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Research Article

FLEXTRANS 4.0 – SMART LOGISTICS FOR SMART CITIES

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ABSTRACT

Today, the transportation sector, which has developed rapidly, has become an integral part of production and trade. In addition to optimizing the criteria such as time, quantity and cost necessary for delivering a product to the consumer, the highest benefit for the whole environment have to be considered to create optimized results. That is why new technologies, like used for Geographic Information Systems, are becoming increasingly important. To provide adequate results apart from knowledge on environmental issues, products, and transport elements, emerging technologies and innovative methodologies have to be considered. Especially, in fast changing dynamic environments like transportation, it is essential that applications are adaptable for different demands. The ability of the system to respond to various needs, adaptability and permanence are one of the most important features. In this paper, the implementation of new FLEXTRANS4.0 applications for logistics and smart cities within the European Union have been examined and the developed method discussed in detail. A model is drawn up on what kind of method should be used to implement the application, considering time and cost constraints. FLEXTRANS4.0 is available in logistics and transportation, and it is a piece of work ensuring permanent and flexible solutions.
Keywords: FLEXTRANS 4.0, Geographic Information Systems, Industry 4.0, NETSIM.

1. INTRODUCTION

The change in the underlying structures of businesses limits the availability of traditional planning methods today and leads to a search for new approaches. At this point, one of the most important facts is that not only the cost and permanence have become more important but also the formation of different objectives. Especially nowadays, where business functions are increasingly outsourced in supply chains in the production or service sector, these changing conditions lead to difficulties in planning and management. The concept of 'optimum' which is losing its meaning regarding business, is being transformed into an optimization on a supply chain basis [1], [2]. In such an optimization, the duration of use and life cycle of the supply chain is increasingly significant. The understanding of the system emerging in these applications, the determination of the elements affecting the system and the criteria that can improve the system is essential for the planning activity and affect the short, medium and long-term planning of the business [14], [15], [16]. The fact that there is not a single company in question in these applications means that a search for a systematic optimum outside the local optimums and return of the investment at the

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investment ph ase is also required to be taken into account. Many criteria affect planning, both internal and external [2], [4], [6].

2. CURRENT SITUATION AND PROBLEMS

According to the examination of the structural changes in today's businesses, it is clear that the use of a business structure, where all the necessary activities for the product or service are carried out, is decreasing (Figure 1). One of the most important elements in the reduction of this structure known as value chain is the increase of outsourcing of enterprises and therefore the realization of only desired activities within the company and the outsourcing of other activities. In addition to the benefits that such a structure can bring in terms of costs, the difficulties that arise in terms of planning and management are also evident [2], [3], [4], [5], [7].

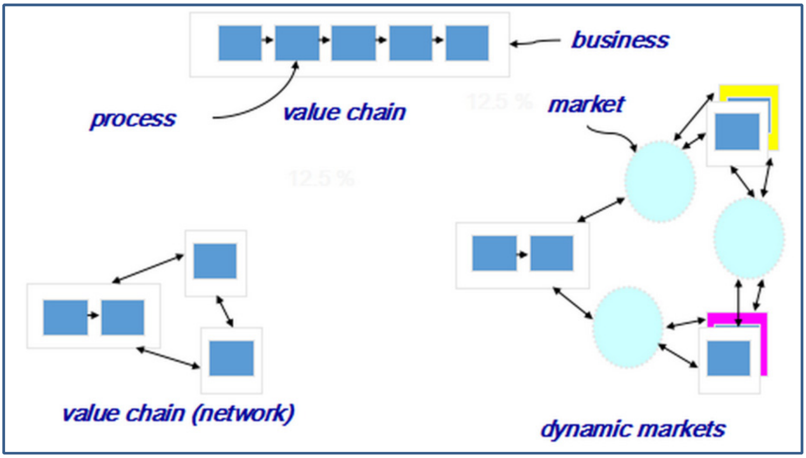

Figure 1. Value chain operation structure

Apart from the purpose of lowering the costs of outsourcing, it becomes necessary for companies to specialize to be able to become or remain competitive, and a supply chain structure with specialized companies is now seen as a business structure which should be realized by all enterprises as an alternative (Figure 2) [2], [4], [7].

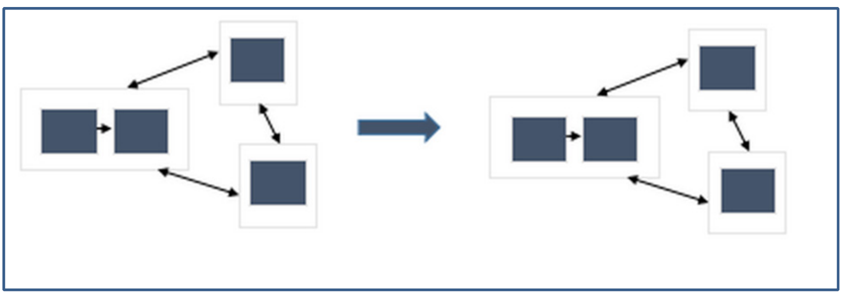

Figure 2. Value network operation structure

In addition to the fact that such a business structure will be cost-effective for enterprises, the difficulties that may arise in both planning and application areas are quite large, and companies might reach the limits of classical planning and management philosophy [2], [7]. Industry 4.0 presents the idea of increasing production and productivity by predominantly using big data analytics, the robots, internet of thing- the creation of smart factories -that every machine involved in the manufacturing process can communicate with each other by forming an extensive network [18]. Key technologies in that industrial revolution are mobile internet and internet of things, cloud computing, big data and advanced analytical techniques, robotics [19]. The automation and reuse components used in recent Industry 4.0 applications also prove the importance of real-time control. FLEXTRANS 4.0 was developed for addressing real-time control as well [17]. Flextrans (Flexible Transportation 4.0) is an application designed for planning, monitoring and if necessary supporting complex network structures. In this systems, automatic response procedures are realized, which support to fasten decision-making processes and improve reaction time. In respect of recent applications, fully automated systems in the field of transportation have become more important. Full automation is meant being driverless, as well as to determine how the system will be used or worked in different situations. The primary objectives are summarized as reduction or elimination of human errors as well as the cost, consideration of geographical factors and increased satisfaction factors. Operational safety enhancement devices, enabling automatic operation of the day to day transportation business, is called Unattended Train Operation (UTO). To achieve UTO three primary system have to be implemented (table 1), which is Automatic Train Protection (ATP), Automatic Train Operation (ATO), and Automatic Train Control (ATC). ATP manages the basic safety behavior, ATO enables a system to handle the essential driving functionalities, and ATC regards roots and signals operations. UTO can be graded into four grades of automation: Grade 1: ATP with a driver, grade 2: ATP and ATO with a driver, grade 3: driverless, and grade 4: UTO [20]. Other systems and technologies used are Radio Frequency Identification (RFID) and Global Positioning Systems (GPS) [10].

Table 1. Unattended Train Operation (UTO).

<table>
<tr><td colspan="3">Train Operation (TO) systems</td></tr>
<tr><td colspan="2">Automatic Train Protection (ATP)</td><td>manages the basic safety behavior</td></tr>
<tr><td colspan="2">Automatic Train Operation (ATO)</td><td>enables a system to handle the essential driving functionalities</td></tr>
<tr><td colspan="2">Automatic Train Control (ATC)</td><td>regards roots and signals operations</td></tr>
<tr><td colspan="3">Train Operation (TO) grades automation</td></tr>
<tr><td>Grade 1</td><td>ATP with a driver</td><td>setting train in motion by a driver, stopping a train by a driver, door closure by driver, and operation in the event of a disruption by a driver.</td></tr>
<tr><td>Grade 2</td><td>ATP and ATO with a driver</td><td>setting train in motion: automatic, stopping train: automatic, door closure by a driver, and operation in the event of disruption by a driver.</td></tr>
<tr><td>Grade 3</td><td>driverless</td><td>setting train in motion: automatic, stopping train: automatic, door closure by train attendant, and operation in the event of disruption by train attendant.</td></tr>
<tr><td>Grade 4</td><td>Unattended Train Operation</td><td>setting train in motion: automatic, stopping train: automatic, door closure: automatic, and operation in the event of disruption: automatic</td></tr>
</table>

In practice, only one area is covered (railed and non-railed terrestrial, underground, sea or air) and only transfer points are considered for their combination. According to the development in the world, it is found that most applications currently are start-stop lines, offering point to point (p2p) transportation; while systems for complex network structures are still under development. Several examples that can be given to Intelligent Transportation Systems (ITS): the driverless metro system in Copenhagen (Denmark), the driverless metro in Lille (France), the Jubilee Underground Line in London (England), the completely automated driverless metro system in Paris (France), the automated and driverless Vancouver SkyTrain (Canada), the driverless Nippori-Toneri train in Tokyo (Japan), the North-East-Line (NEL) in Singapore are transportation examples.

Due to the importance of transportation, it is certain that the workings in this area will be subject to a further increase and it turns out that what methods should be used and how to use them will change according to the demands. Especially cooperation will be critical, and the use of a sole method will be inadequate. However, given that the specialization will be won by companies in the long run, this structuring is no longer an alternative but a requirement. The greatest challenge at this point is that businesses that benefit from outsourcing within the value network may have different business objectives and criteria, and this difference will affect firms in the entire value chain [7], [8], [9].

While the fundamental foundation for an enterprise is the amount of production, the criterion for the other may be the best capacity utilization and the time factor for the other (the rules may vary by the sector in which the entity operates and by business objectives).

Target maximums of all enterprises within the value network may be below the possible peaks outside the network (without taking into consideration other factors). But from the perspective of long-term planning, it is the sustainability and the elimination of the outsourcing risk that arises [11], [12], [13].

3. AN APPROACH FOR TRANSPORTATION: FLEXTRANS 4.0

Transport practices are under the influence of many different criteria today. While the primary purpose envisaged in past applications was ensuring the shortest path, cost, quantity, and term; factors like persistence and benefit maximization are taken into account today. The most interesting criterion in this area is customer satisfaction. In an application to be carried out within a business, in addition to the concepts that can be easily measured such as cost or time, the introduction of the factors such as customer satisfaction makes it harder to implement. In this respect, the planning and management of a transport application in different stages and sections reveal the difficulty of desire for permanence, as well as the difficulty of being found positive both regarding businesses and customers [2], [4], [7].

FLEXTRANS 4.0, as a model, incorporates the continuity and optimization criteria as well as the methods currently applied to transport applications and suggests current approaches to achieve the result. The first of these predict that transport will be implemented in a multistage manner with an NETSIM (NETwork Simulation and Modeling) method rather than a single step [4], [7]. By this approach, the transport system should consist of subsystems and should bring benefits to the central system in each subsystem. While subsystems are connected to other systems using connections, subnetworks that give different values at this point are evaluated by various criteria. At the same time, the decision criteria at the connection points provide the necessary notifications during modeling and operation of the system and allow the system to make the necessary decisions [2], [4], [7]. The three alternatives used at the connection points are identified as "and", "or", "xor" and "nor", as shown in figure 3 below, thus the system itself gives control.

Connection types can be used both in the regional networks and in the interconnections, and they can control the operation of the system. Figure 4 shows the local and general use of connection points [2], [4], [7].

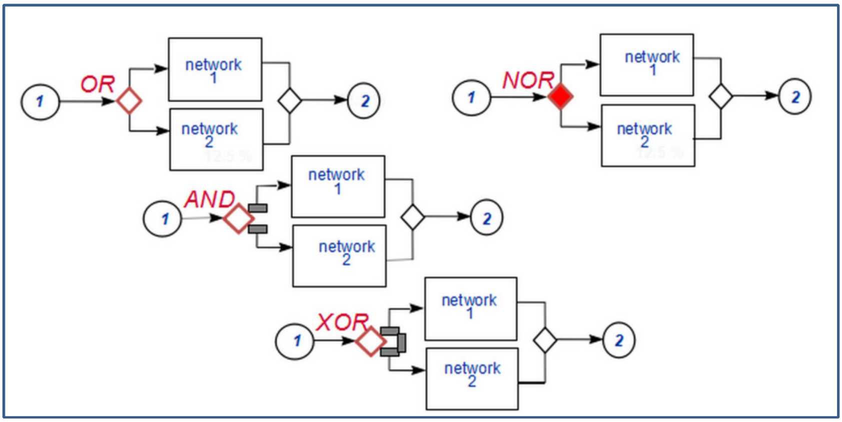

Figure 3. Connection types AND, OR, XOR and NOR

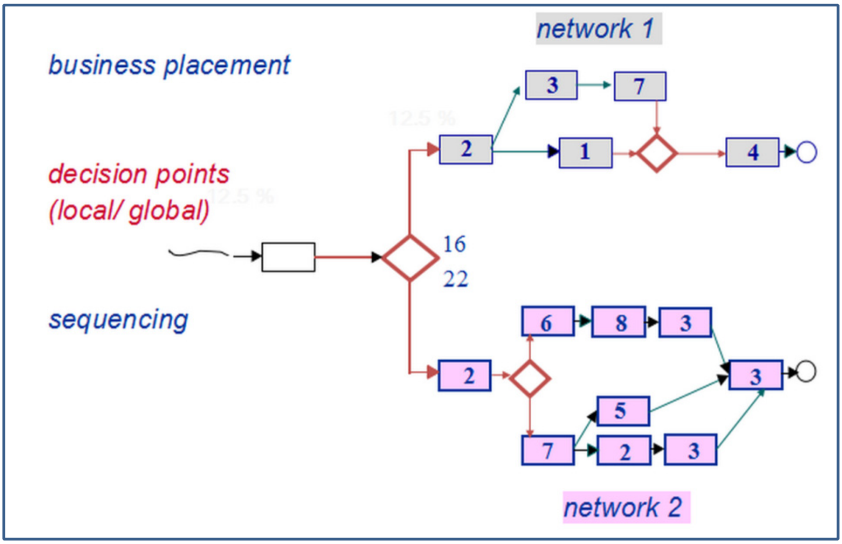

Figure 4. Local and Global Connection Points

The web-based software (Figure 5) developed for FLEXTRANS 4.0 and generated from NETSİM WEB software enables to control the network structures defined during application from different points and allows each unit on the system to monitor the network structure instead of one control point. In this way, it includes both central and local control possibilities [2], [4], [7].

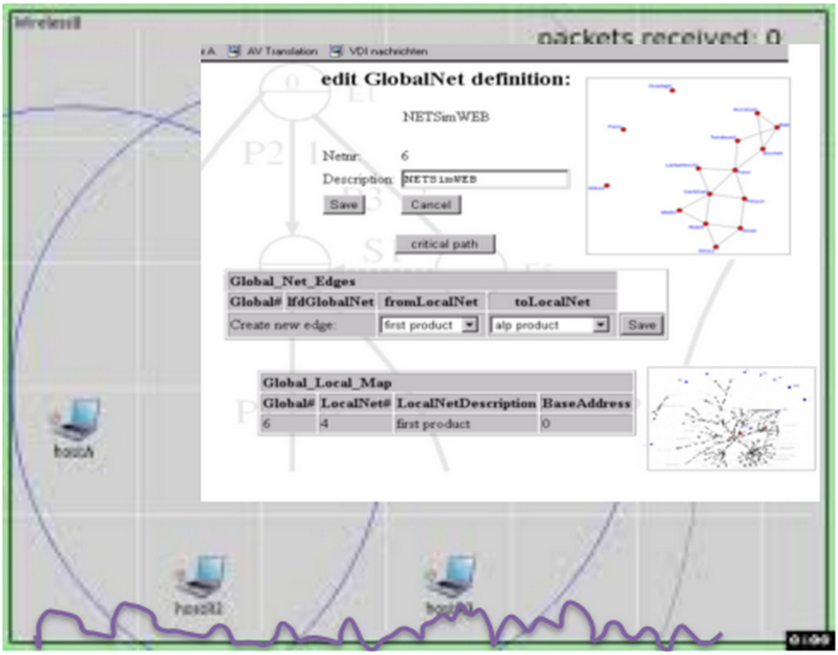

Figure 5. WEB Application

Since the developed software is web-based, it can be used in any browser and operating system, and it can support adaptation by usage purpose. Since the connection points are also at feedback scores (defined as HUB in the method), two different ways of use are available. They can be called distribution points and junction points (Figure 5). Also, various conditions can be defined in the HUB.

4. FLEXTRANS 4.0 STEPS

In addition to the primary criteria used in classical modeling and management methods, different assessments and weights can be applied to each regional network in this process. In this way, for example, urban transport and out-of-town transport and modeled and planned transport systems for hospitals, schools, residential, industrial areas can be evaluated differently. Especially at this stage, geographic information systems offer an advantage. For this purpose, GIS4EU provides the system with desired data and demographic criteria and can be used in FLEXTRANS 4.0 (Figures 6 and 7) [7], [10].

Figure 6. GIS4EU GIS Details

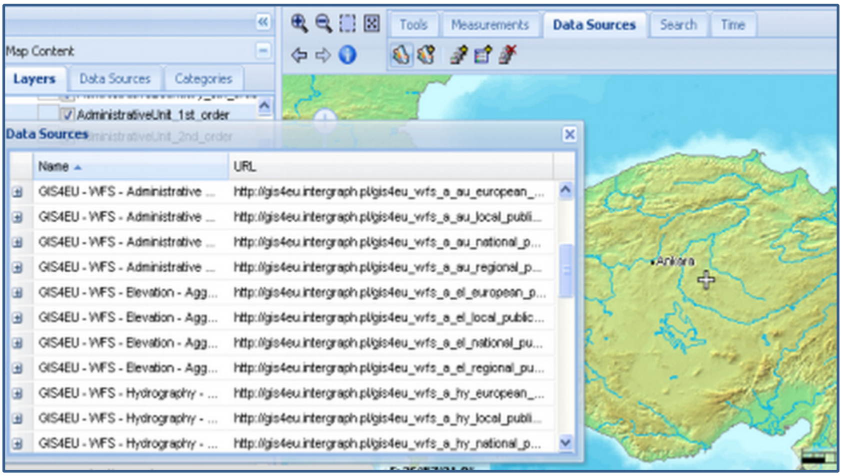

Figure 7. GIS4EU

The steps in this approach can be summarized as follows:

A. Main and side networks (taking transport targets and other criteria into account)

B. Determination of all network systems and connection points and required decision variables and conditions

C. Creation of general scheme plan and planning of optional network

D. Comparison of control values of local network plans

E. Local planning by considering local requirements, unit properties, and other capacities

F. Determination of other internal and external parameters that are influential on the network model

G. Establishment of the general network plan and the realization of local changes for improvement

H. Constant control of the generated general system program with GIS data and adaptation if necessary

At the same time, the application allows to view transport in real time, and it is possible to evaluate the results that will occur in the event of modification in parameters by any simulation program, as well as display only. Particularly in the case of unexpected situations, like an earthquake, how the system can work, and the ability to make real-time inspections of decisions are necessary.

5. CONCLUSIONS AND FURTHER STUDIES

FLEXTRANS 4.0 is a system developed to investigate the solution of current transportation problems, and it is a method that enables to react quickly in unexpected situations which can work in real time and aims to plan, use and manage different transportation units together. It will be able to use other European Union Project Products such as GIS4EU, which can be used during implementation, and will provide advantages in planning and implementation stages. In particular, thanks to the automatic feedbacks to be used on the application, it is possible for the system to be fully automated and the human factor to be used for control purposes only. Given examples are Paris, Singapore, Dubai, Copenhagen, and it is important to note that these applications are only used for simple networking, that they apply to two defined points, and that work continues for complex networking. FLEXTRANS 4.0, which is utilized in the European Union by similar applications within small models, will contribute to transport problems in cities.

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