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CONTROLLING OF LOGISTICS PROJECTS

Abstract: A logistics project can be defined as a complex, special and unique sets of activities which can be described by technical and economic parameters and is determined by cost, time, and scope in order to aid logistics management in enterprise/supply chain. Controlling of the logistics project is process of measuring progress toward an objective, evaluating what remains to be done, and taking the necessary corrective tasks to achieve or exceed the objectives of the logistics project. This paper describes the idea of logistics projects. The controlling of logistics projects is discussed. In the paper tools dedecated for controlling of logistics projects are presented. The tools can be applied to the controlling process to support the management of logistics projects.

Keywords: controlling, supply chain, logistics project, uncertainty, fuzzy logic.

1. Introduction

Nowadays, companies have to achieve a high logistics performance combined with low costs and high quality. Companies are increasingly being forced into adapting their products to changing needs, promoting technological developments and fulfiling the high requirements placed on delivery lead time and reliability, quality and costs. Conventional, resource-oriented production planning and control is unable to meet these demands [1]. A well-managed logistics system can provide the organization with a sustainable competitive advantage because an effective logistics management helps increasing customer satisfaction while maintaining delivery quality and decreasing costs [2]. Only goal-oriented process planning can help in right logistics management.

Companies increasingly are becoming aware that their opportunity to having a competitive edge in business can come through supply chain [3, 4, 5]. In the case of companies operating on global scale, supply chain strategies drive operational efficiencies and affect the bottom line. Unlike technology or other core areas affecting

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business, supply chain is always in a dynamic mode. Project managers who head supply chain projects are often faced with lot of challenges and issues to over come all through the project. Supply chain projects involve technology implementation including infrastructure and software. They also involve multiple logistical modules involving transportation, international freight and warehousing etc. Projects involving a lesser extent one of the areas of logistics is called logistics projects. They are used to solve the problem in the area of logistics management, eg implementation of Just-in-time, the reorganization of the distribution network [6].

In order to right management of logistics project, controlling process is needed. The essence of controlling is to assist managers in the management of subordinate objects. This means in practice to assist in the management of functional areas, processes, projects. With regard to the support of project management is distinguished by projects controlling.

Controlling of logistics projects is a kind of logistics controlling. It can be defined as the type of logistics management subsystem that by coordinating the planning and control, based on right information, allows you to control the logistics project to achieve its objectives of projects in the area of logistics.

This paper describes the idea of logistics projects. The controlling of logistics projects is discussed. In the paper tools dedecated for controlling of logistics projects are presented. The tools can be applied to the controlling process to support the logistics projects management.

2. Logistics projects definition

The logistics project can be defined as a complex, special and unique sets of activities which can be described by technical and economic parameters and is determined by cost, time, and scope in order to aid logistics management in enterprise/supply chain [4, 6, 7]. Logistic projects are characterized by specific features (Figure 1).

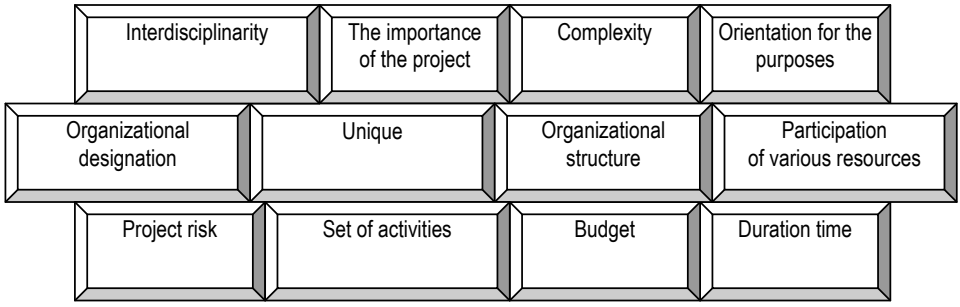


Fig. 1. *Characteristics of logistics project*

Logistic projects can vary in scale and scope. This means in fact that the logistics project can be implemented on a scale of one company. For example, the project may

involve construction of finished goods warehouse, or choose a new supplier of raw materials. Moreover, in practice we are dealing with logistics projects implemented in the supply chain – supply logistics project. A supply chain project encompasses all of these elements and spreads them across multiple independent entities, thus incrementing the complexities by orders of magnitude at each step along the way. For example, a logistics project involving supply chain for liquids or other non-discrete products may involve coordinating material and information flow among producer – distributor – retailer as the key players, with numerous warehouses, shippers, handlers and other players along the way.

The organization of the supply chain in two or more countries may be an example of the logistics project implemented internationally. Global logistics projects are carried out by global corporations, or agencies of states. An example might be construction of a factory by the car manufacturer and its need to create a global network of suppliers and subcontractors, and companies cooperating [6].

Main criteria of classification and types of logistics projects that result from the criteria are presented in Table 1.

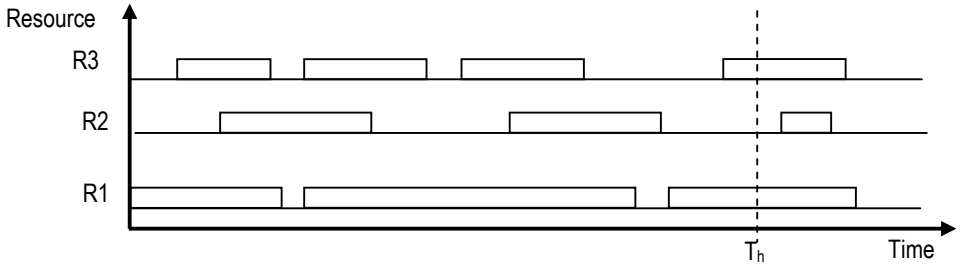
Table 1. *Criteria of classification and types of logistics projects [4, 6, 7]*

Criterion	**Typed of projects**	**Examples of logistics projects**
Types of actions and their results	training	training courses in it
	advisory and commercial	audit and rationalization of a logistics system
	investment (including infrastructure)	modernization of internal transport system
Time and significance of results of their realization	strategic	centralization of distribution network
	tactical	establishing standards of reserves management
	operational	optimization of transport route
Sources of financing	self-financing	purchasing informational system of the ERP class
	combine self-financing and form public sources	building a logistics centre according to PPP model
	financed from public sources	building a ring road
Budget	microprojects	training in business logistics
	high volume projects	building a logistics centre
Sources of funding	logistcis department	reorganization of the warehouse
	enterprise budget	Implementing software system
Role of logistics department	implemented within the logistics department	reduction in inventories
	coordinated by the logistics department	realization of customer orders

Table 1. *Criteria of classification and types of logistics projects – cont'd*

Criterion	Typed of projects	Examples of logistics projects
Organization of the project	Simple logistics project	One logistics project
	Complex logistics project	Set of sub-logistics project
Functional area of a project	locational	localization of an incineration plant
	transport	choosing a model of transport services
	storing	constructing a warehouse
	inventory management	choosing a model of reserves management
	improvement of quality of supply service	forming a strategy of customer service
	reverse logistics	establishing a system of managing reusable packaging
Number of participants	projects realized by a single enterprise	implementing kanban technique
	projects carried out directly between the supply chain links – supplier – customer	purchasing organization and supply of a specific material
	interorganizational projects – realized by a few cooperating organizations as a part of supply chain	implementing VMI concept between a supplier and a recipient
	global projects	construction of car plant and creating a global network of suppliers and subcontractors, and companies cooperating
Spatial range	local	optimization of municipal communication services system
	regional	building a regional distribution centre
	national	establishing an electronic forwarding market
	international	building a tunnel under La Manche Channel
Subject range	projects affecting organizations that participate in them	implementing JIT concept
	projects affecting sector, regional or macroeconomic environment	building a regional/international logistics centre

Realisation of logistics projects requires the simultaneous use of various resources, such as physical, financial, human. Implementation of the project is conditional on access to resources, which are usually limited in time (Figure 2). This follows from the fact that the planning horizon of the resource is involved in various processes and projects.



Legend:

R1, R2, R3 – resources
– resource used in process
T_h – end of planning time

Fig. 2. *An example of time contrained resources*

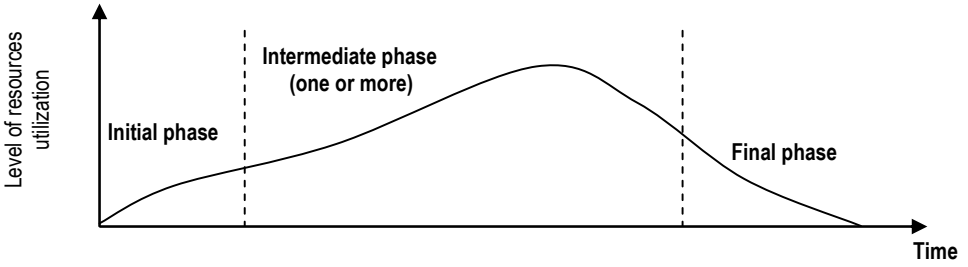


Fig. 3. *Model of project life cycle [8]*

Logistics projects are burdened with a certain degree of uncertainty. The limited availability of the necessary resources to realization the logistics project and changing environment makes the implementation of projects is subject to considerable risk. To reduce the risk of the logistics project and increase oversight of its conduct of the logistics project can be divided into phases. Each phase set from first phase to last phase is called the project life cycle. Phases can be distinguished on the basis of their effects. If the effect is a separate, possible to verify the product (e.g. detail design, prototype), then it can be one the stage. Division into phases helps to control the phase of the logistcs project, but the logistics project manager must look globally for the

whole project to control e.g. costs. The final inspection is performed after each stage, it is related to the approval of the effects of the previous phase and the decision to move to the next (or discontinue the project). In some cases, it is possible that the next phase will begin before the previous is finished (parallel work of logistics projects). Such a situation is acceptable when the risk of not completed phase is low. Figure 3 shows an example of the project life cycle. Many specialists in project management has tried to model the life cycle of concrete projects. In practice this means the division of the project life cycle with more or less phases [8].

The division of the logistics project into successive phases of the project is usefull in management of logistics projects (i.e., define specific activitys, resources, deadlines, costs, project team). Planning of logistics project is related to risks and uncertainties. One of the major characteristics of logistics projects is their high level of risk. High risk projects are subject to new and unique. Achieving success in logistics project management requires the ability to plan projects and proper implementation of logistics in scheduling specific activitys. The specification of projects, their uniqueness makes them that the risk is an integral part. The level of this uncertainty is different, depends on the type, scope, size of project logistics, the conduct and other factors.

The level of uncertainty is accordingly high in the first stage, i.e. the stage of planning the realization of an order of a project type [9]. The uncertainty on realization of a logistics project is reduced to zero in the final stage of realization. What also increases the risk of failure is the danger of not fulfilling all guidelines, expectations and goals of logistics project. Internal and external factors of a given a logistics project also play an important role. It is impossible to completely eliminate uncertainty. It may be reduced to minimum by taking certain actions, like implementing rules, methods and mechanisms of management [10].

In order to increase the chance of logistics project success, project managers are motivated to reduce risks by implementing right controlling of the logistics projects. The next section presents basic information about controlling of logistics project.

3. The idea of controlling

The essence of controlling is to assist managers in the management of subordinate objects. This means in practice to assist in the management of functional areas, processes, projects [11]. With regard to the support of project management is distinguished by controlling projects. Controlling is defined in the literature in many ways. Examples of definitions that can be found in the literature are as follows:

- supporting enterprise management system,
- result-oriented company control process, achieved through planning, monitoring and reporting,
- general method, tool, management tool supporting the traditional functions of governance as a system of controlling the whole set of rules to assist (primarily managers) towards the objectives set [12, 13, 14].

Controlling in the company supports the goals established in the Balanced Scorecard. It was originated by Robert Kaplan (Harvard Business School) and David Norton as a performance measurement framework that added strategic non-financial performance measures to traditional financial metrics to give managers and executives a more 'balanced' view of organizational performance. The Balanced Scorecard provides executives with a set of indicators needed to navigate the company in the direction of future economic success [15]. The Balanced Scorecard suggests that we view the company from four perspectives, and to develop metrics, collect data and analyze it relative to each of these perspectives (Figure 4).

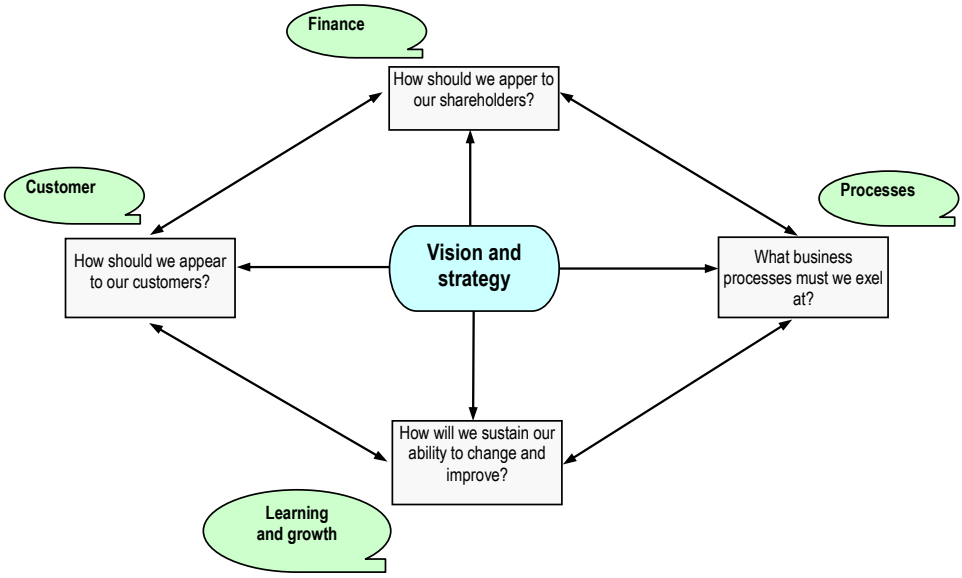


Fig. 4. *The idea of Balanced Scorecard [15]*

The relevant set of measures of the various perspectives is primarily to enable filling the information gap on the current state of the company. It is a kind of diagnostics business, which in turn allows the verification of implementation of the specific mission of the company strategy. Developed business model evaluation can be used for ongoing monitoring of business processes and control objectives with the effects of decisions taken. It is a kind of complex tool to integrate the environment in which the company operates and manages the company's resources [16]. Figure 5 presents an example of evaluation measures from the customer's perspective.

Customer perspective	
Objectives	Measures
Response time to customer enquiry (max 24 hours)	Date of response – Date of enquiry
Decrease the number of complaints (<7%)	Number of complaints/Number of work orders
Improved timeliness (<5%)	Number of overdue orders/Number of work orders

Fig. 5. *Objectives and measure of customer perspective*

3.1. Controlling of logistics project

Controlling of logistics projects, is a subsystem of enterprise controlling, selected next to controlling sales, finance, marketing, controlling production, etc. It can be described as a support system for management of logistics project, which by coordinating the planning, control, collection and processing of information, ensures the effective achievement of the objectives of the project logistics during logistics project life cycle. Figure 6 presents the components of enterprise controlling [13].

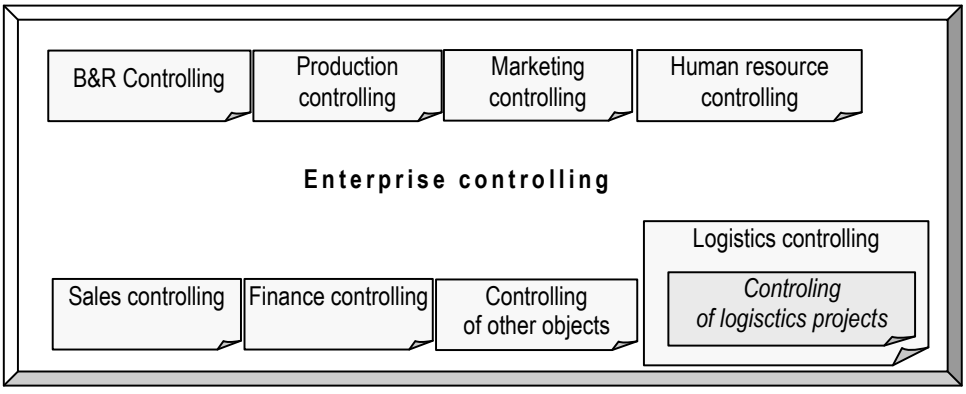


Fig. 6. *Components of enterprise controlling*

The role of the logistics projects controlling is due to logistical support for the logistics project management. Controlling of logistics projects may have a different scope. In defining the scope, coverage and criteria for logistics project management is defined the areas of controlling operations of the given logistics project.

The main activity of logistics projects controlling is to support logistics project in planning and control of actual values and a comparison with the logistics projected values (Figure 7). The proper functioning of logistics projects controlling in the enterprise requires access to a wealth of information and data. Data can be both precise nature of the data and imprecise.

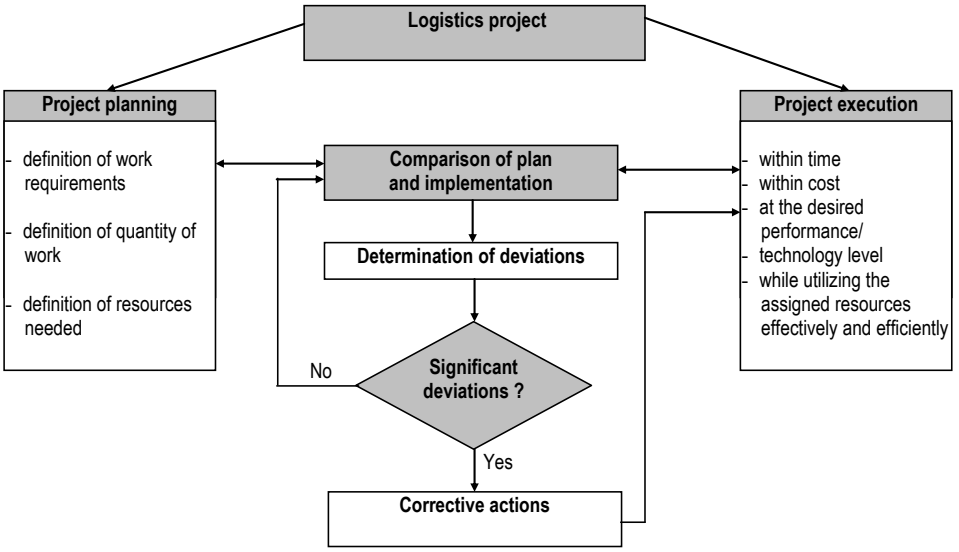


Fig. 7. *Idea of controlling of logistics projects*

For example, the logistics project, whose goal is to choose a new supplier of the material requires access to necessary information, including: the size of the transport capacity, time delivery, quality, delivery time, etc. The number and type of the analyzed information and data depends on the type , the scope, size of project logistics. Data analysis is one of the key factors of logistics projects controlling.

3.2. Tools of controlling of logistics projects

In this sub-section, we present controlling tools of logistics projects that we can be used in the life cycle of the logistics project.

In the first phase of the logistics project life cycle it can be used network techniques. When the activity duration of logistics project is deterministic and known, Critical Path Method can be useful tool [17]. In deterministics logistics projects networks techniques like CPM, all of network parameters (definition of activities, sequence of activities and duration of activities) are defined deterministically. In stochastic network techniques Program Evaluation and Review Technique PERT duration of activities are stochastic variable [18].

Let us suppose that the duration times of the logistics project are not deterministics. The duration times have stochastics character. Table 2 presents specification of an example of logistics project. Let us consider a logistics projects of warehouse construction. In order to estimate the total time of logistics project realization we use the PERT method. The estimation time of the given logistics project with PERT method is presented in table 3. The total duration time of the logistics project is over 57 weeks. The analysis of the crititical and non-critical works depicts that there are two critical

path in the logistics project. The delays of the work on the critical path lead to extend the schedule of the given project.

Table 2. *Input data of a given logistics project*

Activity	Immediate predecessor	Duration time [week]		
		Optimistic time	Most likely time	Pessimistic time
A	–	11	12	13
B	A	2	2	3
C	A	8	10	11
D	A	4	5	6
E	C	2	2	3
F	B	8	10	13
G	E	1	1	2
H	E	4	5	6
I	D,F	2	2	2
J	G,H	5	6	7
K	G,H	5	6	8
L	J	6	7	9
M	D,J	3	3	4
N	K	4	5	6
O	M	2	2	3
P	D,M	3	4	5
Q	J,K,P	13	15	17
R	J,K,P	10	12	13
S	F,P	7	8	9
T	F,P	7	8	9
U	M,P	1	1	2
V	I	1	1	1
W	K,U,V	5	6	8
X	K	2	3	4
Y	S,T,W	1	1	1

Methods of network planning known so far, Critical Path Method and Program Evaluation and Review Technique method were modified. The CPM and PERT models have been extended to fuzzy time parameters [19]. The deterministic duration times were replaced by fuzzy duration times. New methods were created – fuzzy CPM FCPM, fuzzy PERT FPERT. These methods are based on the previous ones but time characteristics were replaced with triangular fuzzy numbers. Fuzzy set theory has been applied to network-based planning techniques by some scholars such as Chanas and Kamburowski [20], Kuchta [21], Pisz [7] and others. In the network techniques with fuzzy time (Fuzzy Critical Path Method FCPM, Fuzzy Program Evaluation and Review Technique FPERT), the only fuzzy parameter is the activity time,

total duration time, but others parameters like costs of activities, cost of project are certain.

Table 3. *The time estimation of a given logistics project with PERT method*

Activity name	On Critical Path	Activity Mean Time	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack (LS−ES)	Activity Time Distribution	Standard Deviation
A	Yes	12	0	12	0	12	0	3-Time estimate	0,3333
B	no	2,1667	12	14,1667	34,6667	36,8333	22,6667	3-Time estimate	0,1667
C	Yes	9,8333	12	21,8333	12	21,8333	0	3-Time estimate	0,5
D	no	5	12	17	30	35	18	3-Time estimate	0,3333
E	Yes	2,1667	21,8333	24	21,8333	24	0	3-Time estimate	0,1667
F	no	10,1667	14,1667	24,3333	36,8333	47	22,6667	3-Time estimate	0,8333
G	no	1,1667	24	25,1667	27,8333	29	3,8333	3-Time estimate	0,1667
H	Yes	5	24	29	24	29	0	3-Time estimate	0,3333
I	no	2	24,3333	26,3333	47	49	22,6667	3-Time estimate	0
J	Yes	6	29	35	29	35	0	3-Time estimate	0,3333
K	no	6,1667	29	35,1667	36	42,1667	7	3-Time estimate	0,5
L	no	7,1667	35	42,1667	50	57,1667	15	3-Time estimate	0,5
M	Yes	3,1667	35	38,1667	35	38,1667	0	3-Time estimate	0,1667
N	no	5	35,1667	40,1667	52,1667	57,1667	17	3-Time estimate	0,3333
O	no	2,1667	38,1667	40,3333	55	57,1667	16,8333	3-Time estimate	0,1667
P	Yes	4	38,1667	42,1667	38,1667	42,1667	0	3-Time estimate	0,3333
Q	Yes	15	42,1667	57,1667	42,1667	57,1667	0	3-Time estimate	0,6667
R	no	11,8333	42,1667	54	45,3333	57,1667	3,1667	3-Time estimate	0,5
S	no	8	42,1667	50,1667	48,1667	56,1667	6	3-Time estimate	0,3333
T	no	8	42,1667	50,1667	48,1667	56,1667	6	3-Time estimate	0,3333
U	no	1,1667	42,1667	43,3333	48,8333	50	6,6667	3-Time estimate	0,1667
V	no	1	26,3333	27,3333	49	50	22,6667	3-Time estimate	0
W	no	6,1667	43,3333	49,5	50	56,1667	6,6667	3-Time estimate	0,5
X	no	3	35,1667	38,1667	54,1667	57,1667	19	3-Time estimate	0,3333
Y	no	1	50,1667	51,1667	56,1667	57,1667	6	3-Time estimate	0

Project Completion Time = 57,17 weeks
Number of Critical Path(s) = 2

The main work of logistics project controller in the implementation phase of the logistics project is controlling the project realisation. For controlling the work progress of individual work packages of logistics project or whole logistics project it can be used Gantt chart. A Gantt chart is a type of bar chart that illustrates a logistics project schedule. This kind of chart illustrates the start and finish dates of the works of logistics project. A Gantt chart also show the dependency (i.e., precedence network) relationships between activities. The controllling tool can be used to show current schedule status.

Figure 8 presents an example of logistics project. The Gantt chart consists of blue and red bars. A blue bar for each activity indicates the non-critical activities. A red bar for each activity indicates the critical works. Analysis of the Gantt chart indicates that some activities are late due to planned deadline. For example, the first activity was started afer time – one day later than planned time. The second and the third activity was started after time. The delay in this case is equal 2 days. The delays of activities have impact on the given logistics project deadline. The considered logistics

projects seems to be behind schedule. This infeasible situation should be explained by the logistics project controller. The corrective actions should be done.

Another kind of controlling tool dedicated to controll logistics project is Earned Value Analysis EVA. This kind of controlling tool helps to control cost and schedule especially in larger logistics projects. Earned Value Analysis is a method of performance measurement. Earned Value is a program management technique that uses "work in progress" of the logistics project to indicate what will happen to work in the future. The controller of logistics project can create risk mitigation plans based on actual cost, schedule and technical progress of the work. It is an "early warning" controlling tool that enables logistics project controller/manager to identify and control problems before they become insurmountable. It allows projects to be managed better – on time, on budget.

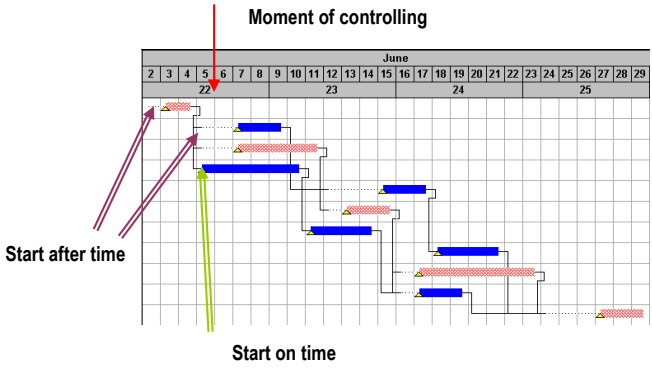


Fig. 8. *Gantt chart as a controlling tool in implementation phase of logistics project life cycle*

Use of Earned Value Analysis requires the designation of two values, i.e. Cost Performance Index and Schedule Performance Index. The Cost Performance Index (CPI) and Schedule Performance Index (SPI) is calculated with the following formulas:

$$CPI = \frac{EV}{AC} \tag{1}$$

where:

EV – earned value,
AC – actual cost.

$$SPI = \frac{EV}{PV} \tag{2}$$

where:

EV – earned value,
PV – planned value.

Figure 9 presents an example of EVA analysis in a given logistics project. We obtain $CPI = 0,4$ and $SPI = 0,67$. It means that the logistics project is over budget and behind schedule. The corrective actions should be proposed by the controller of the logistics project.

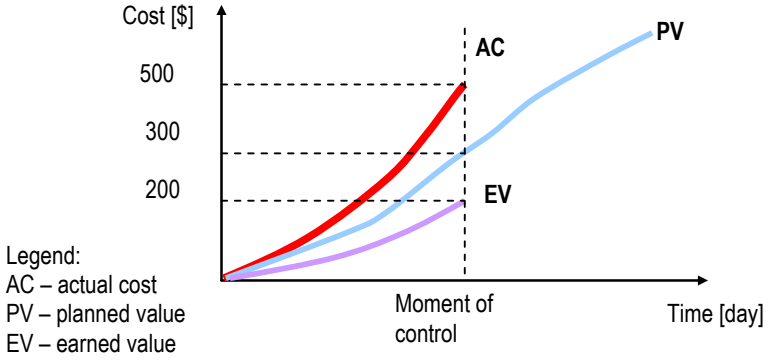


Fig. 9. *Earned Value Analysis in logistics project*

3.3. Fuzzy Decision Making System as a new controlling tool

A logistics project is unique and limited over time. Logistics project has a unique content and unique scope. Each logistics project differs from others regarding its goals, activities, resources and deliverables. Different project definitions might warrant different success criteria. Each logistics project manager/controller has to develop range of controlling measure. He/she has to monitor the performance of undertaken project by using a large quantity of information. In order to support and improve managerial decision-making the decision support systems can be used in the final phase of logistics project life cycle.

Proposed Fuzzy Decision Making System consists of following elements: fuzzification, fuzzy database rules, fuzzy decision making, and defuzzification (Figure 10). Fuzzy set theory is a branch of modern mathematics used to model the vagueness intrinsic to human cognitive processes. Since then, it has been used to tackle ill-defined and complex problems due to incomplete and imprecise information that characterizes the real-world systems. It is, therefore, suitable for uncertain or approximate reasoning that involves human intuitive thinking [22].

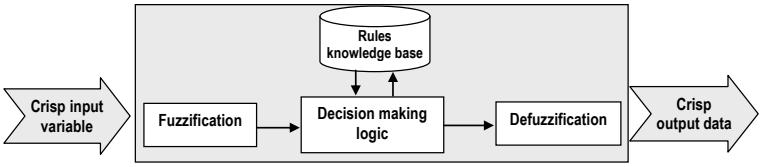


Fig. 10. *The structure of fuzzy decision making system*

Fuzzification stage: At this stage the measured value of the input variable is converted in to the fuzzy set of variables. This operation is called fuzzification. The fuzzification is done by giving values to each of a set of a membership function. The value for each fuzzy number is determined by the variable and the shape of membership function. The triangular membership function is the simplest one and gives good results. An example of the triangular membership function of fuzzy number – delivery time is presented on Figure 11.

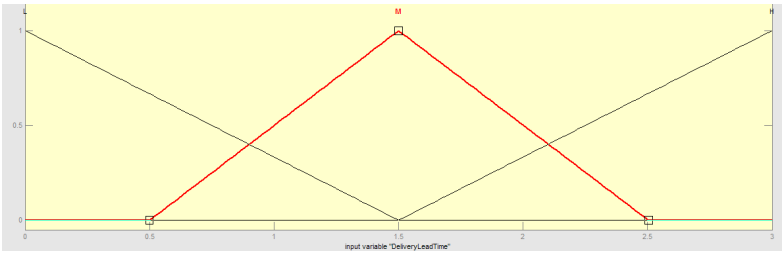


Fig. 11. *Membership function of positive triangular fuzzy number*

Fuzzy database rules: The fuzzy database rules consist a set of fuzzy rules of the following form "**If-Then-**". Variables may adopt both values estimated in words, e.g. "small", "medium", "high", and numerical values. Single rule in the base of rules may have the following form:

IF Quality is High **AND** Cost is Low **THEN** Success of the Logistics Project is Medium

Rules are created by experts (project manager/controller or others experts) on the basis of knowledge possessed by them and experience acquired in the given field.

Fuzzy decision stage: The decision making is similar to simulating human decision making in inferring fuzzy control actions based on the fuzzy rules of inference in fuzzy logic. At this stage the knowledge base and implemented methods are used to solve the given problem. An example of inference mechanism based on the rule with two inputs and one output so called Min Inferencing, is presented in Figure 12. The entire strength of the rule is considered as the minimum membership value of the input variables' membership values. In case of larger number of rules in the knowledge base, obtained membership functions for all rules are aggregated, in order to achieve final function of membership.

Fig. 12. *Implementation of fuzzy rule set*

Defuzzification stage: At this stage the fuzzy variables generated by the fuzzy logic rules are turned into a non-fuzzy value. The fuzzy logic process which does this

is called defuzzifacation because it combines the fuzzy inputs to give a corresponding real (non-fuzzy or crisp) output which can be used to perform some action. The defuzzifier combines the information in the fuzzy inputs to obtain a single crisp (non-fuzzy) output variable. Among many methods of defuzzification, the most common one is the Centre of Gravity Method (COG).

As an example of using the Fuzzy Decision Making System in Matlab system consider the same logistics project as previous one. During a summary of the logistics project it became clear the deadline was exceeded by 17%, the actual costs amounted to 103% of the planned budget, the quality of the measured technical parameters of the project has reached 90% level expected and the level of customer satisfaction – the investor, was at the level 85%. The final evaluation of the project take into account the importance of individual criteria. In this axample it is supposed that the controlling criteria have the same weight. The result of the final evaluation of the logistics project in the Fuzzy Decision Making System is a single value equal 0,632 (Figure 13). Evaluation of the project is relatively low.

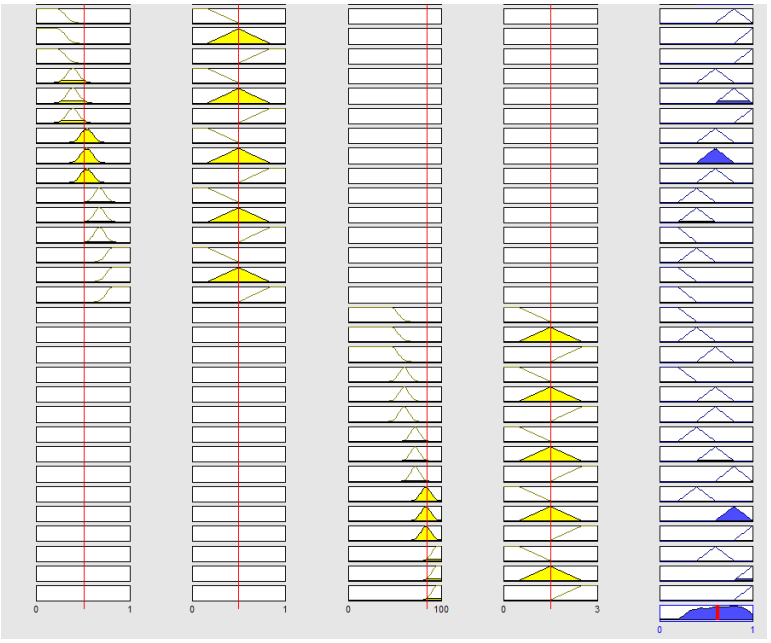


Fig. 13. *Implementation of a part of fuzzy rule set in Matlab system*

4. Conclusions

A logistics project will not be successful unless all, or at least most of the participants are not only competent but also motivated to produce a satisfactory outcome. To achieve this, a number of methods, procedures and techniques have been developed,

which together with the general management and people skills, enable the project manager to meet the set criteria of time cost and performance/quality in the most effective way. In order to right management of logistics project controlling process is needed.

The controlling of logistics project is a subsystem of the management from functional point of view which coordinates the planning, impementation the supervision and the information supply of the logistics project. The base of this type of controlling is the measurement of the output embracing the logistics project. Controlling of the logistics project is process of measuring progress toward an objective, evaluating what remains to be done, and taking the necessary corrective tasks to achieve or exceed the objectives of the logistics project.

In the paper was presented the idea of controlling of the logistics project. The best practice of the controlling during the logistics project life cycle was discribed. A new tool for controlling of logistics project was demostrated. The Fuzzy Decision Making System was done in Matlab system. The proposed computer system dedicated for controlling can be usefull tool. The managers/controller of logistics project can be aided in the controlling process. The output of the system in important information concerns the considered logistics project.

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