CONCEPT OF AUTOMATED MANAGEMENT OF MULTIMODAL FREIGHT TRANSPORTATION BUSINESS PROCESSES

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Abstract

Article discusses concept of automated management of business processes in multimodal freight transportation. Objects such as port, ship, airplane, train, customs, truck, etc. are discusses. In the analysis, attention is devoted to identification of factors that affect efficiency of transportation process (time, costs, etc.), its business processes and business rules. Business processes of multifunctional shipments have to be analyzed, classified, structured and optimized based on systematic approach (analysis) and methods of operational research. An imitative model of system management has to be designed based on graphical model of Petri nets and methodology of conducting computer experiments has to be developed in order to make optimal decisions. A common concept has to be developed with an objective to design multimodal shipment process support computer system and to develop it based on object-oriented programming and unified databases.

Keywords: Multimodal freight transportation. Business process. Management Information Systems. BPMN. UML. ERP. Servcice Oriented Architecture.

1. Importance and Topicality of Concept

Study and solution of problem areas in multimodal freight transportation business process automated management is very important as from international perspective, as well as specifically for Georgia. It is of current importance on a regional scale (Georgia, transcaucasia, corridor to Central Asiatc, etc.). The concept itself is of a complex nature and less studied. The topic requires applying of systematic attitude as well as ability of multifunctional reasoning in terms of management, logistics, information and software support.

First of all, initial information for conducting systematic analysis and identifying problem areas has to be collected. Present concept can be attributed to the category of large and complex information systems, which involves conducting computerized imitation studies for the distributed system of multimodal freight transportation based on modeling of hardly formalized, stochastic processes.

In addition, establishing assessment system is needed for the respective results from the aforementioned imitation studies that will act as a basis for developing a computer support system that is undoubtedly of high topicality and importance.

If we look at the current state of research of this problem, we will see that as secondary, internet-based research shows, there is scarcity of literature sources on multimodal freight transportation. The field itself is basically related to provision of transportation services, logistics and freight forwarding management. In practice, various companies all over the world operating within transportation industry perform various activities (for instance, shipment of automobiles from Japan, US, European countries, etc). There is a scarcity of materials depicting theoretical and scientific research, while those of a complex, systematic research are not found at all.

2. Research Object

Research has to be done on Georgia's air, sea, rail and road multimodal freight transportation system. Algorithms will be developed to optimize complex work activities that occur in this system and to developing a computer support system based on them. Research object of the multimodal freight transportation is complex and involves a number of objects (resources).

As already mentioned above, research object deals with four modes of transport: sea, air, rail and road. A chain of multimodal freight shipment may involve a combination of two or more transport modes (e.g. ship-rail or truck-ship-rail-truck, etc). Each shipment has a transit time which may depend on a number of factors: distance, routing, shipment time/season, port operating capacity/functioning, customs documentation, etc.

Such factors directly influence duration of a shipment's transit time. In practice, rarely can be found a shipment in case of which total actual transit time is the same as the planned one. In fact, common are those events or happenings that could not have been foreseen at the time the shipment was being planned. Same can be said about shipment costs that like transit time (but with less influence) may vary or considerably change during the transportation process.

Analysis of a whole multimodal transportation chain has to be done and complex processes existent in it have to be optimized based on simulation modeling.

In order for the analysis of a shipment chain to take place a thorough study and analysis of objects comprising it has to be done.

3. Defining Objects and their Attributes

For instance, sea port structures vary, they comprise of a territory and aquatory, rail and automotive ways, various objects of telecommunication, civil and manufacture facilities, storehouses, security structures, berths, coast protection structures and others (Figure 1).

Dynamic objects of a sea port are ships (passenger, cargo, mixed), rail wagons (closed, open, special), cranes (port, bridge, cable, crawler, motor, rail), shipment machinery (auto, electric, etc.), cargo (bulk, general), teams of workers, etc.

The above listed objects influence a transportation process and consequently they have to be taken into account at the stages of shipment planning and effectuation. Ineffective planning of cargo related port activities in a shipment chain may lead to delays, fines (extra charges of demurrage or detention) that will have direct negative affect efficiency of transportation process. Consequently, the future computer support system should act as a mean of facilitation for an organizer of a shipment and help solve such problems as:

1) Minimization of a ship or wagon detention/demurrage time;
2) Usage of load/unload means at mazimum capacity (cranes, special machinery, etc.);
3) Effective planning of port transit taime.

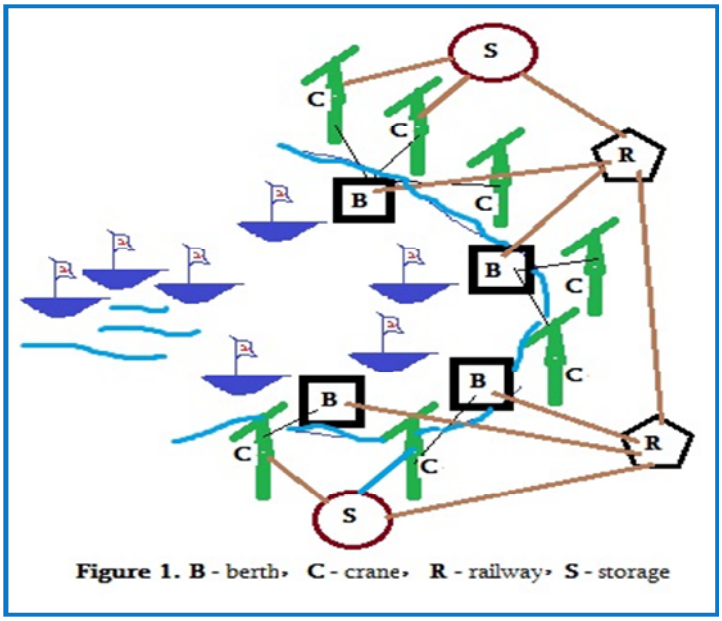

Figure 1. B - berth, **C** - crane, **R** - railway, **S** - storage

In general, solve the problem of timely and efficient passage of cargo to the next, further mean of transport in the shipment chain.

Cargo: Identificator, type, condition, type of packaging, unit dimensions (length, width, height), unit volume, total volume, unit weight, quantity of units, total weight, dangerous/non-dangerous, customs code, shipper, consignee, origin, destination, etc;

Ship: Identificator, type, craned/non-craned, condition, storage limit, load capacity, volume, location, location, etc.;

Berth: Identificator, length, depth, allowable load, specialisation, release time, passage/bandwith (power), attribution to district, etc.;

Warehouse: Identificator, type, area, floor/store, percentage occupied, allowable load, location, address, attribution to district, etc.;

Crane: Identificator, type, lifting capacity, maximum arrow length, minimum arrow length, lifting height, hook release (sink) depth, lifting speed, rotation speed, hook height change speed, speed, total weight, location, etc.;

Airplane: Identificator, type, condition, volume, maximum transportable unit dimensions (length, width, height) location, etc.

Truck: Identificator, type, condition, load volume, allowable dimensions of a freight unit (length, width, height), allowable unit weight, maximum payload, location, etc.;

Work crew - Identificator, type, qualified members, number of members, location, type of work to be performed, output norm, technological work scheme, etc.;

Shipment route – Identificator, origin (town/country), exit point/location, transit destination(s), final_destination (town/country), entrance point/location, distance, transit time (plan.), transit time (act.), etc.;

Shipment term: Identificator, origin term, destination term (International shipping terms - INCOTERMS).

D-Network of a sea port district can be given as Figure 2 shows [4,5].

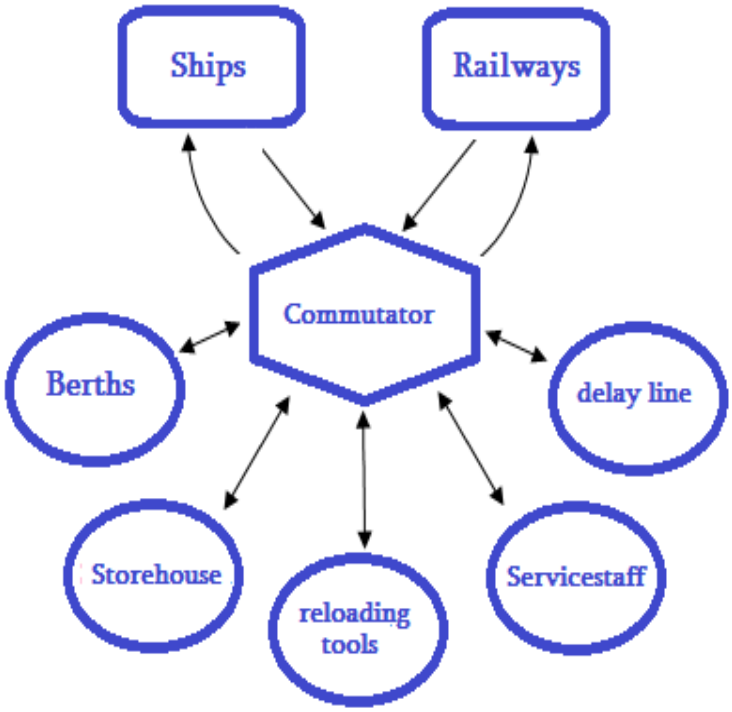

Figure 2. D-network Seaport

Converters that play flow commutation role in objects are gathered into a single commutator. Sources that correspond to ships model patterns of cargo vessels (coal, ore, wood, etc.) entering the port. There exist also vessels that carry fruits, vegetables, sugar, salt and other types of products.

Objects formed from the source-entrance go via commutator either to converter or outflaw current. Role of this current is performed by ships and trains that receive cargo and further move out of the port area. Outflaw objects and converters have characteristics with values that change once they enter the commutator exit. Change in values of characteristics occur in accordance with the graphs of converters and source passages.

4. Conclusions

Project envisages systemic research of processes of multimodal freight transportation (Air, Sea, Rail, Automotive) with the objective to optimize its business processes using market analysis and enterprise resource planning systems [6]. First time within this project building an imitative model of managing multimodal freight transportation is given based on mathematical tool –

Coloured Petri Nets (CPN) and mass service theory (Markov processes) [7,8]. Pilot version software of the system will be implemented using service-oriented architecture (SOA), process-oriented modeling (BPMN) and object-oriented approach – Unified Modeling Language (UML) technologies [6,9].

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მულტიმოდალური გადაზიდვების ბიზნეს-პროცესების ავტომატიზებული მართვის კონცეფცია

გიორგი გოგიჩაიშვილი, გიორგი სურგულაძე
საქართველოს ტექნიკური უნივერსიტეტი

რეზიუმე

განიხილება მულტიმოდალური გადაზიდვების ავტომატიზებული მართვის კონცეფცია, ისეთი ობიექტები, როგორიცაა პორტი, გემი, თვითმფრინავი, მატარებელი, საბაჟო, ავტოტრანსპორტი და სხვა. თითოეულის გაანალიზებისას ყურადღება ეთმობა ისეთი ფაქტორების გამოვლენას, რომლებიც შესაძლოა ზემოქმედებდეს მულტიმოდალური გადაზიდვის ეფექტურობაზე (დრო, ხარჯი და ა.შ.). გამოსაკვლევია საქართველოში მულტიმოდალური გადაზიდვების სისტემის მდგომარეობა, მისი ბიზნეს-პროცესების და ბიზნეს-წესების ერთობლიობა. სისტემური მიდგომის (ანალიზის) და ოპერაციათა კვლევის მეთოდების საფუძველზე უნდა განხორციელდეს მრავალფუნქციური გადაზიდვების პროცესების ანალიზი, კლასიფიკაცია, სტრუქტურიზაცია და ოპტიმიზაცია. უნდა შემუშავდეს ამ სისტემის მართვის იმიტაციური მოდელი პეტრის ქსელების გრაფული მოდელის საფუძველზე და მოხდეს კომპიუტერული ექსპერიმენტების ჩატარების მეთოდიკის შემუშავება ოპტიმალური გადაწყვეტილებების მისაღებად. უნდა შემუშავდეს ერთიანი კონცეფცია მულტიმოდალური გადაზიდვების პროცესების სრულყოფის მიზნით მზარდამჭერი კომპიუტერული სისტემის ასაგებად და მის სარეალიზაციოდ ობიექტ-ორიენტირებული დაპროგრამებისა და მონაცემთა ერთიანი ბაზების საფუძველზე.

КОНЦЕПЦИЯ АВТОМАТИЗИРОВАННОГО УРПАВЛЕНИЯ БИЗНЕС-ПРОЦЕССАМИ МУЛЬТИМОДАЛЬНОЙ ТРАНСПОРТИРОВКИ

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Резюме

Рассматривается концепция автоматизированного управления мульти-модальными перевозками грузов, с такими объектами как порт, судно, аэропорт, самолет, железнодорожный- и автотранспорт, таможня и т.д. При анализе каждого вида транспорта особое внимание уделяется выявлению таких факторов, которые могут воздействовать на эффективность мультимодалных перевозок (время, расходы и т.д.). Следует исследовать состояние мультимодалных перевозок в Грузии, их бизнес-процессов и бизнес-правил. На основе системного подхода и исследования операций анализируется, классифицируется, структуризируется и оптимизируется процесс многофункциональной перевозки. Разрабатываются иммитационная модель этой системы с помощью графовой модели сетей Петри и методика проведения компьютерных экспериментов с целью выработки приемлемых решений. Разрабатывается единая концепция построения поддерживающей компьютерной системы для совершенствования процессов мультимодальной транспортировки грузов и их программной реализации на основе объектно- и сервис-ориентированного подходов и единой распределенной базы данных.