (Anghel, 2005). These two modules operate the transmission of information, the demands of the client and the offers generated by the server.

On the client branch THE CLIENT WEB APPLICATION manages the performance of the user interface that allows the demand initiation and the submission of offers, respectively. Within the frame of THE USER INTERFACE, the client introduces in the system the parameters of the transport he wishes to apply for:

- the commodity type, weight and volume;
- the locations of forwarding and of destination;
- the time schedule of the transportation.

After entering the data, the client submits the demand online, thus transmitting the parameters of the requested transportation to the server. After he receives the offer that corresponds to the required parameters, which contains the cost details, among other things, the client can analyze the offer and then decide whether or not to accept it.

On the server branch THE SERVER WEB APPLICATION, once the client request is received, the parameters of the requested transport are analyzed with the help of the module for selecting the potential means of transportation (THE ALGORITHM FOR THE SELECTION OF THE POTENTIAL MEANS OF TRANSPORTATION).

This algorithm performs the search inside the system database, which contains the parameters of all the means of transportation registered in the system. From among these are selected those means of transportation which are available in terms of volume, tonnage and time of transport. If the means of transportation is not fully loaded, the route of the transport becomes also a criterion of selection. To this purpose, the program includes cases in which the means of transportation is partially loaded, and the volume and tonnage of the commodity for which the transportation is requested matches the remaining free space inside the means of transportation; in this case, this means of transportation is considered available and will become an option when the offer is generated. For this means of transportation there will be a recalculation of route, optimal itinerary and costs, so as to fit with the new transport and also with the ones already accepted.

The selection of the means of transportation is followed by the selection of the itinerary (THE LOCATION PASSING ALGORITHM). The source code of the selection module, which is also usable when dealing with multiple transports (multiple loads on the same means of transportation), is presented hereinafter.

```
% Location passing algorithm

posib = perms([1 2 3 4 5 6]);
cond1 = [1 2
      2 3
      3 4
      5 6
      4 5];
[ifin,jfin] = size(posib);
[mfin,nfin] = size(cond1);
ind_a_crt = 0;
ind_b_crt = 0;
k = 1;
posib1 = posib;
[u v] = size(posib1);
for m = 1:mfin
   a_crt = cond1(m,1);
   b_crt = cond1(m,2);
   for i = 1:u
      posib1;
```

```
        ind_a_crt = find(posib1(i,:) == a_crt);
        ind_b_crt = find(posib1(i,:) == b_crt);
        if ind_a_crt < ind_b_crt
          posib2(i,:) = posib1(i,:);
        end
    end
    clear posib1;
    posib1 = posib2;
    clear posib2;
    [u v]  = size(posib1);
end
for j = 1:u
    if sum(posib1(j,:))>0
        posib3(k,:) = posib1(j,:);
        k = k + 1;
    end
end
disp(posib3)
```

% Location passing succession.

Parcursul 1: 1 2
Parcursul 2: 3 2

% The permutation matrix

4	3	2	1
4	3	1	2
4	2	3	1
4	2	1	3
4	1	2	3
4	1	3	2
3	4	2	1
3	4	1	2
3	2	4	1
3	2	1	4
3	1	2	4
3	1	4	2
2	3	4	1
2	3	1	4
2	4	3	1
2	4	1	3
2	1	4	3
2	1	3	4
1	3	2	4

1	3	4	2
1	2	3	4
1	2	4	3
1	4	2	3
1	4	3	2

% The corresponding result for the location passing succession

4	3	1	2
4	1	3	2
3	4	1	2
3	1	2	4
3	1	4	2
1	3	2	4
1	3	4	2
1	4	3	2

In the matrices presented above, each row is represents transited locations numbers. It is to be observed that the result of the algorithm is the selection of those rows from the permutation matrix (all possible cases of disposal) that are in compliance with the requested order of the locations to be transited: 1-2 for transport no. 1, 3-4 for transport no. 2.

The algorithm selects those routes that correspond with the order of loading and discharge (the locations of forwarding and destination) of all possible routes (obtained as a matrix of permutations of the locations numbers).

Once the correct routes are determined, the shortest route is calculated, using search algorithms (THE ALGORITHM FOR THE SEARCH OF THE SHORTEST ROUTE). In the case of the designed informational system, a variant of the A* algorithm (and Dijkstra algorithm) is used.

In the initial phase, it is used that variant of the program in which the geographical map of the logistic system is assimilated with a graph whose nodes symbolize forwarding and destination locations. The values associated with the edges of the graph represent the actual distances between the nodes of the graph. These values can then be replaced with calculated values, considering the speed limit on the road and the traffic conditions. The implemented A* algorithm has been tested on various transportation situations, with very good results.

In order to demonstrate the way the algorithm functions, we shall present hereinafter the pseudo code format of the A* algorithm.

The algorithm goes through different routes, starting from an initial node (which represents a forwarder) and going towards a target node (which represents a receiver). For each scanned x node, there are three values to be recorded:

g – the shortest distance between the initial node and the current node;

h – the linear Euclidean distance between the current node and the target node;

f – the summation of the two values: g and h.

Starting with the initial node, the algorithm stores the nodes that are to be scanned in a *v* vector. The highest priority is distributed to the node whose *f* value (which represents the distance to the target node) is smallest. At each phase of the algorithm, the node with the smallest *f* value is eliminated from the *v* vector, the values of the *f* and *h* functions specific to the adjacent nodes are recalculated, and these adjacent nodes are added to the *v* vector. The algorithm runs until the *f* value, corresponding to the target node, has a value that is smaller than any other node present in the *v* vector. In this case the *f* value corresponding to the target node is the minimum distance, because the *h* value corresponding to the target node is 0. The covered trajectory, corresponding to the minimum distance, is remade by going through its nodes in reverse.

After finding the optimum route, the costs are calculated with the help of a linear sequential algorithm (COST CALCULUS), after which the offer details are generated: the cost, the itinerary, the period between the forwarding and the reception (OFFER ENUNCIATION), which is issued to the client, with the help of two user-interface web applications. If the user accepts the offer, the latter is registered (OFFER ACCEPTANCE REGISTRATION) in the database. The database is dynamic, in the sense that it is updated with every offer acceptance. This structure is managed with the help of the DATABASE MAINTENANCE INTERFACE module.

3. CONCLUSIONS

The designed informational system has been tested in actual operating conditions, by co-optating ten EMSs from the Bihor county area.

The interest for using this system has been high. Some of the elements considered positive by the users, in the testing period, were: usability, the automatic assignment of a motor vehicle, according to the characteristics of the product, which eliminates to a large extent the subjective factor, the automatic route generation, the optimal delivery sequence generation and the selection of goods according to the cluster “route” of the system.

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