Periodica Polytechnica
Transportation Engineering

45(1), pp. 8-11, 2017
DOI: 10.3311/PPtr.9222

RESEARCH ARTICLE

How to Choose and When to Start Best ITS Projects That Enhance Logistic Performance?

Ádám Török[1*], Gabriel Fedorko[2], Vieroslav Molnar[2], Nikoleta Husaková[2], Csaba Csiszár[1]

Received 22 March 2016; accepted 30 May 2016

Abstract

This paper is dealing with the evolvement of operational research in logistics related to ITS projects. Basically a static model has been introduced by the authors. The model is an extended assigned method. There are more and more quasi-real-time data existing on the changing properties of real world elements and processes due to the less and less cycle time of data collecting. On the other hand volume of the data mapping the real world in more details increased significantly. Therefore ITS projects in logistic has been examined. Later on the model has been partly dynamited.

Keywords

intelligent transport services, static model, quasi-dynamic model, dynamic model

[1] Department of Transport Technology and Economics,
Faculty of Transportation Engineering and Vehicle Engineering,
Budapest University of Technology and Economics,
Muegyetem rkp 3. 1111 Budapest, Building ST., Hungary

[2] TU Kosice, F BERG, Logistics Institute of Industry and Transport

Ádám Török, ResearcherID: E-6139-2012
Vieroslav Molnar, ResearcherID: J-4278-2012
Gabriel Fedorko, ResearcherID: B-7337-2011
Nikoleta Husakova, ResearcherID: J-4278-2012
Csaba Csiszár, ResearcherID: B-7086-2013

*Corresponding author, e-mail: atorok@kgazd.bme.hu

1 Introduction

Static is similar over time by definition. Dynamic is changing over time by definition. In this article authors have combined the simplicity of static assignment models with the time sensibility of dynamic models in logistics in order to find the optimal timing of ITS investments.

Logistics is the management of the flows of goods, semi-products, products and human resources between the point of origin and the point of destination or consumption in order to meet requirements (quality and quantity as well) of customers or corporations (Bokor, 2012). The resources managed in logistics can include physical items, such as food, materials, animals, equipment and liquids, as well as abstract items, such as time, information, particles, and energy (Tadić et al., 2015). Accordingly flows of physical items, information and values together form the operation of the system. These flows are mutually interrelated. The logistics of physical items, which is material handling, production, packaging, inventory, transportation, warehousing, and often security usually involves the integration of information flow. The complexity of logistics can be modelled, analysed, visualized, and optimized by dedicated simulation software. The minimization of the use of resources is a common motivation in logistics. The objective function of optimisation is always a question.

Logistics engineering is a field of engineering dedicated to the scientific organization and optimisation of the purchase, transport, storage, distribution, piping or conveying and warehousing of materials and finished goods (Fedorko et al., 2015; Fedorko and Molnar, 2014). Similarly the information supply of these processes is to be organized and optimized properly. Most times logistics is a cost minimisation or transport time minimisation problem. But logistics also provides value via improved efficiency and customer satisfaction that can be described with logistic services level or logistic service quality. The quality is a rather complex indicator, which is calculated by several variables. The real challenge in this field mapping (quantification) of qualitative/subjective factors. It can quickly lose that value if the customer becomes dissatisfied. The specific (personal) expectations/preferences may influence significantly the perceived quality. The end customer can include another process or work centre inside of the manufacturing facility, a warehouse where items are stocked or the final customer who will use the product (Markovits and Bokor, 2014).

Another much more popular derivative and a complete usage of the logistics term which has emerged in recent years is the supply chain. The supply chain also looks at an efficient chaining of the supply / purchase and distribution sides of an organization. The prerequisite of efficient organization and operation of supply chains is integrated information systems with advanced services. While logistics looks at single echelons with the immediate supply and distribution linked up, supply chain looks at multiple echelons/stages, right from procurement of the raw materials to the final distribution of finished goods or products to the customer. It is based on the basic premise that the supply and distribution activities being integrated with the manufacturing / logistics activities can result in better profitability for the organization. The local minimum of total cost of the manufacturing operation is getting replaced by the global minimum of total cost of the whole chain, resulting in better profitability for the chain members and hence lower costs for the products (Salling and Leleur, 2015).

2 Methodology

In engineering as a scientific field linearity due to its simplicity is very popular and linear programming whereas the object function is linear and static is very frequently used. Therefore linear programming is a well-known technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. Linear programming got his name as the feasible region in space is a convex closed polytope, which is defined by the intersections of finitely many half spaces, each of which is defined by a linear inequality as subject function called constraints. Its objective function is a real-valued affine (linear) function defined on this polyhedron. A linear programming algorithm finds a point in the polyhedron where this function has the smallest (or largest) value if such a point exists in the space.

A method of statically allocating organizational resources to a process called assignment method. The assignment method is used to determine what resources are assigned to which department, machine or organisational unit of operation in the production process to fulfil the objective function (can be profit maximisation or transport time minimisation or both -complex function). This method is used to allocate the proper amount of resources to a machine or task in the cost (money, time, human resource) is well-known. In this method time of assignment is not considered at all that is why these models are static. The time of assignment is not considered and has no influence of production.

Definition of dynamic programming: "*method for solving complex problems by breaking them down into simpler subproblems and values of earlier times can be used by working backwards, using a recursive relationship*". With dynamic models the complex models can be broken up to smaller and simpler models. By definition making dynamic model from static assignment problem has no effect on questions related to staring time. Therefore authors have built a quasi-dynamic model that uses time in the objective function. This model is more complex then static assignment models, while the cost function need to be known in every moment, but still simpler while discrete dynamic function of cost is enough and continuous dynamic function is not required..

3 Results

Firstly common assignment method has been described, the objective function (1) was defined with the usage of investment and operational costs:

$$\min\{Z\} = \sum_{i=1}^{n}(k_i \cdot x_i) + \sum_{i=1}^{n}(s_i \cdot x_i) \tag{1}$$

where:

Z: objective function [Ft] to be minimised

k_i: the investment expense of the project *i* [Ft]

i: the number of possible ITS projects in the set 1..i..n [-]

x_i: the number of particular ITS projects to be realized

s_i: the operational total costs of the project *i* in the investigation period [Ft]

Our aim is to minimise the objective function beside the satisfaction of the limiting conditions, in this case x_i can be only integer and can be greater then 1 – that would mean that parallel more similar projects can be financed:

$$x_i \geq 0 \quad (i = 1,2,...,n) \tag{2}$$

Further constrains or subject functions can be defined as:

$$a_i \cdot x_i = A_i \quad (j = 1,2,...,n) \tag{3}$$

where

a_i: coefficient, that is marking the efficiency of the project variant i (for example due to the ITS 5 min/year repair time decrease can be achieved).

A_j: the marginal values of the efficiency indicators, which we want to achieve with the realisation of the given investment program (for example: 1 working hour of repairtime decrease we would like to attain).

So far the model can choose the ITS projects in logistics based on their investment and operational costs in order to fulfil or not to reach the efficiency indicators. Time of investment is not considered and has no influence on decision.

The dynamic solution of such problem is relevant, for example in case of logistics where the unexpected closing (or missing information) of a road induce a change in transportation costs.

Management of unexpected situations in transportation requires advanced and in many cases automated interventions (Nagy and Csiszár, 2013). When such cost changes occur after an initial assignment has been made, a new problem occurs. This new situation different from the original problem. In our case the start of ITS projects in logistic can have dynamic effect on investment and maintenance costs. Further on authors only considered the dynamic change in maintenance cost. As information technology evolves and becomes obsolete quickly time has more significant role in ITS related projects than in other cases.

However, the dynamic version of the assigning algorithm can solve the new problem more efficiently by repairing the initial solution obtained before the cost changes. Although the dynamic model follows changes but cannot handle time as constrain (Csete and Török, 2009). Therefore authors have designed a quasi-dynamic model, that is built on the static model but can handle time as a constrain to have as the basis of optimisation. The project duration can be expressed in this model as changes in maintenance function.

Accordingly the objective function (1) was modified and time as to be optimised parameter were incorporated (4):

$$\min\{Z\} = \sum_{t=0}^{m}\left(\sum_{i=1}^{n}\left(k_{it}\cdot x_{it}\right)\right) + \sum_{t=0}^{m}\left(\sum_{i=1}^{n}\left(\frac{s_{it}}{(1+r)^{t}}\cdot x_{it}\right)\right) \tag{4}$$

where:

Z: objective function [Ft] to be minimised

k_{it}: the investment expense of the ITS project *i* in the year *t* [Ft]

i: the number of ITS projects 1..i..n [-]

t: the duration of the examination 1..t..m [year]

x_{it}: the number of ITS projects to be realized in the year *t* [pcs]

s_{it}: the operational costs of the project *i* in the year *t* [Ft/year]

r: the discount rate counted on the unit of the investment [%],

Our aim is to minimise the objective function beside the satisfaction of the limiting conditions (5):

$$x_{it} \geq 0 \quad (i = 1,2,...,n) \text{ and } (t = 1,2,...,m) \tag{5}$$

So the number of ITS projects realized in the year *t* is not negative.

$$\sum_{t=0}^{m} a_{it}\cdot x_{it} = A_i \quad (i = 1,2,...,n) \tag{6}$$

where

a_{it}: coefficient, that is marking the efficiency of the ITS project *i* in the year *t* (for example due to the ITS 5 min/year repair time decrease can be achieved in year t).

A_j: the marginal values of the efficiency indicators, which we want to achieve with the realisation of the given ITS investment (for example: 1 working hour of repair time decrease we would like to attain)

4 Conclusion

Authors have built up a model in order to ensure the optimal time of ITS investments in logistics.

Logistics management is a fact of business, as a most powerful tool for achieving ultimate strategic advantage. Today's business is constantly changing and evolving in response to change in technology, social and economic environments, and climate. Changes in business models drive a "new" logistics approach. That novelty could be described through several major characteristics:

- logistics role has moved from being tactical to being strategic;
- logistics complexity and dynamics are constantly growing;
- logistics completely focuses on value from customers' point of view.

Hence, new paradigms in business evolve new logistics and logistics management strategies. To understand and apply those new logistics thinking, appropriate way of dissemination of logistics knowledge to future and current employees should be created. Hence, the overall objective of this paper is to promote the innovation and implementation of quasi-dynamic assignment model.

Dynamics of market changes dictated by globalization, liberalization and constant technological development places the effectiveness of logistics in the centre of economic success and competitiveness of a country or region. Logistics effectiveness is based on the appropriate level of excellence regarding logistics infrastructure, applied practices and technologies, logistics culture and competence. Logistics competence implies understanding of new strategic role of logistics activities in contemporary strategies for logistics management. Understanding and application of the principle of contemporary logistics management requires creation of appropriate dissemination of new logistics knowledge with ITS solutions. Unlike in some other economic fields, in the field of logistics and logistics management there are great potentials which can be activated by minor investments. Activation of the mentioned potential requires the appropriate knowledge when to invest and what to finance.

Acknowledgement

Authors are grateful for the support of CEEPUS CIII-RS-1011-01-1516 Network, Fostering sustainable partnership between academia and industry in improving applicability of logistics thinking (FINALIST)

References

Bokor, Z. (2012) Cost calculation model for logistics service providers. *PROMET-Traffic&Transportation*. 24(6), pp. 515-524. https://doi.org/10.7307/ptt.v24i6.1198

Csete, M., Török, Á. (2010) Investment optimisation for the reduction of the emissions of settlements. *Periodica Polytechnica Social and Management Sciences*. 17(1), pp. 41-45. https://doi.org/10.3311/pp.so.2009-1.04

Fedorko, G., Molnar, V. (2014) The Simulation Model of Experimental Equipment for the Research of Pipe Conveyor Belts Using ABAQUS Software. *Applied Mechanics and Materials*. 611, pp. 183-187. https://doi.org/10.4028/www.scientific.net/AMM.611.183

Fedorko, G., Molnar, V., Dovica, M., Toth, T., Fabianova, J. (2015) Failure analysis of irreversible changes in the construction of the damaged rubber hoses. *Engineering Failure Analysis*. 58(1), pp. 31-43. https://doi.org/10.1016/j.engfailanal.2015.08.042

Markovits-Somogyi, R., Bokor, Z. (2014) Assessing the logistics efficiency of European countries by using the DEA-PC methodology. *Transport*. 29(2), pp. 137-145. https://doi.org/10.3846/16484142.2014.928787

Nagy, E., Csiszár, Cs. (2013) Research on automation of operative scheduling in urban public transportation. *Acta Technica Jaurinensis Series Transitus*. 6(3), pp. 94-109. URL: http://acta.sze.hu/index.php/acta/article/view/229/182

Salling, K. B., Leleur, S. (2015) Transport project evaluation: feasibility risk assessment and scenario forecasting. *Transport*. 1-12. https://doi.org/10.3846/16484142.2015.1063003 Article in press.

Tadić, S., Zečević, S., Krstić, M. (2015) City logistics–status and trends. *International journal for traffic and transport engineering*. 5(3), pp. 319-343. https://doi.org/10.7708/ijtte.2015.5(3).09