ТРАНСПОРТНЫЕ СИСТЕМЫ

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OBJECT-ORIENTED APPROACH TO FORWARDING SERVICE PROCESS SIMULATION

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Abstract. *The basic structure of simulation model of the forwarding service process for motor transport has been given. Base classes and interfaces of the simulation model have been presented in order to develop suitable decision-making support software. It has been demonstrated that at the moment the simulation is the most acceptable option in forecasting the demand for freight forwarding services and interaction between agents at the transport service market.*

Key words: *forwarding service, simulation model, object-oriented programming.*

ОБЪЕКТНО ОРИЕНТИРОВАННЫЙ ПОДХОД К МОДЕЛИРОВАНИЮ ПРОЦЕССА ТРАНСПОРТНО-ЭКСПЕДИЦИОННОГО ОБСЛУЖИВАНИЯ

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Аннотация. *Предложена принципиальная структура имитационной модели процесса транспортно-экспедиционного обслуживания на автомобильном транспорте. Определены базовые классы и интерфейсы имитационной модели.*

Ключевые слова: *транспортно-экспедиционное обслуживание, имитационная модель, объектно ориентированное программирование.*

ОБ’ЄКТНО ОРІЄНТОВАНИЙ ПІДХІД ДО МОДЕЛЮВАННЯ ПРОЦЕСУ ТРАНСПОРТНО-ЕКСПЕДИЦІЙНОГО ОБСЛУГОВУВАННЯ

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Анотація. *Запропоновано принципову структуру імітаційної моделі процесу транспортно-експедиційного обслуговування на автомобільному транспорті. Визначено базові класи та інтерфейси імітаційної моделі.*

Ключові слова: *транспортно-експедиційне обслуговування, імітаційна модель, об’єктно орієнтоване програмування.*

Introduction

The forwarding service (FS) process is a comprehensive technological process. The process management is described by the presence of a significant quantity of alternatives in different stages of decision-making. Besides, the process is influenced by a considerable quantity of random factors that complicate the decision-making. The error cost in decision-making is high enough as due to this the high cost of idle time of vehicles, possibility of cargo damage and loss of additional incomes of forwarding agents may occur. However the current approaches to the FP decision-making allow solving a narrow series of tasks without taking into account the majority of the parameters to determine the technological process efficiency. It proves the development necessity for universal software packages on decision-making support that are based on the present-day scientific methods and approaches. A basis for developing the software modules is the structure of the process under modeling defined in base classes.

Analysis of publications

In [1, 2] there are the statements that the simulation modeling is one of the most widespread quantitative methods to solve the management problems. In [3] it is noticed that the basic advantages of simulation modeling are dynamic character of the system presentation, possibility to take into consideration some random factors and complex dependences, comparative simplicity of modifications making to a model, practically unlimited possibilities of mathematical apparatus application.

In [1] there are the following conditions of the simulation modeling application that determine the expedience of the given methodology for the problem solution in the FS process management: simulation modeling is an unique possibility owing to complexity of the experiment and supervision of the phenomena in real conditions; a time scale compression is necessary for long-term action of a process under research; excepting an estimation of certain parameters, realization on simulation model of supervision over a process course during a certain time is desirable.

Among the papers related to the development of methods to support the managerial decision-making in forwarding service the simulation modeling has been used in [4–6]. The author of work [4] offers a technique of on-line plan formation for motor-car transportations in the international road traffic. Thus, the use of simulation modeling as the methodology of the problem solution instead of known methods on the basis of linear programming is proved by necessity of the constant plan correction.

In [5] and [6] the author offers simulation models of marketing system for sale of forwarding services and model of a strategic choice of the forwarding enterprise (FE). In papers the specific interactions of categories and elements that embrace the marketing activity in system of the forwarding services have been described. However in [6] there is no definition what exactly is chosen – the forwarding agent by the client or the development strategy by the forwarding agent. Besides, models of the FE functioning in papers [5, 6] are presented neither in schematic, nor in formal and in descriptive form though in conclusions there is the statement that such models have been obtained.

The purpose and problem statement

The paper objective is to develop the basic structure of the FS process simulation model. The object under the research is the FS process and the subject under the research is the FS process model.

In order to achieve the research objective it is necessary to solve the following tasks: to formalize structure of the forwarding service process on motor transport, to define base classes and composition of simulation models for the main trends of the forwarding service efficiency increase.

Base classes of simulation model for the forwarding service process

When considering the process of forwarding service on the road transport, it is necessary to allocate three basic subjects: the forwarder (the forwarding enterprise), the carrier (transport agency) and the freight owner. In this case the forwarding agent and the carrier are unambiguously divided by the functions performed, co-ordination and transportation, thus the forwarding agent can carry both co-ordination, and co-ordination and transportation, whereas the carrier can do only transportation.

Using the methodology of the object-oriented approach [7] to the development of complex system models, in the FS process model it is possible to allocate the objects of three corresponding classes: the forwarding agent, the carrier and the freight owner. As objects of the given classes can be presented by entry fields of the similar content (enterprise name, address, arrangement region, etc.) it is expedient to develop the ifcAttributes interface containing similar attributes for their description. Besides, the direct instances of the clsForwarder and clsCarrier classes contain (can contain, if it is forwarding agent's question of matter) the «rolling stock fleet» object for realization of which it is convenient to use the separate interface (ifcFleetStructure), and the clsForwarder class –

the «warehousing» object that is described by the corresponding ifcWarehouse interface. Thus, in the FS process model one of the main principles of object-oriented programming, the inheritance principle is implemented. The clsForwarder and clsCarrier classes inherit the ifcAttributes and ifcFleetStructure interfaces and the clsFreightOwner class inherits only the ifcAttributes interface (fig. 1).

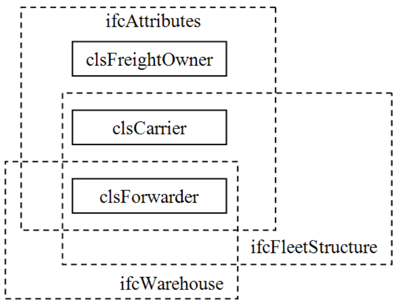

Fig. 1. Inheritance of interfaces in base classes of the FS process model

The service requests arrive to the forwarding agent from freight owners (about necessity of a cargo lot transportation) and from carriers (about necessity of a vehicle loading). Under the given definitions of the FS process subjects it is possible to say that the freight owner cannot address with the request directly to the carrier as the carrier having a possibility to accept the requests (so, to perform the function of transport process coordination) is the forwarding agent by definition. Thus, between subjects of the FS process some interconnections are possible: between the forwarding agent and the freight owner (fig. 2, a), between the forwarding agent and the carrier as the customer of service (fig. 2, b), between the forwarder, the carrier and the freight owner (fig. 2, c).

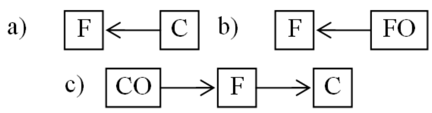

Fig. 2. Relations between subjects of the FS process: F – forwarder; C – carrier; FO – freight owner

The basis and the reason of mutual relations between participants of the FS process is the service request. As can be seen from the layouts on fig. 2, the requests can be divided into 3 types: the request from the carrier to the forwarder (fig. 2, a), the request from the freight owner to the forwarder (fig. 2, b, c) and the request from the forwarding agent to the carrier (fig. 2, c).

So, by the form, the request coming to the forwarder can be divided in two types: requests from carriers (C-F) and requests from freight owners (FO-F). The carrier addressing to the forwarder puts the request about necessity of return vehicle loading and the freight owner – about a cargo lot delivery. The request arriving from the carrier is characterized by the following values: vehicle body type (floor covering type), possible ways of loading, body volume and tonnage, trip direction (not a specified place of destination, possibly, region).

The freight owner request contains the following obligatory elements: cargo type, tonnage and dimensions, packing type and route. Excepting the above parameters of the carrier and the cargo owner applications it is necessary to emphasize the payment form. If the request flow for a forwarding service is under the consideration then each application is described by a receipt interval (a space between time of receipt of the previous and current request).

It is evident that the request from the forwarder to the carrier (F-C) brings the same set of parameters as the request of the freight owner to the forwarder but optionally duplicates it. The forwarder looking for variants of return loading and, probably, enlarging the lots of cargoes, in the transportation papers specifies the corrected (optimized) route line with the instructions on freight owners' special requirements.

It is necessary to notice that currently the domestic forwarders, in most cases, due to the absence of needed qualification and the specialized software are not engaged in optimization of delivery routes, i.e. the request is directed to the carrier with the same parameters as received from the freight owner.

In order to describe the FS applications, in simulation model it is rational to mark out the separate abstract class – the clsApplication class. Considering the application parameters of various types (tab. 1) it is possible to allocate the general properties that, obviously, should be presented in the clsApplication: cargo type – body type, floor covering type, and trip (direction) and request receipt interval. For the quantitative characteristic of a trip route, the request parameters, zero mileage and delivery distance, are presented in tab. 1.

Table 1 Request parameters for the FS services

Parameter	Request type		
	C-F	FO-F	F-C
Cargo type – body type	+	+	+
Container and packing type	-	+	+
Consignment dimensions	-	+	+
Consignment volume	-	+	+
Body dimensions	+	-	+
Floor covering type (for all-service trucks and vans)	+	+	+
Possible way of loading/unloading	+	-	+
Vehicle carrying capacity	+	-	+
Trip route (direction)	+	+	+
Delivery distance	-	+	+
Zero mileage	-	-	+
Request receipt interval	+	+	+

Under the resulted classification of the forwarding service requests the clsApplication descendant classes are defined as: clsCFApp (the C-F request type), clsOFApp (the FO-F request type) and clsFCApp (the F-C request type).

The forwarding service is the process of service of a request flow by the forwarding agent and the request flow is a time-ordered set of separate request receipt. So, it is possible to present the process of forwarding service as a set of subprocesses – processes of service of separate requests that can be fulfilled in parallel, consecutive or combined way (it is specified by a forwarder's organizational structure).

The service process of the particular request in view of its complexity is expedient for describing in a separate class – the clsSingleAppService class. It is possible to present the process of forwarding service of separately considered forwarding enterprise as a class (clsForwardingService) defining the methods which actualize the algorithms of the request flow management. The process that contains the forwarding service process management at the single enterprise is the formation and management of logistic chains (clsLogisticService). Taking into account some subordination of the above-stated base classes and the sequence of their program implementation the lowest level are the classes describing the basic subjects of the forwarding service process (forwarder, carrier and freight owner) and the subject of their mutual relations (the service request). The next level is the process of service of the separate request, the higher level – process of the request flow service for the forwarding service and the highest level – logistic management of delivery chains. As a whole, the hierarchy of base classes is presented on fig. 3.

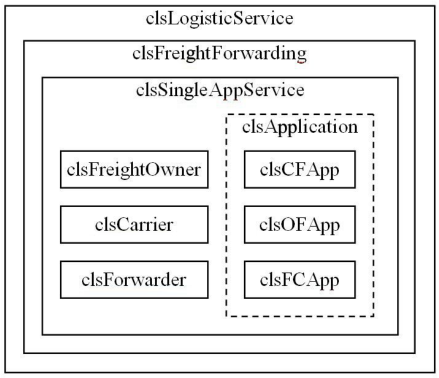

Fig. 3. Hierarchy of base classes of the FS process simulation model

Structure of the simulation models for the forwarding service process management

There is the statement in [3] that the technological processes are of the highest complexity that is caused by a considerable quantity of the information containing in researched subsystems and in mutual influence of parameters of subsystems. Accordingly, the model of technological process of the FS as a model of complex system should consider some interrelations between elements of system and make possible the determination of a set of indices to describe the process under research.

One of the basic feature of the model is its universality [8] defined by the model applicability to the analysis of numerous group of the same type objects, to their analysis in one or many functioning modes. Universality of the forwarding service model should provide the possibility of its application when modeling an operation of various forwarding enterprises for various parameters of the transport market services, and it also should give the possibility to solve the tasks of various types. However an increase of the model universality results in its excessive complexity. The usage of bulky and resource-intensive universal model to solve the specific problems is unreasonable. Therefore in order to simulate the FS process it is expedient to develop a dynamic-link library of the above-listed base classes in the dll-files form (dll – dynamic-link library), the objects of which can be used when solving the specific tasks. The use of such library will allow avoiding a massiveness of created models but, thus, the universality of the approach to the FS process simulation will be saved. So, the structure of the simulation model is defined by tasks for solution of which the model has been developed. Besides, the problem statement and the required accuracy determine the complexity of structure (the study depth) and necessity of the simulation application in general. Here the model accuracy is understood as its property in reflecting degree of coincidence of values of the object parameters predicted by means of the model with the true values of these parameters. The main tasks solved in simulation of forwarding service on the motor transport can be divided into the following groups: forwarding service process efficiency estimation, forwarder structure improvement, forwarding service competitiveness estimation, forwarder functioning strategy optimization in the competitive market of transport services, conflict resolution between the market agents in time of service price substantiation, forwarding services' demand estimation. In the problem solving for each of the specified groups, the development of the special simulation model is required as the modeling of processes various by the form and the content is needed, so, the implementation and use of methods, properties and events of various base classes is necessary.

The content and elementary structures for the resulted groups of the tasks solved in the simulation modeling of the FS process are given in table 2.

Table 2 Elementary framework of simulation models for the FS management process

Set of tasks to be solved in the forwarding service process management	Processes under simulation	Base classes used
Forwarding service process efficiency estimation	Receipt and service of requests under known parameters of demand and for the exact forwarder structure	clsForwarder, clsCarrier, clsApplication, clsSingleAppService
Forwarder structure improvement	Forwarding service for various ways of the forwarder organizational structure	clsForwarder, clsCarrier, clsApplication, clsSingleAppService, clsFreightForwarding
Forwarder competitiveness estimation	Operation of several rival forwarders	clsForwarder, clsApplication, clsSingleAppService, clsFreightForwarding
Optimization of the forwarder functioning strategy on the competitive market of transport services	Service of request flow for various ways of strategy with the presence of competitors	clsForwarder, clsCarrier, clsApplication, clsSingleAppService, clsFreightForwarding
Conflict resolution between the participants of the market when creating the service price	Conflict situations when making the cost of forwarding services	clsForwarder, clsCarrier, clsFreightOwner, clsApplication
Forwarding services demand estimation	Receipt of requests for forwarding services for a set of customers	clsFreightOwner, clsApplication
Management of material flow advancement process	Process of a logistic chain fragment functioning	clsForwarder, clsLogisticService

Conclusions

Development of dynamic link library on the base classes offered when making a simulation model of forwarding process allows avoiding an inconvenience of created models and, thus, keeping the universality of the approach to simulation.

The described base classes are the bottom for the software development – a system of the forwarding service process simulation and decision-making support to simultaneously control the forwarder operational process and the delivery chains in order to provide the best quality service from the customer's viewpoint.

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