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CZECHOSLOVAK ACTIVITY TO PREPARE EUROPEAN NORMS FOR CONTAINERS BEFORE THE SECOND WORLD WAR

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Keywords: Czechoslovakia, containers, norm, Second World War, Europe
Abstract: In many articles we can read that containers weren't in Europe before 1966, when ship SS Fariland came with 35 feet containers invented by Keith Tantlinger for Sea Land Company owned by Malcom McLean. The focus of this study is on the problem with development norms for European containers. Thus, the main definitions and briefly literature overview in the analysed research area are given. Later, the information about these constructions are developed. Article presents Czechoslovak activity to preparation of three European norms for containers, which were described before Second World War.

1 Introduction

Regular connection of luxury passenger train London-Paris, Golden Arrow/Fleche d'Or begun in 1926. For conveyance baggage of passengers was use four containers. These containers was loaded in London or Paris and carried to ports, Dover or Calais, on flat cars in UK and "CIWL Pullman Golden Arrow Fourgon of CIWL" in France [2].

In begging of 30's years railway had feel more and more competition from road transport. First big speaking was under First World Motor Transport Congress in London November 14-17, 1927.

Six main headings for discussion have been agreed. These are as follow [17]:
1. Road construction and improvement in relation to the development, efficiency and economy of road transport.
2. Mechanical road transport as an instrument of development of world resources.
3. The necessity of co-operation between road and rail transport.
4. The development of motor vehicles suitable for service on had roads and for cross-country use.
5. The improvement of facilities for international travel by road.
6. Fuels and fuel supplies for road motor vehicles [17] [10].

On the Second World Motor Transport Congress in Roma September 25-29 1928, There Italian senator Silvio Crespi proposed to create an international organ as the lines of the Sleeping Car Company to advantages of container and railroad systems to use as collaboration not as a competition [16] .

After Second World Motor Transport Congress in Roma September 25-29 1928, the then president of the International Chamber of Commerce, Alberto Pirelli, invited the following organizations to form an international committee to conduct a competition with the object of finding the best container system [12]: Advisory and Technical Committee on Communications and Transit of the League of Nations; Bureau International de Normalisation de l'Automobile; Central Council of International Tourists' Associations; International Federation of Commercial Motor Transport; International Association of Recognized Automobile Clubs; International Permanent Bureau of Motor Manufacturers; International Union of Railways [17].

Early 1929r experts of International Chamber of Commerce prepare conditions for two kinds of containers to European railroads [5]:
• With total mass 2,5 tons, with dimensions: length 2,25m, width 2,10m, high 2,10m,
• With total mass 4 tons, with dimensions: length 4,2m, width 2,10m, high 2,10m.

Very important influence for development of container transport was big economy crash in 1929. This day called Black Thursday, October 24, 1929 In many sources is known as a Stock Market Crash of 1929.

That begins a Big Depression in world economy.

The committee of competition was formed with S. E. Silvio Crespi as its chairman, and on January 24. 1930 drew up the conditions of the competition [17].

This situation was one of important theme in Rail Congress of UIC in Madrid 5-15 May 1930 [10], one of part of discussion was an exploitation of containers.

2 Conditions of Competition Established On January 24, 1930

A competition is opened for the best system of containers for use in international traffic. This competition is organized by the following [12]: International Chamber of Commerce; Advisory and Technical Committee on Communications and Transit of the League of Nations; International Railway Union; Bureau Permanent International des Constructeurs d'Automobiles; International Association of Recognized Automobile Clubs; Conseil Central du Tourisme International; Federation Internationale des Transports Commerciaux Automobiles; Bureau International de Normalisation de 1'Automobile.

The problem is to find the most practical method of through transport of goods by sea, rail, and highway, with a view to suppressing as far as possible costs of packing, storage, and sorting and to enable goods to be carried from the place of production to the place of consumption in the most rapid and economical manner.

The conditions with which containers must comply and the terms of the competition are set forth below: the following are permitted to compete: Firms manufacturing railway or motor equipment, Transportation undertakings, Organizations of these industries, Technical schools and higher institutes of commercial training, Public institutions dealing with goods traffic and transportation matters.

The competition will take place at the headquarters of the International Chamber of Commerce in Paris, and will be governed by French law. All communications should be addressed to the International Committee for the Container Competition, International Chamber of Commerce, 38 Cours Albertler, Paris [12].

The containers are to be of two models; open and closed. For each model, competitors must submit three containers of different sizes. The outside dimensions of these three containers are to be as follows Table.1. [9]:

Table 1. Parameters for European containers for competition in September 1931 [9]

	First class	Second class	Third class
	Meters		
Length	3.95	At option of the competitor on condition however that, as far as possible, these be submultiples of class 1.	
Width	2.15		
Height	2.20 for closed containers. 1.10 for open containers.		

1. All these containers to be so designed as to be able to carry 5 tons less their own weight. Competitors will endeavour to reduce the weight of their containers as far as possible, while specifying for their construction materials capable of with- standing the strain involved by the corresponding weight of contents. All containers must be capable of being carried on motor lorries, railway trucks, of normal gage or narrow gage, and on board ships.
2. Open containers are intended to carry raw materials and semimanufacturned goods, that do not call for complete protection against weather conditions; on the contrary, the closed containers must be so constructed as to protect the goods carried against direct or indirect damage caused by weather, and in particular by damage that may be caused by interior condensation or by dampness of the floors of railway trucks or motor lorries. However, they must provide adequate means of ventilation. Competitors must describe in detail the devices used for the opening and closing of containers and these devices must be such as to enable the container to be quickly opened or closed for loading and unloading. Should doors hung on vertical hinges be used, the bottom of these doors must be at least 50 centimetres from the bottom of the container, so as to allow the doors to swing over the sides of railway trucks and motor lorries. However, the whole lower part of the same side of the container must be capable of being lowered entirely (ISO degrees). The containers, both open and closed, must be so designed as to fit one on top of the other or one side by side the other. The interior of the containers must present no projections, but countersunk rings or other devices must be provided to enable goods to be attached at suitable heights inside the containers.
3. The containers must be very strongly built, as they will be subject to many shocks and various causes of injury, in particular the risk of shocks from the tackle of cranes, and also lateral strain when lifted loaded. Competitors must also take in o account that, especially on board ship, these containers will be piled one on top of the other (at least three of the first class), without losing sight of the fact that the weight of the containers must be as low as possible.
4. The designs presented by competitors must be for rigid containers. Competitors will also have the right to present separate designs for folding containers, presenting the possibility of shipping empties by knocking-down the containers in sections or in parts. In the latter case, competitors must present means of keeping the component parts of the containers together to prevent loss.
5. In designing their containers, competitors must conform to the customs regulations applying to railway trucks (see chapter 2 of the final protocol of the International Conference of Berne, of May 18, 1907).
6. Containers must be provided with the necessary devices to permit their handling and their raising by means of cranes, tackle, lifting trucks, etc. They must also be provided with the necessary devices to permit their removal by sliding (ramp, inclined plane,). In any case, it is advisable to avoid as far as possible the use of any detachable apparatus for the handling of containers by sliding, roiling, etc.

Competitors must indicate in detail what operations are necessary for loading the container from the ground on to the railway truck or motor lorry, its unloading, and its passage from railway truck to motor lorry and vice versa.
7. Competitors must indicate the methods of fastening containers to the railway trucks or motor lorries. If for such fastening the container includes special apparatus, the inventor must also submit drawings of such apparatus and indicate how it is to be used. In any case, the devices for fixing the containers must be such as not to injure the railway truck or motor lorry, and to be easily and quickly adaptable to existing trucks and lorries.
8. For each type of container designed, the competitors must indicate the class of material to be used in its manufacture, and indicate the weight contemplated, the

approximate cost of manufacture of the container, of detachable apparatus and devices that maybe suggested to facilitate loading and unloading. Prices must be stated in dollars.
9. In order to decide on the relative value of the plans submitted, the jury will take into account:
(a) The lightest weight;
(b) The lowest cost of manufacture, taking into account royalties to be paid;
(c) The lowest maintenance charges and greatest length of life;
(d) The easiest, most rapid, and cheapest handling feature of the container;
(e) The least trouble in fixing the container to railway trucks or motor lorries;
(f) The best method of closing.
10. The competition will be in two parts. For the first part, competitors must present their plans to the International Chamber of Commerce before September 10, 1930, accompanied by:
(a) General plans of the container on a scale of not less than 1 to 10;
(b) Detailed plans of the principal features and of the devices for attaching the container to the railway truck or motor lorry on a scale not less than 1 to 5;
(c) Calculation of the parts and devices subjected to heavy stress, especially lifting devices;
(d) If necessary, a reference to patents covering the devices submitted in whole or in part, as well as an indication of royalties demanded for the use of each such patent.

The plans and documents submitted therewith must be in French. The jury will then proceed to a selection. The best plan will be retained for the second part of the competition. For the second part of the competition, competitors must undertake the construction of their models that will be submitted to the tests considered necessary by the jury. The jury may call upon several competitors to agree to present a single model, uniting the various features selected as best from their plans. In case of the refusal of the competitors to conform to the instructions of the jury provided in the two above paragraphs, the jury may have the model built and deduct the cost thereof from the prizes to be distributed to no consenting competitors.
11. The jury will be entirely free to award, within the limits of the credits placed at its disposal for this purpose, such prizes as it may consider justified by the importance of the new inventions submitted to it. The above credit is a maximum which the jury is not obliged to award in full if it thinks fit.
12. The prize-winning models will be exhibited. They may be accompanied by a text in the competitor's native tongue [9].

The jury nominated by the committee was constituted as follows [12]: League of Nations.—General de Candolle; International Chamber of Commerce.—Jacques Lacour-Gayet, A. Maynard, Paul Silverberg,; Dr. Zietzschmann; International Union of Railways.—G. Del Guerra, F. Duchatel, H. W. Philips; International Association of Recognized Automobile Clubs.—Colonel Peron; International Permanent Bureau of Motor Manufacturers.—Dr. Scholz; Bureau International de Normalisation de Automobile.—Maurice Berger; International Federation of Commercial Motor Transport.—A. Kundig; Secretaries—G- Del Guerra, G. Drugeon, Paul Wohl.

The competition was intended not only for transport undertakings and builders of transport material, but also for forwarding agents' organizations, i.e., all those interested in traffic questions.

On September 10, 1930, drawings of competitors from the following countries were submitted: Czechoslovakia, France, Germany, Great Britain, Italy, Rumania, Spain, and Switzerland.

The jury retained the 14 following drawings for the first stage of the competition:

- Butterley Iron Works Derby (England).
- Christoph & Unmack Aktiengesellschaft, Niesky
- (Germany).
- Ewak A. G., Berne.
- Forges de Strasbourg, Strasburg.
- Gesellschaft m. b. H. fur Oberbauforschung, Berlin 1.
- Gloucester Railway Carriage & Wagon Co., Ltd.
- Gloucester (England).
- Gothaer Waggonfabrik A. G., Gotha.
- Gottfried Lindner Aktiengesellschaft, Ammendorf
- (Germany).
- Le Metal Deploye, Paris.
- Maschinenfabrik Augsburg-Nurnberg A. G.
- Officine Mecanniche Italiane, Reggio Emilia (Italy).
- Siegener Eisenbahnbedarf Aktiengesellschaft, Siegen.
- (Germany).
- Thiercelin Aine et Boissee, Paris.
- Waggonfabrik A. G. Uerdingen (Germany).

These drawings were examined by the jury, the following points being specially taken into consideration: tare or maximum load, unit capacity of loading, resistance to normal strain, impact resistance, protection against condensation, ventilation, protection against rain, weatherproof properties of door joints, protection against risk of damp, arrangement of doors, their number and position, fastening of doors, handling of containers, placing of them side by side and one on the other, securing of containers, projections in the interior of the containers, cost of manufacture, cost of maintenance, and assembling component parts of collapsible containers.

Out of 14 competitors, the following 6 with 13 types of containers were retained for the second stage [6]:

- Butterley Iron Works, Derby (Figure 1). 1 closed and 2 open which 1 was demountable;
- Gesellschaft m.b.H. fiir Oberbauforschung (Sirius), Berlin. 2 closed;

- Gloucester Railway Carriage & Wagon Co. Ltd., Gloucester (Figure 2), 1 closed;
- Gothaer Waggonfabrik A.G., Gotha, 2 closed and 1 open, which was collapsible ;
- O.M.I.- Officine Mecanniche Italiane, Reggio Emilia, 1 closed and 1 open;
- Siegener Eisenbahnbedarf Aktiengesellschaft, Siegen, 2 closed of which 1 was demountable.

These competitors were asked to submit models belonging to the first category laid down in the competition conditions. The practical tests which formed' the second stage of the competition took place in Venice on September 30, 1931, on one of the platforms of the Maritime Station (Mole di Ponente), kindly placed at the disposal of the jury by the Italian railway management, who had taken the greatest care to provide all the equipment necessary to conduct the various tests [12].

Tests including [6]: Drenching for 5 minutes by means of the special appliance which delivered water under pressure over all parts of containers, Shock resistance when loaded with 5 ton and shunted against a dead stop buffer at speed of 0 kilometres per hour, Compression under a superimposed load 12,5 tons, Result of a drop or fall from a height of 1 ft. 7 in. (50cm), for this purpose one end only was lifted to the requisite height and then suddenly released, Tests of loading into vessel [6].

Figure 1. Butterley containers under competition in Venice 30 September 1931 [6]

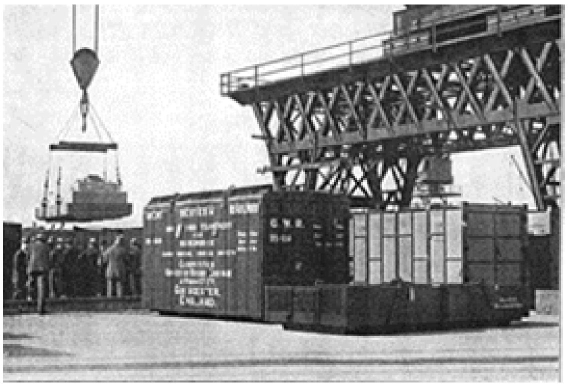

Figure 2. Gloucester containers under competition in Venice 30 September 1931 [6]

3 Creation an International Container Bureau B.I.C.

After test competition on Venice in Europe many state railroads had problems with fluently economic. Very important were information from North America.
There in 1928 Pennsylvania Railroad (PRR) start with regular container service in east north of United States of America. In April of 1929 in Washington three railroads companies spoke about provides for container transport [1]. After begin a Big Depression in world economy (1929) in many countries all kinds of transport were without cargo (Figure 3, Figure 4). Railroads was sought a possibility to find a cargo, and container was a big chance. In November 1932 in Enola PRR opened first rail container terminal in the world (Figure 5) [13].

Figure 3. Rail wagons without cargo [3]

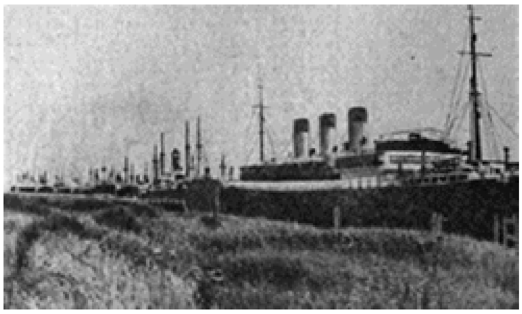

Figure 4. Sea ships without cargo [19]

Figure 5. Enola rail container terminal, opened by Pennsylvania Railroad in November 1932 [8]

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That was good conditions to create a container office. Under the auspices of the International Chamber of Commerce on February 22, 1933, in Paris, France, has been taken resolution by the Committee recommending the creation of an International Container Bureau, and was the inaugural meeting of the International Container Bureau (BIC). In addition to the German, French, British, Italian, and Belgian railways, who have already agreed in principle to affiliate, many of the railway administrations belonging to the International Union of Railways, as well as the automobile organizations, shipping companies, associations of forwarding agents, etc., of a number of countries were represented at this meeting. The object of the International Container Bureau is to organize International collaboration on a permanent basis for the best possible exploitation of containers in international traffic [7].

There were three forms of cooperation with companies and countries. The first group is formed private or public transport and railway lines and groups of visitors, created on the basis of an agreement between the lines and trans port and railway companies operating over containers. These were: England, Belgium, China, France, Spain, Italy, the Netherlands, Germany, Morocco and Saar Basin.

The second group, corresponding members, create institutions and individuals producing, exploiting, or interested in the technical progress of containers. These were: England, Belgium, Czechoslovakia, Denmark, France, Spain, Italy, Germany, Poland and the United States of North America. .

The third group consisted of members of the founding members of the office BIC, which also organized in the 1930-1931 competition in Venice for most practical container. These were: England, Belgium, France, Germany and Italy [14].

4 Norms For European Containers

4.1 First norm for European containers 1933 year

In June 1933 'Bureau International des Containers et du Transport Intermodal' (B.I.C.) decided about obligatory parameters for containers uses in international traffic. Containers handled by means of lifting gear, such as cranes, overhead conveyors, etc. for traveling elevators (group I containers), constructed after July 1, 1933 [11]. Obligatory Regulations:

Clause 1.—Containers are, as regards form, either of the closed or the open type, and, as regards capacity, either of the heavy or the light type (Figure 6 and 7).

Clause 2.—The loading capacity of containers must be such that their total weight (load, plus tare) is: 5 metric tons for containers of the heavy type; 2.5 metric tons for containers of the light type; a tolerance of 5 percent excess on the total weight is allowable under the same conditions as for wagon loads (Table 2) [11].

For identification that containers is for international trade BIC definite a sign as a big letter **i** – as international (Figure 8).

Table 2. Obligatory norms for European containers since 1 July 1933 [11]

Heavy types	length [m]	width [m]	high [m]	Total mass [tons]
Close type 62	3.25	2.15	2.20	5
Close type 42	2.15	2.15	2.20	5
Open type 61	3.25	2.15	1.10	5
Open type 41	2.15	2.15	1.10	5
Light Type	length [m]	width [m]	high [m]	
Close type 22	2.15	1.05	2.20	2,5
Close type 201	2.15	1.05	1.10	2,5
Open type 21	2.15	1.05	1.10	2,5

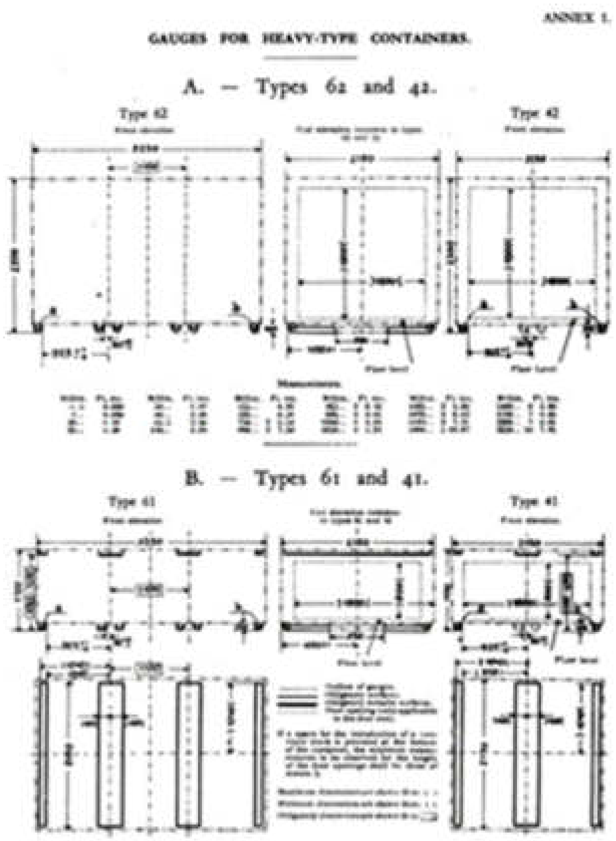

Figure 6. Gauges for heavy type containers from European norms since 1 July 1933 [12]

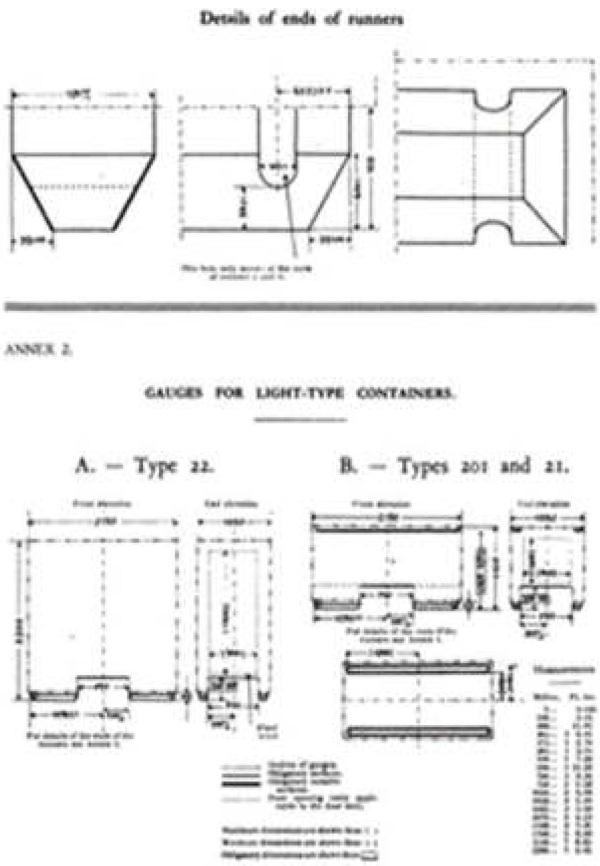

Figure 7. Details and gauges for light type containers from European norms since 1 July 1933 [12]

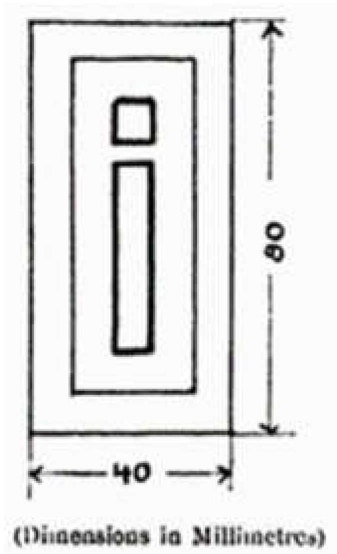

Figure 8. Sign for containers accepted in international traffic and maximal gauges for container type 62 from European norms since 1 July 1933 [12]

Implementation of containers by the office of the BIC resulted in changes in Czechoslovakia.

In July 1933 labour organizations of shippers and railroads made the proposal to organize into cooperatives, whose aim was to cover the entire collection and action steps freight to rail, car sharing, through the common organization of acquisition and installation services for railway Czechoslovakia. That was based on results of exploitation of Deutsche ReichsBahn Schenker Company from 1928. The aim was to create groupage centres of trade and industry [20]. Now, after near 90 years we see that speditor can help railways provide for better economy condition.

4.2 Second norm for European containers from 1935 year

From 1 January 1935 in Europe was UIC Convention on the mutual use of the container. It defines word container, low of owner of containers and a customs regulation [18]. Under meeting of UIC in Baden-Baden established parameters for intentional container after 1 April 1935. Obligatory parameters for containers are using in international traffic (Table 3.) [21] [5]:

Table 3. Obligatory norms for European containers since 1 April 1935 [21]

Category		Length [m]	Width [m]	High [m]	Total mass [tons]
1) Heavy types					
Close	62	3,25	2.15	2,550	5
	42	2,15	2,15	2,550	
Open	61	3,25	2,15	1,125	
	41	2,15	2,15	1,125	
2) Light Type					
Close	32	1,50	2,15	2,550	2,5
	22	1,05	2,15	2,550	

In 11-19 April, 1935, in Milano was Second Meeting of B.I.C. There were was presentation and tests of containers [15]. In 16-19 June 1937 was in Paris the Second International Week of Containers. Under this meeting was spoken about developing of container transport in Europe ad was a presentation types of containers [4].

Conclusion

Czechoslovakia had participated in creation of standards of norms for European containers before Second World War.

Czechoslovakia was one country from east and middle Europe which was active in first step of standardization of containers before WWII.

Europe had standard for containers before Second World War. In means that Malcolm McLean wasn't pioneer of containers for Europe, and isn't father of containerization.

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References

[1] Container service hearings close, The Railway Age, April 16, p. 901-905, 1929.
[2] De Luxe travel on the Nord Railway of France. Railway Gazette, no 12, sep. 17 1916, p. 328-331, 1926.
[3] Dworce towarowe ośrodków przemysłowych. Gazeta Bydgoska, nr. 11/1932, p.8, 15.01.1932.
[4] II Międzynarodowy Tydzień Kontenerów W Paryżu 16 - 19 Czerwca 1937, Codzienna Gazeta Handlowa / [Ajencja Wschodnia ; red. Adam Brzeg]. R. 12 (1937) No. 127, wtorek 8 czerwca 1937.
[5] Informations, Les Transports Combinés Parauto, Rait Et Bateau, Le Temps (Paris. 1861) 1929/03/25 (Numéro 97). P.4., 1929.
[6] International competition for the best type of container, Railway Gazette No 16 1931, oct 16, p. 499-501, 1931.
[7] International Container Bureau. The Sydney Morning Herald (NSW : 1842 - 1954) (NSW: National Library of Australia), 18 April 1933. p. 13, 1933.
[8] KURAŁOW Teodor: Dzisiejsze koleje amerykańskie, Ładowanie stalowych skrzyń na wagony, Życie Techniczne, No. 4, p. 67-71, 1937.
[9] Le condizioni del concorso internazionale per casse mobili, Rivista Tecnica delle Ferrovie Italiane 15 aprile 1930, p. 158-159, 1930.
[10] LE XIe CONGRÈS INTERNATIONAL DES CHEMINS DE FER (Madrid, 5-15 mai 1930). „Le Génie civil » : revue générale des industries françaises et étrangères, 1930/06/24 (A50,N25,T96). Tomx XCVI - N- 25, p. 602, 1930.
[11] Les transports es containers (cadres), Reuve Generale des Chemin de Fer, No. 5 1933 II p. 301-304, 1933.
[12] LONG RODNEY W.: Railway And Highway Transportation Abroad A Study 1935 Of Existing Relationships Recent Competitive Measures And Coordination Policies 1935 155, Trade Promotion Series—No. 155 Transportation Division, U.S. DEPARTMENT OF COMMERCE 1935.
[13] L'organisation du service par containers sur le Pennsylvania Railroad, Reuve Generale des Chemin de Fer\nr 6 1936, p. 455-456, 1936.
[14] Międzynarodowe Biuro Dla Kontenerów, (Bureau Internati0nal Des Containers), „Codzienna Gazeta Handlowa" / [Ajencja Wschodnia ; red. Adam Brzeg]. R. 10 (1935) nr 108, 1935.
[15] Próby Techniczne Kontenerów Dla Przewozu Drobnicy, Codzienna Gazeta Handlowa / [Ajencja Wschodnia ; red. Adam Brzeg]. R. 10 (1935) nr 76 niedziela 31 marca-poniedzfjftłek 1 kwietnia 1935.
[16] The World Motor Congress at Rome, Railway Gazette, Oct. 26, p. 520-523, 1928.
[17] Transport Matters For Discussion. Commercial Motor, 14th June 1927, p. 64, 1927. http://archive.commercialmotor.com/article/14th-june-1927/64/transport-matters-for-discussion.
[18] Übereinkommen über die gegenseitige Benutzung der Behälter (Container) im Bereiche des Vereins Mitteleuropäischer Eisenbahnverwaltungen. Gültig vom 1. Januar 1935 an. [1934.] 19 s. 4 taf.
[19] Wielki zastój w porcie hamburskim, Gazeta Bydgoska, nr. 174/1931, 31.07.1931, p.6, 1931.
[20] Współpraca spedytorów z koleją w Czechosłowacji (c) Codzienna Gazeta Handlowa / [Ajencja Wschodnia ; red. Adam Brzeg]. R. 8 (1933) nr 195, niedziela 27 — poniedziałek 28 sierpnia 1933, p. 5, 1933.
[21] WSZEWŁAD Nikołajew: Przewóz w kontenerach, Inżynier Kolejowy 5/1935, 1935.

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WHAT WAY DETERMINE THE CORRECT ALLOCATION AND LAYOUT FOR THE NEEDS OF PARKING FREIGHT DESIGN IN CONCRETE REGION

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Keywords: layout, transport, optimization, allocation, truck parking

Abstract: In terms of building a network parking strategies for freight transport may be considered two variants: a building (completing) car parks on abandoned of border crossings, respectively building a whole new network of parks. Creating a network of parks for freight is in the interest of the Slovak Republic as well as the European Union. The subsequent optimization is dependent on the quality of road infrastructure and the traffic intensity in the monitored sections. It is therefore important selection of suitable candidates, administrators and their subsequent assessment of the appropriateness and services provided in selected locations. Identification of parking in the SR enables to choose the effective solution for intelligent networking and secure parking.

1 Introduction

The correct position of the car park, firm, machinery, warehouse in area has a great effect on transport cost, the time it takes for the distribution and to all activities associated with the distribution. Allocation and layout are dependent on a number of factors to be taken into account at choosing a site. In terms of solutions, it is appropriate to use a number of approaches that could complement each other. To determine the location of car parks network can be applied methods as a method of A. Weber, Launhardt´s method or multicriteria decision making approach (System Block Criteria Decision - SB method) which in its solution considering other possible factors such as traffic, which may influence the decision about the location [1]. Assuming that the optimal distance of car parks is increasing with the quality of road infrastructure (sections of motorways, highways and I. class roads) is necessary to the evaluation of locations to apply the results of the qualitative analysis, as well as the prospect of building elements of the road network. Truck driver has a tendency in any situation to achieve maximum range of during limited hours under the current of level of traffic laws and road infrastructure. An important parameter of the entire network of car parks is evenness of coverage of the whole territory of the Slovak Republic with the capacitance variation of the intensity of traffic in specific area [2].

Slovak Republic is a part of the Schengen area since 2007, resulting is many abandoned border crossings and their related parking. For this reason, as one of the variants was investigated possibility of using the surplus assets today, for this is difficult to find application.

In terms of strategy of building a network of Intelligent Safety Parking (IBP) for trucks may be considered two options [1]:

- building (complete) parking on abandoned border crossings,
- developing a completely new network of parks.

When choosing the strategy of building an Intelligent Parking System network (IPS) for trucks can be guided by four variants and their combinations:

- reconstruction of the parking lots of abandoned border crossings,
- developing a completely new network of parks,
- use of parking areas at fuel stations and roadhouses,
- use of parking areas of road freight business (National Bus Transportation - NAD).

2 Analysis of the elements of the concrete region for the needs of allocation and layout

The Trans European Road Network (TERN) of the Slovak Republic is represented by the best road system that the state provides, it is motorway network and additional network, which consists of highways and roads, some stretches of I. class. TERN road network of the Slovak Republic provides the fastest connection to the transit traffic in the east - west and north - south. The road network of the Slovak Republic is shown in Figure 1. TERN road network structure clearly defines the allocation for building intelligent network parks [1], [2], [3].

Among the studied site of the former border crossing, and the national parks network TERN be classified Vyšný

Komárnik, Stará Ľubovňa, Trstená, Skalité, Makov, Trenčín, Rajka, Šahy, Zvolen, Milhosť, Berg, Sekule, Závod, Malacky, Zlaté Piesky, Stupava, Lamač, Triblavina, Čataj, Zeleneč, Červeník Piešťany, Hrádok, Beckov, Kostolná, Zamarovce, Dubnica n/V, Prejta, Ivachnová, Dechtáre, Čemice, Velínok, Hybe, Petrovany, Janovík.

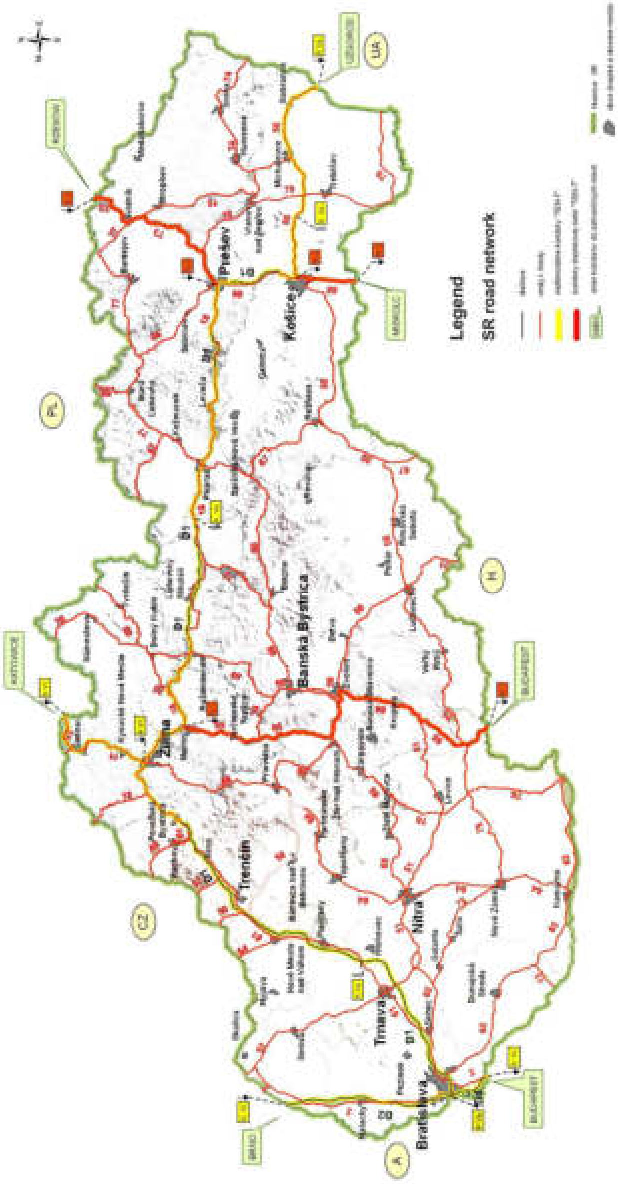

Figure 1 TERN road network of the Slovak Republic (source: Slovak Road Administration)

The intensity of road transport within the territory of the Slovak Republic is regularly monitored by a nationwide road traffic census since 1958. Cycle of adding is five-year national surveys since 1980 in years ending in 0 and 5. The last nationwide road traffic census survey was executed in 2010 for highways, roads I. and II. Class III and selected roads classes [2].

Figure 2 shows the progress of the intensity of road transport on main transport corridors of the Slovak Republic, while road traffic intensity is expressed by thick lines depicting the road network. When the line is thicker, then is higher the intensity of road traffic. Figure 2 shows that the traffic intensity increases moving from east to west of the Republic. On the basis of traffic levels in recent years can be assumed that the requirements for the capacity of the individual parks will be higher in the west - east.

Analysis of available information, such as www.truckinform.eu where the road freight transport in the SR is listed the six high-capacity car park (Bratislava 2, Rožňava, Košice, ...). It was found that there are at least four parking spaces; respectively companies listed on the web site services do not offer parking.

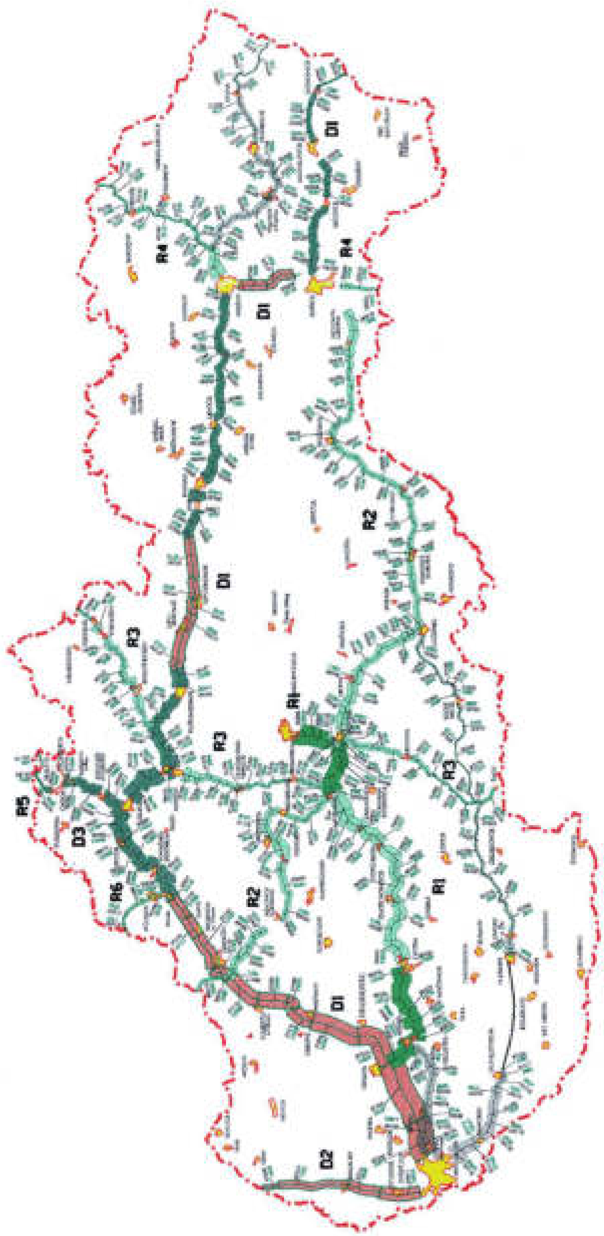

Figure 2 The schema course of the intensity of traffic on major road routes SR

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Additional parking, but are very limited, offering parking areas and parking for highways and expressways. Services within these parks offer a particular food, sanitary facilities and the ability to refuel, have less opportunity and the possibility of rest. The current state of large-scale parking in SR is non-systematic points in their building and the low level of service. A survey of the SR is resulting that the establishment and development of high-capacity of car park is based on the personal initiative of several business entities, taking into account the wider road network structure of SR, its needs and without taking into account the Trans European Road Network (TERN) to European standards. Unsystematic construction of car parks with the risk of loss of profitability for entrepreneurs and thus risk extinction of such parks [1].

3 Define of the allocation and layout for parking of freight transport in concrete region

In terms of network design for freight car parks is important to define the distance between parking lots; with great influence in this direction has a position and size of the country. It is important for the allocation of parking areas to take into account the position relative to surrounding states, respectively high-capacity car parks in neighbouring countries.

Slovak Republic in terms of transit has an important position in Central Europe and also in terms of transit between Western and Eastern Europe. SR is one of the smaller countries of Europe. The largest direct distance in the direction east - west (Záhorská Ves - Nová Sedlica) is 429 km. The largest direct distance in the direction north - south (Skalité - Obid, a road connection about 250 km) is 196.7 km.

The assessment of landscape parameters, it is clear that it is important to systematically build parking lots to the small area to avoid unnecessary congestion and the possibility of unused capacity [3].

In terms of building a network of parks in general seems appropriate to divide the parking areas on two levels. I. level is represented by parking lots that would provide all the standards of modern parks. II. level is represented by parking lots that would provide basic services for drivers and transport.

Benefit of completion of the existing car parks at border crossings is saving considerable funds for landscaping, the existence of utilities, the existence of social facilities and the possibility of building for the needs, rest, food, medical assistance, service and ensuring security services.

The disadvantage of such a system may in some cases: obsolete sanitary facilities, inadequate parking situation in terms of location and in terms of spatial options for further completion.

An analysis of traffic intensity at each border crossing that border crossings with the highest intensity in Poland are: Vyšný Komárnik – Barwinek, Trstená - Chyžné, with Czech Republic: Mosty u Jablunkova - Svrčinovec, Makov - H. Bečva, Drietoma - Starý Hrozenkov, Brodské - Břeclav, with Austria: Bratislava - Petržalka - Berg, Jarovce - Kittsee, with Hungary: Čunovo – Rajka, Rusovce – Rajka, Šahy - Parassapuszta, Milhosť – Tornyosnémeti, with Ukraine: Vyšné Nemecké - Užhorod.

In terms of prospective analysis of the use of parking spaces at gas stations and motels focuses on the TERN network. In these cases the guarded area, where certain services, such as options, restrooms, snack bar, respectively restaurants, without accommodation.

Other options available parking and parking areas are at gas stations, Shell, OMV, Avanti, Agip and Slovnaft and roadhouses, where parking capacity is quite limited, ranging approximately from 20 to 50 such trucks for example Zamarovce pri Trenčíne, Janovík, Biele Studničky, roadhouse Halier, Dechtáre, Cieľ, Čataj, Budča and more.

In an analysis of the current state to privatization for trucks has been made a survey in enterprises of the former freight car transport (NAD), which are now privately owned. The analysis shows that the parking capacity is not currently used, respectively, companies do not offer such services, though, as they have adequate facilities, as well as services. One of the few companies that offer a lot to guard the trucks is NAD Trnava.

In terms of future developments in the field of road haulage parking is possible to reach the current businesses and offer them the opportunity to enter a network of car parks within the EU.

The analysis of free parking areas after the former state enterprise bus was contacted current owners of road haulage firms and bus companies Slovakia. The above analysis shows that free parking space in most regional and district towns, namely: Bratislava, Košice, Poprad, Svit, Humenné, Michalovce, Vranov nad Topľou, Sobrance, Dunajska Streda, Nové Zámkye, Trnava, Banská Bystrica, Trenčín, Liptovský Mikuláš, Žilina, Považská Bystrica, Zvolen, Lučenec, Prievidza, Detva, Svidník, Rožňava, Stropkov, Rimavská Sobota, Senica, Stará Ľubovňa.

In terms of economy and the possibility of building intelligent parking system for trucks in the Slovak Republic are rated as the best network following parks:

- a network of parking areas at border crossings,
- a network of parking spaces for car traffic of freight operators and Slovakia bus.

After Slovakia's entry into the joint space and termination of Schengen crossings remained at the entrance to the Slovak Republic a number of unused buildings that have sanitary facilities, unused office and industrial space, utilities and appropriate adaptations to

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the areas for parking trucks. These sites can be used just to build a smart parking system with a network service.

In terms of uniformity of coverage of the Slovak Republic parking spaces, a network of suitable parking areas at border crossing added to the site within the territory (Figure 3).

Figure 3 Network of car parks at border crossing points and parking areas of NAD, SAD [2]

Another possibility to extend the parking system for trucks is to use parking spaces that are owned by the current operators of freight by road (NAD) and respectively Slovak Bus Transport (SAD) (Figure 3).

Some of the interviewed companies have also now offer a variety of services for trucks and are willing to extend its range of services required, to meet the requirements of intelligent parking.

As the best variant appears at present is a combination of both systems networks (Figure 3) the need for proper analysis, assessment and selection of allocated points and their inclusion in group I. parking category II. categories, respectively their exclusion from the system by the non-defined criteria.

In terms of the global assessment of the structure of the road network and international transport routes for heavy goods vehicles is necessary to consider with the existence of suitable parking spaces that are allocated on the border crossing points to neighbouring countries and operators parking areas the current road freight transport operators (NAD), respectively. Slovak Bus Transport (SAD) (Figure 3) [3].

The positions of the of abandoned border crossing points are largely equipped with suitable parking areas, built social network, they are suitable for security of car parks and there are built network engineering. The problem of these sites is the property of the corresponding object relations and the necessity for further investment to adapt of these places for the needs of standard level of trucks car parks [3], [4].

Another option is the use of existing private parking areas within the existing of carriage of goods transport operators (NAD), respectively Slovak Bus Transport (SAD). Some private car parks satisfy the requirements for operating within an international network of car parks and are willing to expand their services according to the requirements and needs of the EU. Private operators expect financial participation by the state, respectively EU to build these parking spaces [2].

Because network structure of car parks for trucks (NV) contains in terms of allocation of car parks positions a few points [5], is in terms of its final realization suitable to define of building in stages (Figure 4).

In the 1st stage is necessary to build a car parks NV position in locations Prešov, Žilina, Zvolen and Bratislava, the site is meant wider environment destination depends on the connection to the road infrastructure and construction possibilities in the defined area.

In the 2nd stage is necessary to build a car parks position of NV in locations Košice, Nitra and Trenčín.

In the last 3rd stage it is necessary build a car parks position of NV in locations Strážske, Poprad, Lučenec and Trnava.

The resulting solution since the 1st stages of building car parks for positions trucks (NV) satisfies logic, logistics and quality requirements for car parks for layout positions. Each subsequent stage of building car parks improves the quality of services provided and defined network.

Truck parks on border crossings, currently owned by the National Highway Company (NDS) are for implementing a whole is not very difficult but morally and physically worn out and in terms of implementation are also consuming for investment [3], [6].

Car parks privately owned are in terms of using immediately available and classifiable into the network structure car parks of NV. In terms of capacity, the car parks offer a view of the capacity requirements of the market, is in all cases the necessary investment in the capacity and technical completion [7], [8]. The current owners of car parks for in this regard expect support from either the state or the EU. The only drawback is parking agreement between the owner and the state.

Economically and time least favourable in terms building a network is to build a car parks of NV in localities of existing industrial parks, in addition to set-aside from land resources and any engineering networks there is nothing. In these cases, the State, respectively EU will have to invest a considerable financial volume [9], [10].

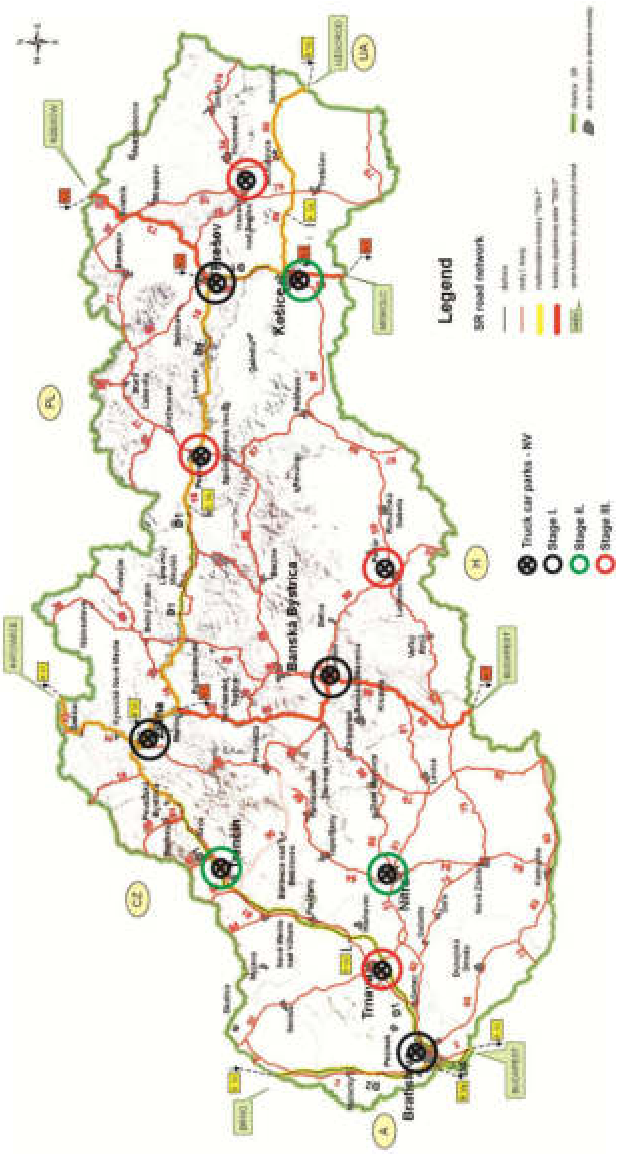

Figure 4 The final proposal of the car parks layout for NV according to construction phases [3]

Although these mentioned aspects show the correctness of phased building a network parks NV in Slovakia. In the 1st stage of building positions Bratislava, Žilina, Zvolen a Prešov can be used car parks at border crossing points and car parks in privately owned of NAD and SAD, which already exist and in the current economic situation are this approach advantageous and real for state [11], [12], [13].

4 Project of the car parking network building

In the pilot project was selected four suitable locations Prešov, Žilina, Zvolen and Bratislava. In the individual locations have been defined appropriate business entities which have adequate capacity, technical safety and services (Figure 4).

In location Prešov was selected, as the appropriate subjects following companies: SAD Prešov, a.s., Košická 2, 080 01 Prešov and Marian Troliga - MT, Košická 20, 080 01 Prešov.

In location Žilina was selected, as the appropriate subjects following companies: NDZ, s.r.o. Žilina, Košická 2, 010 01 Žilina and VALIN, s.r.o., Pri Celulózke 1376, 010 01 Žilina.

In location Zvolen was selected, as the appropriate subjects following companies: SAD Zvolen a.s., Balkán 53, 960 01 Zvolen a D.K.C., s.r.o., Balkán 53, 960 01 Zvolen.

In location Bratislava was selected, as the appropriate subjects following companies: NAD 820 Bratislava, a.s., Rožňavská 2, 821 01 Bratislava 2 a Slovak Lines a.s., Mlinské nivy 31, 821 09 Bratislava.

In the locality of Prešov was negotiated with two firms which have adequate space for the creation of smart parking area their position on the road network, capacity possibilities, services rendered and the possibilities for their future completion. Companies which was addressing are SAD Prešov, a.s., Košická 2, 080 01 Prešov, www.sad-po.sk and Truck Centrum Marián Troliga – MT, Košická 20, 080 01 Prešov, www.mttroliga.sk.

Companies are positionally near each other but SAD Prešov, a.s. has limited access from the street Košická, which leads directly to the highway D1. Within the arrival is built railway underpass, which limits and prevents in crossing of higher freight vehicles. The railway underpass can be bypass but with complications towards the city centre across the street Budovateľská.

Access to Truck Center MT - Troliga is directly from the street Košická without restrictions.

In terms of capacity, both companies have roughly similar capacity for parking of 60 parking places. Within the SAD is also necessary to allow for priority parking their buses, which significantly reduces the capacity of parking.

For the above reasons, it was at negotiations continued only with company Truck Center MT - Troliga, which is from the possible development and allocation of smart parking area in the locality Prešov more favourable.

In the locality of Žilina was negotiated with two firms which have adequate space for the creation of smart parking area their position on the road network, capacity possibilities, services rendered and the possibilities for their future completion. Companies which was addressing are NDŽ, s.r.o. Žilina, Košická 2, 010 01 Žilina, www.ndz.sk a VALIN, s.r.o., Pri Celulózke 1376, 010 01 Žilina, www.valin.sk.

Companies are positionally near each other but NDŽ, s.r.o. Žilina spite of initial promise of participation in the project for the delay in the solution (interruption of the project in 2011), dealt with their economic situation renting of parking space to other businesses. Consequently, the company currently not have adequate facilities and project resigned.

As another business entity which is willing to work on a pilot project is the company VALIN, s.r.o. Žilina. In terms of capacity the company has 35 parking spaces for freight. Allocation VALIN, s.r.o. Žilina is an advantageous to way I. class I/18 with direct connection to the highway D1. VALIN, s.r.o. Žilina is interested in the future development of activities related to the provision of parking services. It is the reason the inclusion of this company in the pilot project.

In the locality of Zvolen was negotiated with two firms which have adequate space for the creation of smart parking area their position on the road network, capacity possibilities, services rendered and the possibilities for their future completion. Companies which was addressing are Prvá dopravno-mechanizačná spoločnosť, s.r.o., T.G. Masaryka 3425 – Bariny, 960 02 Zvolen, www.1dms.sk a D.K.C., s.r.o., Balkán 53, 960 01 Zvolen, www.dkc.sk.

Companies are positionally located advantageously to the main motorways. Even 1.DMS, s.r.o. Zvolen and also D.K.C., s.r.o. Zvolen are favourable entrance and exit to the way of international importance E77 with direct connection to the R1 expressway.

In terms of firm capacity DMS, s.r.o. Zvolen has about 30 parking spaces D.K.C., s.r.o. Zvolen has about 60 parking spaces.

The fact that both companies are willing to participate on a pilot project of smart parking areas are conveniently located to transport infrastructure and provide quality services for freight transport also capacitive differences in the number of parking spaces is recommended both companies in the area include to the pilot project.

In the locality of Bratislava was negotiated with two firms which have adequate space for the creation of smart parking area their position on the road network, capacity possibilities, services rendered and the possibilities for their future completion. Companies which was addressing are NAD 820 Bratislava, a.s., Rožňavská 2, 821 01 Bratislava 2, www.nad820.sk and KAISER Spedition, Hraničná 22, 821 05 Bratislava, www.kaiser.sk.

Companies are positionally located advantageously to the main motorways. KAISER Spedition has favourable entrance ande exit from highway D1 and near of company is airport M.R. Štefánika. NAD 820 has good entrance and exit to road I. class č. 61 too with direct connection to the highway D1.

In terms of firm capacity NAD 820 has about 150 parking places. Company KAISER Spedition has about 80 parking places.

The fact that both companies are willing to participate on a pilot project of smart parking areas are conveniently located to transport infrastructure and provide quality services for freight transport also capacitive differences in the number of parking spaces is recommended both companies in the area include to the pilot project.

5 Summary

Based on the results of the survey of truck car parking operators is possible to state the following facts:

- The pilot project addressed all companies are entrepreneurially run and hence also the capital-able and depends only on a specific business plan and return of funds.
- Each of the addressed companies expect support from the Department of Transportation in the form of subsidy for the construction, completion, respectively modification of administered space to the desired level for the needs of smart parking.
- A common feature of the selected companies is that they all need to build, respectively upgraded electronic security systems, lighting, security and fencing of company area and build a public Internet connection in what respect they expect contribution from the state.

From the side of business entities is preparing of parking areas, respectively provision of services (washing trucks, tires service, sale of spare parts, etc.) explicitly understood as investment of business entity without the assistance of the state.

From the side of the state all interviewed companies expect financial support especially during start-up service of smart parking place to achievement of its profitability.

In the current state are companies capable of operation of truck car parks but not in full equipment to the requirements of intelligent parking. The subsequent development of the market will support the business plan and convinces of suitability of investing in this services sector. On the basis of last year car parks traffic will be possible more specific of need of real support - subsidy from the state for companies which realize this service.

Mechanism for financial support truck car parks must be built on parity represented by the state and by business subjects because of commitment and verifiability as by the state, as well as by the business entities. As follows the state also business entities will be interested in the development of car parks and profitability of funds expended [3], [14], [15].

On the basis of requirements of a specific business entity on maintenance and services development, respectively technical assessment of parking place, a fund manager as a representative of the state for the recovery and operation of truck car parks verify its legitimacy. In the case of requirements legitimacy state by parity share 50% financial resources will contribute to the specific purpose and implementation of requirements. Business subject will contribute in the same parity share 50% for the implementation of requirements from its own resources. Support from the state is non-refundable contribution to the traffic of truck car parks.

After the realization of the investment project will check quality implementation and correctness of funds expended by representative of the state. In case of deficiencies business subject gets space to correct errors in the realization, which will be made only at his expense.

Conclusion

For the solution of car parks layout in SR was applied several approaches, which are based on the graphic, as well as the expert and analytical approaches. In the solution was the first time used SB method that appropriately combines graphical display with multicriteria decision. By SB method was developed variant of solutions which meets the minimum, expanded and the maximalist the number of elements in a network of smart truck car parks NV.

Project in the field of information services for freight drivers and made the current state of focus, mainly on the analysis of the state parks in Slovakia, the allocation within the SR, its current status and potential uses for the purpose of building a network of smart parking, defining elements of the logistics chain, analysis of information support and supply chain elements to create basic information and communication structure between the elements of defined supply chain.

The information gathered on the state parks and information support services and distribution processes within the SR that building parking is unsystematic and is based mainly on individual initiative of several business entities, following the broader structure of the European road network.

Because the output of the application is several approaches to solving layout of car parks and is more variants, this reason it is necessary to decide which variant is the most decisive by set of criteria. The solution is the maximum of car parks network, which the best takes into account the defined criteria. Number of car parks in the proposed network in terms of its construction, allows introducing an element of stage. The advantage is gradual release of financial resources in time.

The next step after the implementation of the pilot project will be the completion of a network of smart car parks to the total appearance according to previous proposal. Linked to this is addressing other business subjects (owners of suitable parking places), respectively tender announcement to car parks lease at border crossings, which are owned by municipalities and the state and their completing to required level.

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References

[1] BALOG M., STRAKA M.: Defining of methodology useful for choosing of layout and allocation of parks network of IPS SR, TU of Kosice, ULPaD, p. 31, 2012. (Original in Slovak).
[2] STRAKA M., BALOG M.: Defining of parks network structur of freight transport, TU of Kosice, ULPaD, p. 46, 2012. (Original in Slovak).
[3] STRAKA M., BALOG M.: Definitively design of IPS SR network (pilot project), TU of Kosice, ULPaD, p. 31, 2012. (Original in Slovak).
[4] COOPER L.: Heuristic Methods for Location-Allocation Problems, Operations Research 11(3), p. 331-343, 1964.
[5] KAMPF, R., PRŮŠA, P., SAVAGE, C.: Systematic location of the public logistic centres in Czech Republic, Transport, 26 (4), p. 425-432, 2012.
[6] ROSOVA, A.: Logistics costs of the enterprise, Acta Montanistica Slovaca, 12 (2), p. 121-127, 2007.
[7] BESTA, P.; SAMOLEJOVÁ, A.; JANOVSKÁ, K.; LAMPA, M.; LENORT, R. Evaluation of benefits resulting from innovation of input raw materials dosing process in sintering. Metalurgija, Vol. 51, No. 4, p. 457-460, 2012.
[8] WITKOWSKI, K., SANIUK, S.: Aspect of logistics management of the city infrastructure, Logistyka 41 (2), p. 589-600, 2011.
[9] ŠADEROVÁ, J., KAČMÁRY, P.: The simulation model as a tool for the design of number of storage locations in production buffer store, Acta Montanistica Slovaca, 18 (1), p. 33-39, 2013.
[10] WINKLER, R.: Effectiveness - an attempt about conceptualization of the idea, Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie, No. 820, Cracow, p. 105-117, 2010.
[11] SANIUK, S., SANIUK, A., LENORT, R., SAMOLEJOVA, A.: Formation and planning of virtual production networks in metallurgical clusters, Metalurgija, 53 (4), p. 725-727, 2014.
[12] TREBUŇA, P., KLIMENT, M., FIĽO, M., MARKOVIČ, J., HALČINOVÁ, J.: PLM systems, their history and application today in business process modeling, Mechanics, Scientific researches and methodical development, No. 7, p. 129-133, 2013.

Volume: 1 2014 Issue: 4 Pages: 9-16 ISSN 1339-5629

[13] BEDNÁR, R., VIDOVÁ, H., BELUSKÝ, M.: Lean principles application in business logistics, in: 21st International Conference on Metallurgy and Materials – METAL, Tanger, s.r.o., Ostrava, p. 6, 2012.
[14] SANIUK, S., SANIUK, A.: Rapid prototyping of constraint-based production flows in outsourcing, Advanced Materials Research, Vol. 44-46, p. 355-360, 2008.
[15] CAGÁŇOVÁ, D., ČAMBÁL, M., WEIDLICHOVÁ LUPTÁKOVÁ, S.: Intercultural Management – Trend of Contemporary Globalized World, Electronics and Electrical Engineering, Technologija, Kaunas, 6 (102), p. 51-54, 2010.

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SIMULATION AS AN APPROPRIATE WAY OF VERIFYING THE EFFICIENCY OF PRODUCTION VARIANTS IN THE DESIGN OF PRODUCTION AND NON-PRODUCTION SYSTEMS

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Keywords: design, simulation, product lifecycle, simulation software
Abstract: The paper deals with simulation and her forms of use in designing of production and non-production systems. Points to the possibility of using software can help in planning and subsequently in other phase of the lifecycle production and products. Article informs about some of the advantages of this type of software and his options. Sets out some theoretical knowledge of simulation and in the practical part presents some frequently used simulation software.

1 Introduction

The trend of rapid shortening life cycle of products and innovation, which today is normal in almost every area, it is necessary to look for, means fast design of production and non-production systems. However is necessary pay attention also to the project to be well as effective and planned production or innovation of products entering in the physical parts of its optimum manner. Just for this purpose it is appropriate that simulation capabilities that enable us to verify several possible variations, as has given by production look and eliminate any narrow spots in advance.

1.1 Simulation of production processes

Simulation ranks among leading industrial engineering techniques (Fig.1). Large expansion began to experience at the end of the twentieth century and the development and application is significantly visible also in currently. This is due to the fact that the increased complexity of the problems, which the industrial engineering resolves.

When building a production system operates a variety of different factors which cannot be described by exact mathematical equations. Even before designers begin with the construction of the enterprise, it is necessary to focus on narrow spots in the enterprise, the main risks and crisis situations:

- From an economic point is of view necessary to focus on minimizing costs in general.
- From a management perspective, it is necessary to focus on the consequences project approval, meet the deadline and prices, causes of high stocks and intermediate times.

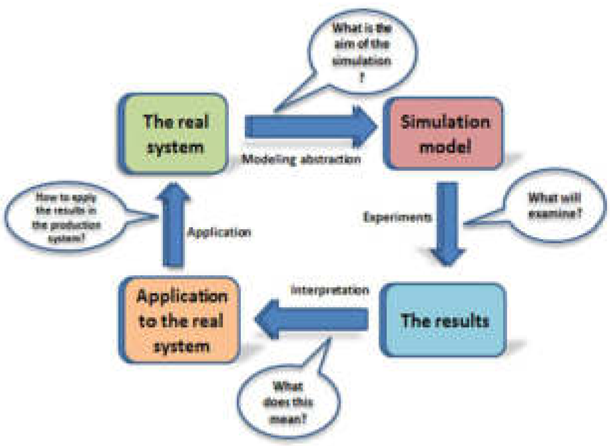

Figure 1 Principles of computer simulation

Simulation is able to remove all the shortcomings of analytical methods, but it is more demanding to time (the design model, model testing, planning and carrying out experiments) and the preparation of input data and by this it is also more expensive. This method overcomes many boundary conditions and limitations of analytical modeling procedures and its use is appropriate in particular in cases where other possible solutions have failed. The simulation is actually an experimental method, based on which the experiments with the model of the production system on the computer. Model production system typically consists of the following types of objects:

- Dynamic temporary objects (moving elements that enter the system, moving between the static parts of the system and at some point the system the leave the - parts and pallets).
- Static lasting objects (immobile parts of the system which are permanently active - machinery, warehouses, etc.).

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- Elements of interconnection with the surroundings (the place where the input dynamic objects in the system and where the system leave the).

Simulation may rank among the statistical experimental methods because it works on the same basis as theoretical methods of mathematical statistics. When it is impossible to examine the whole extensive set, selects a sample that represents the characteristics of our sample set (statistical sampling). This sample is statistically analysed and the analysis result is then applied to the entire file. Similarly, in the simulation takes place as the real system simulation model. This model includes only those characteristics of the real the system, which is interesting in terms of analysis. From experiments with a model it can be concluded about the entire real system. Simulation can be divided into:

- Deterministic - simulation model does not use random variables,
- Stochastic - simulation model uses also random variables.

Based on the principle which is used in the preparation of simulation model distinguishes these types of simulations:

- A continuous simulation - the values of state variables are changing continuously in a given time interval. Value is determined variables are determined by solving differential equations that describe the behaviour of the simulated the system in a very short time steps (numerical solution, usually using the method RungeKutta).
- Discrete simulation - also called event-oriented simulation. From the perspective simulation in this case will simulate only the points in time (events), in which there is a change of state quantities the system. Examples of discrete systems are the majority of production and logistics systems.
- Combined Simulation - contains elements of discrete and continuous simulation. The basic types of simulation are shown in Fig. 2. Even in the simulation of production systems dominated discreetly processes are sometimes combine the principles of discrete and continuous simulation. Some chemical or thermal processes in the production are changing continuously, but in mass production are many discrete processes (e.g. conveyors, lines with plenty of continuously moving material).

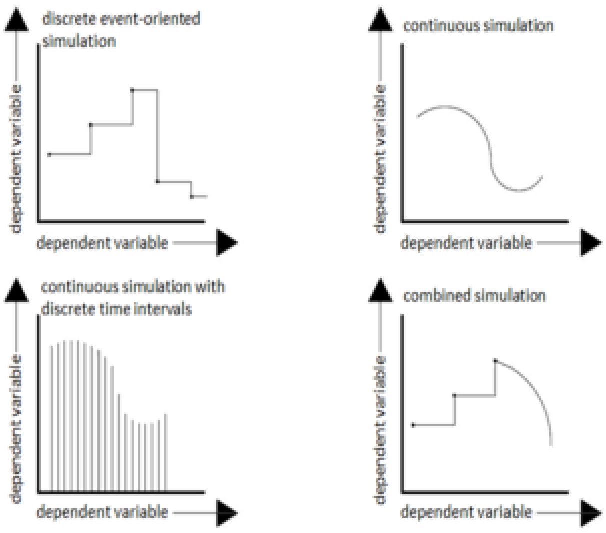

Figure 2 Basic types of Simulation

2 Some Simulation Software

The most used computer systems in area simulation include software modules from Siemens PLM Software and software package with Tecnomatix.

Tecnomatix Plant Simulation, characteristics and advantages

Plant Simulation is computer software developed by Siemens PLM Software for modeling, simulation, analysis, visualization and optimization of production systems and processes, material flow and logistics operations (Fig.3). Using Tecnomatix Plant Simulation enables users to optimize material flow, resources for all levels of planning. The software allows comparison of complex manufacturing production options, including immanent logic processing, using computer simulation. Plant Simulation is used for individual production plans as well as multinational enterprises, mainly as a strategic planning layout, process control logic and complex dimensions of productive investment. This is one of the main reasons for the dominance of this product on market.

Object-oriented programming uses the following three properties:

1. **Heritage** - Users create libraries with their own objects that can be re-used. Unlike copies, any change in the object class library is extended to some of the derived objects (children).
2. **Polymorphism** - Classes can be derived and derived method can be redefined. It allows users to create complex models faster, easier and more transparent in the structure.
3. **Hierarchy** - complex structures can be created very clear on several logical layers, allowing each layer to move between them by relevance.

The program can import data from other systems, such as: Program Access, Oracle databases, Excel or SAP.

Integration of Plant Simulation supports:

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- import data from PLM systems, or can be directly used,
- virtual enterprise putting into service,
- download data from AutoCAD.

Microstation, FactoryCAD etc. are directly into the simulation.

It provides a clear analytical tool for detecting obstacles for monitoring material flow (Sankey diagram) or to detect oversized batteries (Chart).

Provides integrated optimization tools:

- Experiment Manager automatically creates scenarios and evaluate the dependence of two input parameters.
- Genetic algorithms search large space solution.
- Neural networks show the connection between input and output parameters and can be used for forecasting.

The program can:

- Recognize and show problems that might otherwise result in high cost and time consuming remedial measures in the start-up phase.
- Offers mathematically calculated key performance indicators (KPI) instead of an expert,, feeling ".
- Reduce investment costs for production lines without jeopardizing the desired quantity.
- Optimize the performance of existing production lines.
- Incorporate machine failure, availability (MTTR, MTBF) when calculating the numbers throughput and usability.

Higher productivity planning, the program can be achieved by:

- Collection and management of knowledge within a single source of information will ensure the reuse of certified processes and cut costs for capital equipment.
- Ensuring and troubleshooting in production systems that would otherwise require time-consuming and costly remedial measures at the onset of production.
- By limiting tasks associated with planning assembly, shortening, planning and reducing related costs.
- By sharing and analysing information within the digital environment, offering a detailed overview of the various stages of the development process and the impact of these processes.
- Streamlining communications can quickly adapt to customer requirements, the decision is based on facts.

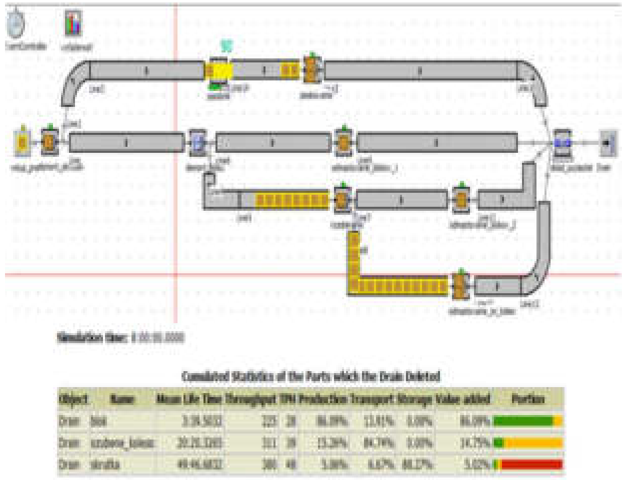

Figure 3 Output from the software Plant Simulation

Tecnomatix Process Designer

Process Designer (Fig.5) is a comprehensive instrument for designing (design) process. Analysis the 3D graphical environment, validation and optimization of production allow parallel planning of technological teams. Planner and technologist evaluate the production time, costs, resources, capacity, logistics and other important information with its help. The basic building block of work in the Process Designer is: what will be produced, whereby will be produced and what processes are used to produce.

Process Designer allows at an early stage planning concept:

- evaluate production alternatives,
- coordinate means,
- to plan a more alternatives,
- Implement changes,
- estimate the cost and duration of cycles,
- define and verify the assembling of products,
- create layout assembly lines,
- assign each operation necessary time,
- assign production functions,
- monitor the use of means,
- analyse the costs of products and production.

Process Designer provides the possibility of jointly to plan analyse and manage production processes for entire plants, lines and the individual operations. Using object-oriented technology corporate libraries means operations, manufacturing best procedures and proven experience, helping to create optimal processes and adapt to several alternative products.

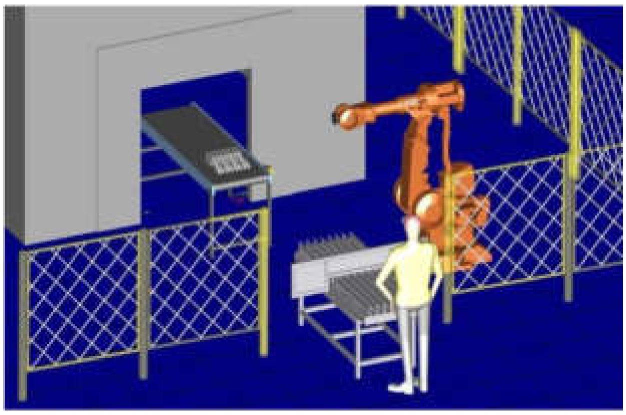
Figure 4 Tecnomatix Process Designer

Tecnomatix Process Simulate

Process Simulate is a digital tool for production solutions for the verification of the production process in a 3D environment. The ability to use 3D data of products and resources facilitates virtual validate, optimize and transfer complex manufacturing processes, leading to a faster onset of real production and the quality of products. Tecnomatix Process Simulate is a toolbox simulation and verification of production tools:

- is integrated with the Process Designer tool for,
- shortens planning helps to optimize production systems,
- uses the technology of smart devices with extensions for teaching robots.

Process Simulate enables the verification of the various segments of the production process: assembly processes, labour, welding, continuous processes such as laser welding and bonding, and an additional amount of robotic processes simulated in the same environment, enabling the simulation of virtual production zones. The simulation mimics the realistic human behaviour, robotic domain controllers and PLC logic.

The main functions of the software module Process Simulate are:

- 3D simulation, Static and dynamic collision detection,
- 2D and 3D cuts,
- measurement in 3D dimension,
- mapping operations,
- robotic assembly and production planning of roads,
- resource modeling (3D and kinematics)
- Design of the production lines and workstations,
- tools for creating documents,
- native support of visualization the standard JT,
- simulation of human tasks,
- simulation of discrete and continuous of production processes,
- simulation robotic automated processes,
- virtual commissioning.

The sub-modules software tool Process Simulate

As almost all the products from the portfolio of Siemens PLM Software and Process Simulate concentrated his work is divided into several functional software sub-modules (Fig.5).

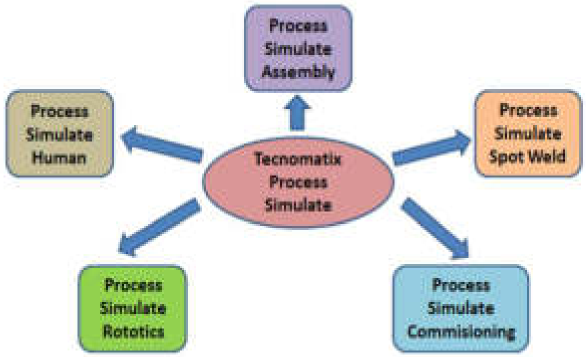

Figure 5 Sub-modules software tools Process Simulate

Tecnomatix Jack

Jack is a separate simulation tool comprising a biomechanically accurate digital model of man, has many of detailed ergonomic and time analysis permitting draft possible most comfortable, safest and a most productive workplace and product. Workplace, operations or product is by simulating possible maximum ergonomics and adapt to the needs of future users during the first stage of development 3D CAD model. Jack also fully supports virtual reality tools (Fig.6).

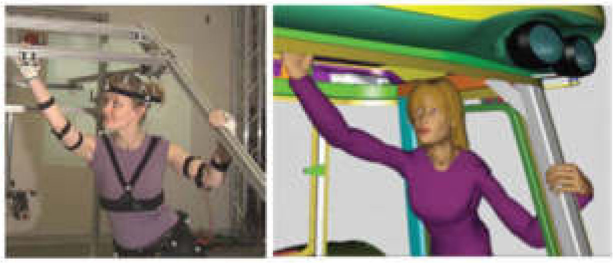
Figure 6 Environment in the Tecnomatix Jack

These and some other software for different types of simulation offers the provider Siemens PLM Software for management and elaboration data across the life cycle of products and their productions. Software similar character provide also offer other providers operating either in PLM systems, or be closely are specializing on simulation.

Conclusion

Simulations are after their introduction of a correct application for the enterprise a big competitive advantage. The advantage lies in several areas, in the planning of new products or product innovation, also in the field of marketing. Simulations are suitable for the presentation of products and processes for their preparation before customers or potential investors in companies. An essential advantage of simulation is cost savings in many ways. This is a saving in production planning, which is in the preparatory phase can be verified several possible options, as well even at the stage of an existing production, which can detect problems and bottlenecks and with the help of the simulation can be removed and transferred into production in already optimized form.

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References

[1] MALINDŽÁK, D.: Simulation of systems, Simulácia systémov. Edičné stredisko VŠT v Košiciach, 256 p, 1986. (Original in Slovak)
[2] Plant Simulation – Plant, life and process simulation and optimization. [online]. [cit. 2013-11-10]. <http://www.sova.sk/Documents/File/Siemens-PLM-Tecnomatix-Plant_Simulation-fs-x7.pdf>.
[3] MORHÁČ, M.: PLM solutions – new strategy of enterprises development, PLM riešenia – nová stratégia rozvoja podnikov. [online]. [cit. 2014-09-04]. (Original in Slovak) http://www.efocus.sk/images/archiv/file_45_0.pdf
[4] FIĽO, M. - PEKARČÍKOVÁ,M.: 2013, Contribution to the creation of the model warehouse management in the company, Manažment podnikov. Vol. 3, issue 2, p. 62-64. 2013.
[5] VOTAVA, V. – ULRYCH, Z. - EDL, M. - KORECKY, M. - TRKOVSKY, V.: Analysis And Optimization Of Complex Small-Lot Production In New Manufacturing Facilities Based On Discrete Simulation. EMSS 2008: 20TH European Modeling and Simulation Symposium, p. 198-203, 17 – 19.9.2008, Amantea, ITALY, 2008.
[6] ŽATKOVIČ, E., STRAKA, M.: Aspect of production projects, 2013. In: Transport & Logistics, Vol. 13 (28), p. 5, 2013. http://www.sjf.tuke.sk/transportlogistics/wp-content/uploads/Zatkovic_Straka_1.pdf.
[7] GABAJ, I., MIRANDOVÁ, G., KRAJČOVIČ, M.: FactoryCAD a FactoryFLOW, logistické nástroje Tecnomatixu. In: Produktivita a Inovácie. p. 18-19.
[8] STRAKA, M., MIKUŠOVÁ, Z., LENORT, R.: Analysis and assessment of warehouse stock, In: Hutnické listy, Vol. 66, no. 3, p. 44-48, 2013.

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INNOVATION LEAN PRINCIPLES IN AUTOMOTIVE GREEN MANUFACTURING

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Keywords: innovation, green manufacturing, lean management, production
Abstract: Today, industries such as automotive and manufacturing industries deal with a lot of environmental regulations. Lean is a production strategy whose fundamental principles drive the industry towards a more effective production of goods and services. The eco-efficiency concept is primary to sustainable development and intends to provide more value with less environmental impact. The aim of this study is to identify and explore the contributions of Lean to reduce environmental impacts that naturally result from industrial activity.

1 Lean Manufacturing System

Lean manufacturing is a efficiency based system on optimizing flow to minimizing the wastage and using advance methods to improve manufacturing system by modified or change pre-existing ideas [3].

Another definition say that Lean Manufacturing is a philosophy that aims to maintain smooth production flow by continuously identifying and eliminating waste resulting in increasing value of activities in the production process. Lean manufacturing approach makes an organization able to sustain market competition by improving its competence for better quality; on time delivery with lower cost Lean Manufacturing aims for Identification and elimination of waste (any activity that does not add value to customer) [1].

Lean manufacturing aims to continuous flow of all manufacturing processes with minimum as minimum wastage. The whole process must be free from waiting, disruption, and backflow.

The basic Elements of Lean Manufacturing System is [6]:
- KANBAN
- TPM (Total Productive Maintenance)
- JIT (Just In Time)
- KAIZEN (Change For Better)
- Quality Circles
- TQM (Total Quality Management)
- Employee Involvement
- 5's

Main benefits of Lean Manufacturing System is [6]:
- Improve productivity
- Overall wastage reduction
- Cost reduction
- Reduce defects
- Overall quality improvement

2 Principles of Green Manufacturing

According to Balan (2008), Green manufacturing is an approach, that all innovative techniques towards effective environmental solutions that result in cost savings from reduced work handling, effluent control, and process automation or other environmental and operational benefits [5]. Faster and cheaper are no longer the only two success measures of manufacturing a product or evaluating an existing process line but also other success factors such as materials used in manufacturing, generation of waste, effluents and their treatment method, life of the product and finally, treatment of the product after its useful life are important elements that added by green manufacturing approach as success factors [4], [5].

The issues that green manufacturing is mostly addressing in process level, and accordingly the objectives of green manufacturing can be stated as the following [10]:
- Provide a cleaner source of energy through new technology or approaches.
- Decrease energy consumption in processes by implementing new technology or approaches.
- Convert pollutants and wastes into byproducts and promote their use and recycling along with that of the product in order to reclaim the energy expended in the process and conserve resources.
- Maximize yield and minimize waste effluents via process improvements, such as by tailoring feedstock selection, selecting proper fuel mix, automation, and establishing control strategies via sensors with real-time feedback loops that control process parameters.

Following Table 1 summarizes similarities and differences between the two concepts - Lean and Green [2].

Table 1: Lean and Green manufacturing concepts comparison

Aspect	*Lean manufacturing*	*Green manufacturing*
Focus of the concept	Focuses on enhancing competitiveness through value creation for customers. Quality, waste minimization/elimination and delivery times are key issues.	Focuses on integration of environmental improvements of industrial processes and products. Reduction or prevention of pollution to air, water and land; reduction of waste at source; and minimization of risks to humans and other species are key issues
Basic principles of the concept	Includes a number of principles related to four categories: philosophy (long-term thinking), process (elimination of waste), people and partners (respect, challenge and grow them), and problems solving (continuous improvement and learning)	Includes principles related primarily to three categories: pollution prevention, reduction of use of toxic substances, and design for environment.
Product and/or process focus	Mainly focus on processes, but the products' influence on performance of processes is strongly acknowledged. Lean product development is a complementary view on the lean enterprise	Focus on both processes and products.
Methods/tools	Various tools are used for process improvements	Various tools are used for improvements of environmental performance of processes and products
Employee involvement	Involvement of employees is key in order to achieve continuous improvement and learning.	Involvement of employees is key in order to implement measures for improving environmental performance of both processes and products
Supply chain involvement	Customer focus and involvement as well as close cooperation with suppliers are important	Involvement of suppliers is essential because sharing and integration of ideas for environmental improvements across organizational boundaries will support the achievement of high environmental performance in manufacturing

3 Lean Impact on Enviromental Performance of Production Systems

Some automotive companies such as Toyota define their new production philosophies as a combination of lean and green approach in order to cope with market and society's heavy environmental requirements.

According to many case studies from praxis, it could be concluded that Lean management has a positive impact on environmental performance of production systems. This is particularly truth for continuous improvement culture and waste reduction. Figure 1 illustrates, by way of a cause-effect diagram (Ishikawa diagram), the origins and implications of waste within production systems [2].

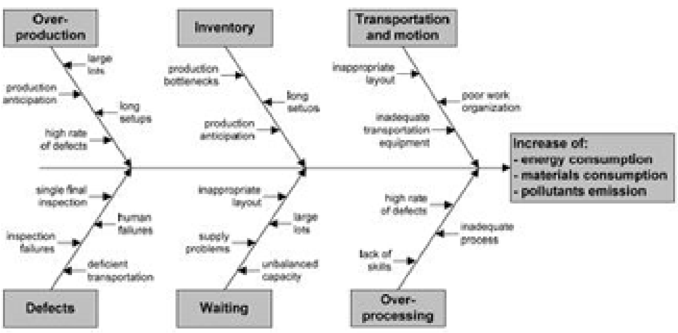

Figure 1: Production wastes of weak environmental performance

This diagram (Figure 1) includes the main causes of each type of waste providing thus valuable hints on how to reduce them. For example, the reduction of equipments' setup time (by applying the SMED methodology – Single Minute Exchange of Die) contributes to reduce both overproduction and inventory. These reductions naturally lower the energy and materials consumption while reducing the emissions. Figure 2 show the main effects of each production waste. All the consequences resulted from the 6 waste types, illustrated in figure 2, can be detailed within the previous classes of environmental impact, namely: energy use, materials consumption and emissions (Figure 1).

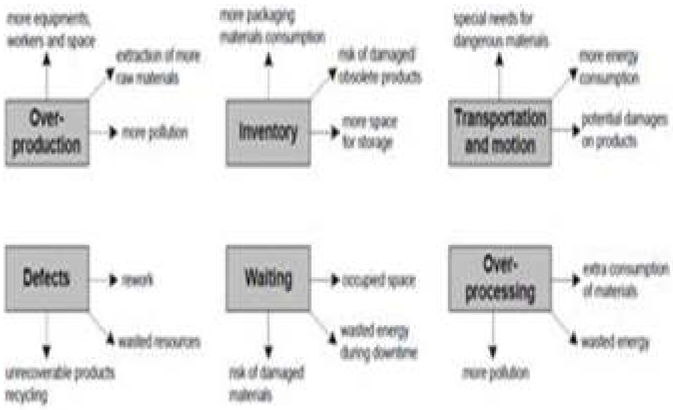

Figure 2: Effect of production wastes [2]

4 Tools and Implications for Enviromental Performance and Benefits

Lean tools can have a lot of implications to environmental waste in general. EPA's lean tools based researches conducted in organizations from various industries has provided an extensive knowledge regarding 5S, TPM, Cellular Manufacturing, JIT/Kanban, Kaizen Events, Six Sigma and their implications for environmental performance and benefits in waste reduction sense. In this chapter is sumarized list of summarizes lean tools and their implications for environmental performance and benefits from a broad environmental waste aspect including implications for chemicals and energy use [3], [7].

5S Method:

- Energy needs can be decreased under the Shine pillar when equipment is painted light colors and surroundings are cleaned.
- Enables workers to be aware of spills or leaks promptly in such workplace so that it makes less waste generation from spills and clean-up.
- Clearly-marked and obstacle-free thoroughfares can reduce potential for accidents of spills and associated

hazardous waste generation (e.g., spilled material, absorbent pads and clean up materials).

- Cleaning regularly, in case cuttings, shavings, dirt, and other substances are accumulated as well as contaminate production processes which can result in defects, can reduce energy and resources needs and avoid waste.
- Organizing and disposing of unused equipment and supplies, which can reduce floor space needed for operations, is benefit for environment because it can save heat and light.
- EPA has proved that organizing equipment, parts, and materials and making them easy find can reduce unneeded consumption because workers prefer to finish one batch of materials or chemicals before opening or ordering more when things are in good order.
- 5S visual cues (e.g., signs, placards, scoreboards, laminated procedures in workstations) can improve employee environmental management as well as increasing their awareness of waste handling and management procedures, workplace hazards and emergency response procedures [8], [9], [12].

TPM (Total Production Maintenance)

- Appropriate equipment and systems maintenance makes fewer defects from a process. Defects reduction can conversely help eliminate waste from processes in fundamental ways.
- TPM can prolong using-life of equipment. Hence, pressure is released for purchasing and/or making replacement equipment. In the other hand, it can also reduce the environmental impacts caused in processes to produce new equipment.
- TPM program may also decrease the solid and hazardous wastes associated with the number and severity of spills and leaks, upset conditions [10], [11], [12].

JIT/KANBAN

- Overproduction can be eliminated by the tool of JIT/Kanban. JIT/Kanban can also reduce waste and the use of energy and raw materials by elimination overproduction.
- JIT/Kanban systems can be applied to reduce inventory both in-process and post-process, which can help to avoid potential wastes caused by product handling [12], [13].

KAIZEN

- The core of Kaizen is to eliminate waste from a targeted process. The typical outcomes of Kaizen culture and process have many similarities to those required by environmental management systems, ISO 14001, and pollution prevention programs. Kaizen involves all workers who may play a critical part in a certain process as well as encourages them to take part in waste reduction activities. Suggestions or opinions on process improving and waste reduction are usually from employees who work in a particular process.

Six Sigma

- Six Sigma can reduce defects by removing variation from production processes. This, in turn, can help to remove waste from processes in three key ways: 1.Decrease the number of products that must be scrapped; 2.Reduce the raw materials, energy and resulting waste resulting from the scrap; 3.Decrease the amount of energy, raw material, and wastes caused by fixing defective products that need to be re-worked.
- Six Sigma tool can free workers to focus more on improving conditions that can cause accidents, spills, and equip mental functions. This can also help to achieve reduction of solid and hazardous wastes associated with spills, leaks, and their clean-up.
- Six sigma can extend product lifetime by increasing durability and reliability of product, in the other words, it can reduce the frequency to replace products, as well as decrease the environmental impacts resulting from meeting customer needs [12], [14], [15].

Sustainable and Lean construction tools enable project cost reduction and accelerated implementation.

- Safety plans
- Site recycle and waste management program
- Commissioning plan
- Lean construction scheduling process
- Lean supply and Lean assembly

Main Lean and sustainable lifecycle operations can be summarized as:

- Lean Sustainability Enterprise framework
- Performance tracking
- Operational efficiency and eco-efficiency
- Training and knowledge transfer
- Project selection, project implementation
- Mentoring and coaching of the organization for continuous improvement, change management and lasting results.

Lean and Sustainability principles are also applicable to the last stages of the facility life cycle. Cost-effective and sustainable decommissioning can be achieved by:

- Planning for decontamination and decommissioning
- Equipment refurbishing, relocation & reuse
- Sustainable building reuse or building demolition
- Recycling of materials collected during decommissioning
- Assistance site sale or lease

Green manufacturing also relies on several methods/tools. The methods/tools relates to both processes and products. In general, the methods/tools can be classified as assessment oriented or improvement oriented. The perhaps most well-known method/tool is the Life Cycle Assessment (LCA). It aims at analyzing environmental impacts over the entire life cycle (raw material extraction, material production, manufacturing, use, and end-of-life treatment) of a product (or service). Various improvement tools have also emerged, such as different DfE handbooks for various types of products, lists of restricted or banned substances, etc. Hence, both Lean and Green manufacturing rely on the application of various types of methods/tools [6], [16], [17] , [18].

Conclusion

Lean and Eco-efficient production systems are highly positive in their findings, resulting in strong evidence that Lean has in fact a positive contribution in the improvement of the environmental performance.

Green concept asserts reduction of material waste and emissions, fewer production steps which also support high resource productivity. Furthermore, the strong focus on continuous improvement in the Lean concept needs employee involvement and training. Improvements of environmental performance, as advocated by the Green concept, also require employee involvement and training. Both concepts require changed mindsets and establishment of company cultures supporting the philosophy underlying each concept. Another feature of the Lean concept is not only to solve any problem that occurs in manufacturing, but to avoid occurrence in the future. This displays similarities with the Green manufacturing concept, which advocates source reduction. That is, attention should be paid to avoidance of negative environmental impacts rather than use of “end-of-pipe” solutions when the impacts occur.

While the depth and variety of these manufacturers' investments are indicative of the automotive industry's movement towards greater use of renewable energy sources and "greening" manufacturing processes, there is still a tremendous amount of untapped potential, both for the industry, and for the nation as a whole. To realize this potential, companies need to take a holistic approach to updating their facilities and define a comprehensive sustainability strategy that is scalable, replicable, and economically viable. Simply "greenwashing" a facility is not sustainable; the automotive industry needs to focus on the environmental impact of its decisions as well as the operational and economic impact of its investments in clean technologies.

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References

[1] CHAHAL, V.: An Advance Lean Production System In Industry To Improve Flexibility And Quality In manufacturing By Implementation Of FMS & Green Manufacturing. International Journal of Emerging Technology and Advanced Engineering, Certified Journal, Volume 2, Issue 12, December 2012.
[2] JOHANSSON, G. – WINROTH, M.: Lean vs. Green manufacturing: Similarities and differences. Available online: http://www.researchgate.net/profile/Mats_Winroth/publication/257492917_Lean_vs._Green_manufacturing_Similarities_and_differences/links/547c92e80cf2cfe203c1add7.pdf
[3] WANG, H., SEZEN, M. B.: Lean and Green Production Development. School of Innovation, Design and Engineering, November 2011.
[4] ANASTAS, P.T., ZIMMERMAN, J.B.: Design through the Twelve Principles of Green Engineering. Environmental Science and Technology. 37. (5), pp 94A-101A, 2003.
[5] BALAN, K.: Introduction to Green Manufacturing. The Shot Peener. 22. (3). pp 4-6, 2008.
[6] MOREIRA, F., ALVES A.C. – SOUSA, R.: Towards Eco-efficient Lean Production Systems. Production and Systems Engineering Department University of Minho, Portugal. Available online: https://repositorium.sdum.uminho.pt/bitstream/1822/19102/1/BASYS10-CR-PAPER%2350.pdf
[7] U.S. Environmental Protection Agency (EPA). The Lean and Environment Toolkit. http://www.epa.gov/lean/toolkit/LeanEnviroToolkit.pdf
[8] U.S. Environmental Protection Agency. What is Green Engineering. http://www.epa.gov/opptintr/greenengineering/pubs/whats_ge.html
[9] GERSTEL, D., GILMAN, D., NGUYEN, T.: Driving forward with green manufacturing. March 2013. Available online: http://www.pwc.com/us/en/technology/publications/cleantech-perspectives/pdfs/pwc-cleantech-green-manufacturing.pdf
[10] PAL, U.: Identifyingthe path to successful green manufacturing. The Journal of the Minerals, Metals & Materials Society (JOM). 54. (5). pp 25, 2002.
[11] NUNES, B., BENNETT, D.: Green Innovation Management in the Automotive Industry. Aston University, UK 2011. Available online: http://www.iande.info/wp-content/uploads/2011/03/Green-Innovation-Management.pdf
[12] WITKOWSKI, K., SANIUK, S.: Aspect of logistics management of the city infrastructure, Logistyka 41 (2), pp. 589-600., 2011.
[13] www.epa.gov

Volume: 1 2014 Issue: 4 Pages: 23-27 ISSN 1339-5629

[14] FIĽO, M., KLIMENT, M.: Data management in the enterprise and their synergy in the complex system of plm: Manažment podnikov. Roč. 4, č. 2, p. 57-60, 2014.
[15] TREBUŇA, P., KLIMENT, M., MARKOVIČ, J.: PLM and its benefits and use in the management of complex business activities in the planning and optimization of production activities, 2013. In: Manažment podnikov. Vol. 3, Issue 2, p. 53-56, 2013.
[16] SANIUK, S., SANIUK, A., LENORT, R., SAMOLEJOVA, A.: Formation and planning of virtual production networks in metallurgical clusters, Metalurgija, 53 (4), pp. 725-727, 2014.
[17] BOŽEK, P., KŇAŽÍK, M., ŠTOLLMANN, V.: Conceptual planning and scheduling of operating funds for the real production of the company, Jaroměř: Technological forum: 5th International Technical Conference, Kouty, p. 192-198, 2014.
[18] TRNKA, K., PINTÉR, T., KŇAŽÍK, M., BOŽEK, P.: Effective programming of energy consumig industrial robot systems, Bratislava: STU in Bratislava, In: Power Engineering. Energy – Ecology – Economy, [Electronic], Conference EEE p. 4, 2012.

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THE METHODOLOGIES FOR INVENTORY ANALYSIS IN THE LOGISTIC CHAIN OF AN ENTERPRISE

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Keywords: inventories, materials, consumption, resources, material substitution
Abstract: Stocks in the process of extended reproduction in a production and in a circulation are items (capital goods and consumer goods), which are stored for later consumption. Their need is caused by a discrepancy between cycles of supplies and consumption of individual stocks in a production, by a specific seasonality, transportation of certain amounts which are not in conformity with current consumption.

1 Introduction

Inventories are material assets in enterprises' premises being part of non-current assets used on a short-term basis. The role of inventories is to ensure continuous and economic production connected with a high level of capacity yield and to hide non-synchronous capacities and processes prone to failures. Inventories can be of positive influence when solving time and product mix-related non-conformities resulting from different unexpected deviations and outages of material production or delivery. In last few years, the way inventories are looked at has changed substantially. They are no longer the first alternative to use when trying to ensure the flexibility in production. Currently, they are seen as the last resort for enterprises [1].

The negative side of inventories is that there are significant capital funds tied up in therm. Moreover, inventories cause further costs and expenses related to their maintenance and there is a risk of their deterioration, obsolescence or unsaleability related to space, capacity or demand when trying to achieve optimum batches and dampen down. From the logistics point of view, inventories have been treated with a significant difference. They are no longer considered the first alternative how to ensure flexible and reliable chain functioning. Currently, they are the last resort or, in other words, emergency solution. From the perspective of logistics, inventories are no longer corporate assets. For logistics they are liabilities.

2 The methodologies for inventory analysis in the logistic chain of an enterprise

Inventories are material assets in enterprises' premises being part of non-current assets used on a short-term basis.

The role of inventories is to ensure continuous and economic production connected with a high level of capacity yield and to hide non-synchronous capacities and processes prone to failures. Inventories can be of positive influence when solving time and product mix-related non-conformities resulting from different unexpected deviations and outages of material production or delivery.

In last few years, the way inventories are looked at has changed substantially. They are no longer the first alternative to use when trying to ensure the flexibility in production. Currently, they are seen as the last resort for enterprises [7].

The negative side of inventories is that there are significant capital funds tied up in therm. Moreover, inventories cause further costs and expenses related to their maintenance and there is a risk of their deterioration, obsolescence or unsaleability related to space, capacity or demand when trying to achieve optimum batches and dampen down. From the logistics point of view, inventories have been treated with a significant difference. They are no longer considered the first alternative how to ensure flexible and reliable chain functioning. Currently, they are the last resort or, in other words, emergency solution. From the perspective of logistics, inventories are no longer corporate assets. For logistics they are liabilities.

2.1 Method of Determining Corporate Stock Levels in a Corporate Logistic Chain

Inventory is any available economic source that is not fully used in the given time interval and its amount is determined so as to able to cover future demands in the best way possible from economic point of view.

Inventories as an item subject to management characterise the active part of corporate capital, which is fully transferred in the manufacturing process of each enterprise and, at the same time, becomes part of corporate performance (product).

Inventories are a first-line cost factor [3].

2.1.1 Standardising Material Stock and Its Consumption

Stock standard – relative values:

$$Z_r = \frac{-DC}{2} + Z_i \cdot \check{C} \tag{1}$$

Stock standard – absolute values:

$$Z_a = Z_r \cdot S_d \tag{2}$$

where:
Z_r = *Material stock standard in its relative time values;*
DC= Average cycle of given material deliveries (in days);
$Z_i \cdot \check{C}$ = *Material safety stock expressed in time units;*
Z_a = *Material stock standard in its absolute values;*
S_d= *Average daily consumption of the material given;* [3]

Then, the turn-round time of a particular item will be calculated as follows:

$$O_d = \frac{-Z_a}{S_d} \tag{3}$$

and the number of given material turns for a certain period of time will be:

$$O_p = \frac{S_c}{Z_a} \tag{4}$$

where:
S_c= *Total consumption of a given material item for time periods monitored;*

2.1.2 Utilisation of Material Sources

The index of average consumption dynamics per one type of material sources for different types of production is expressed by the following formula:

$$I_{ds} = \frac{\sum m_1 q_1}{\sum m_0 q_1} \tag{5}$$

where:
I_{ds}= *Index of consumption dynamics;*
$m_1 m_0$= *Material consumption calculated per unit of production in the monitored and preceding period;*
q_1= *Volume of all kinds of products manufactured from the material given;*

The index of average consumption dynamics per several types of material per unit of production consisting of several types of products is expressed by the following formula [3]:

$$I_{ds} = \frac{\sum m_1 c_0 q_1}{\sum m_0 c_0 q_1} \tag{6}$$

where:
I_{ds}= *Index of consumption dynamics,*
c_0 = *Production or wholesale price of materials;*

2.1.3 Material Consumption

Material consumption (*S*) needed in order to manufacture a product consists of the net consumption of weight or volume of a finished product (S_c), waste (O_d) and non-returnable loss (S_n). In other words [3]:

$$S = S_c + O_d + S_n \tag{7}$$

The degree of useful application of material is expressed in percentage, i.e. as the **utilisation factor** (*Kv*). It is used to calculate the above for single product as well as for all materials used.

$$Kv = \frac{S_c}{S}, Kv = \frac{S_c}{S_c + O_d + S_n}, Kv = \frac{S - O_d - S_n}{S} \tag{8}$$

The loss indicator (*Ms*) concerning materials in connection with mechanical wear is calculated as follows [3]:

$$Ms = \frac{O_d}{S} \cdot 100\% \tag{9}$$

As regards machining, apart from the loss indicator the percentage of economic efficiency related to waste reduction is also specified:

$$H_s = \frac{(Ms_0 - Ms_1)\% \cdot S_1}{100} \tag{10}$$

where:
H_s= *Percentage of economic efficiency concerning waste reduction;*
Ms_0 *and* Ms_1= *Classes of wastes generated from materials in the basic or recorded period (%);*
S_1 = *Total consumption of materials related to machining;* [3]

2.1.4 Consumption Standard

The average standard of consumption and average percentage of material consumption for the identical kinds of products are specified as per the following formula [3]:

$$N_s = \frac{\sum n_i q_1}{q_1}, Ns_p = \frac{\sum n_1 q_1}{q_1} \quad (11)$$

where:
N_s= *Average standard of consumption;*
N_{sp} = *Average percentage of consumption;*
n_i *a* n_1 = *Individual standard and ratio of consumption of monitored materials for different products of the same type;*
q_1 = *Amount of products of each kind produced in the period monitored;*

The average percentage of consumption standard reduction is expressed as follows:

$$N_z = \frac{\sum n_{i1} \cdot \mathrm{q_p} \cdot 100}{\sum n_{i0} \cdot \mathrm{q_p}} - 100\% \quad (12)$$

where:
N_z= *Percentage of consumption standard reduction;*
n_{i0}= *Standards of material consumption in relation to different types of products produced in the preceding period;*
n_{i1}= *Standards of material consumption in relation to different types of products produced in the monitored period;*
q_p = *Planned amount of products per each type in the period monitored;* [3]

The index of consumption standard fulfilment (i_n) for several types of production is calculated as follows:

$$i_n = \frac{\sum n_i \cdot \mathrm{q_1}}{\sum n_1 \mathrm{q_1}} \quad (13)$$

where:
$\sum \mathrm{n_1 q_1} - \sum \mathrm{n_i q_1}$ = *Specifies the economic (+) or excessive (-) consumption of materials in the period monitored;*
q_1= *Manufactured amount of products of each kind in the period monitored;* [3]

2.1.5 Material Substitution

Released materials represent a large amount of scarce material released due to its substitution by some other material. The amount is determined as follows [3]:

$$M_1 = \sum q_1 n_i, \quad \text{or} \quad M_1 = \sum q_1 n_1 \quad (14)$$

where:
M_1 = *Volume of released scarce materials;*
n_i *a* n_1 = *Consumption standard and percentage of consumption of scarce materials per unit of specified production types;*
q_1 = *Total amount of products of each kind manufactured from substituting materials;*

When substituting material in an enterprise ***savings are created*** thanks to the use of substituting materials calculated through the following formula:

$$H_{po} = \sum q_1 (N_{sn} \cdot \mathrm{VC_n} + \mathrm{S_n}) - \sum q_1 (N_{sv} \cdot \mathrm{VC_v} + \mathrm{S_v}) \quad (15)$$

where:
H_{po}= *Economic efficiency on the corporate level;*
N_{sn} = *Consumption standard of substituting materials;*
N_{sv} = *Consumption standard of substituted materials;*
VC_n = *Wholesale price of substituting materials;*
VC_v = *Wholesale price of substituted materials;*
S_n = *Value of products manufactured from substituting materials;*
S_v = *Value of products manufactured from substituted materials;*

The economic efficiency concerning the utilisation of substituting materials (H_{nh}) of different products can be, from the financial point of view, calculated upon the consideration of the length of such product use by consumers, e.g.:

$$H_{nh} = \sum q_1 (N_{sn} \cdot \mathrm{VC_n} + \mathrm{S_n}) - \sum q_1 \left(N_{sv} \cdot \mathrm{VC_v} + \mathrm{S_v} \frac{t_n}{t_v} \right) \quad (16)$$

where:
t_n= *Length of the use of products manufactured from substituting materials;*
t_v= *Length of the use of products manufactured from substituted materials;*

The calculation of efficiency of material substitution shows how much more efficient is to use substituting materials for manufacturing purposes compared to initial materials:

$$K_e = \frac{n_v}{n_n} \cdot \frac{\mathrm{C_v}}{\mathrm{C_n}} \cdot \frac{\mathrm{K_n}}{\mathrm{K_v}} \cdot \frac{\mathrm{t_n}}{\mathrm{t_v}} \quad (17)$$

where:
K_e = *Coefficient of substitution efficiency;*
n_n *a* n_v = *Consumption standards concerning substituting and substituted materials;*
K_n *a* K_v = *Coefficient of the use of substituting and substituted materials in manufacturing process;* [3]

2.1.6 Warehouse Management

The warehouse turnover time of materials (O_d) is calculated using an average stock balance (Z_1), number of days in the period monitored (d) and turnover of such warehouse (O_s) using the following formula: [3]

$$O_d = \frac{\mathrm{Z_1 \cdot d}}{\mathrm{O_s}} \quad (18)$$

The stock turnover is a sum of materials taken from a warehouse and materials issued from such warehouse.

The rate of stock turnover (O_r) is calculated as:

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$$O_r = \frac{O_s}{Z_1}, \text{or } O_r = \frac{d}{O_d} \quad (19)$$

Table 1 Comparison of the advantages and disadvantages of stockholding

	Advantages	Disadvantages
Input stock	• Generating strategic inventories used in the case of late deliveries • Using bulk discounts/rebates • Rational investment should price increase be expected	• Unnecessary costs related to stock maintenance • Capital tied up in inventories • Increase in stock costs reduces the return on investment • Inventories reduce corporate liquidity • Risk of deterioration or obsolescence
Work-in-process stock	• Effective use of capacities in production • Better flexibility related to production scheduling • Removal of irregularities related to corporate plan fulfilment	
Finished product stock	• Eliminating demand variations • Balanced supplying of customers • Safety stock related to production failures	

The stock turnover in the period monitored is calculated as:

$$O_{rp} = \frac{M_p}{\overline{Z_p}}, \text{ or } O_{rs} = \frac{M_s}{\overline{Z_s}} \quad (20)$$

where:
O_{rp} and O_{rs} = Planned and actual number of turnovers in the period monitored;
M_p and M_s = Planned and actual volume of production from warehouses in the period monitored;
$\overline{Z_p}$ and $\overline{Z_s}$ = Planned and actual average product stock balance;

A relative increase or decrease of ***actual average stock*** (Z_r) caused by faster or slower turnovers of stock compared to the planned turnover is calculated as a difference between the average actual and average planned stock using the following formula [3]:

$$Z_r - \overline{Z_p}, \text{ and } Z_r = \frac{M_s}{O_{rp}} \quad (21)$$

2.1.7 Warehouse Performance/Outputs

The indicator of stock keeper's ***performance*** is expressed as:

$$v = \frac{O}{P} \text{ or } v = \frac{M}{P} \quad (22)$$

where:
v = Performance of a single worker in a warehouse;
O = Total turnover from implementation,
P = Average number of employees working in a warehouse;
M= Total number of unloading and loading jobs in a warehouse; [3]

The coefficient of (K_m) stock work ***mechanisation*** is expressed by the following formula:

$$K_m = \frac{M_m}{M} \quad (23)$$

where:
Mm= Volume of stock handling jobs carried out using machines [3].

2.2 Defining the Structure and Level of Sales Stock

In last few years, the way inventories are looked at has changed substantially. They are no longer the first alternative to use when trying to ensure the flexibility in production. Currently, they are seen as the last resort for enterprises.

2.2.1 Effective Level of Sales Stock

The effective level of sales stock specifies the amount of finished products and the number of days, for which such finished products are stored in corporate sales warehouses from the moment of their takeover from production to the moment of their dispatch to customers. It is determined by [3]:

- The technical and economic calculation of basic elements forming stock;
- The use of warehouse statistic data for the period preceding the given period;

The statistical approach concerning the effective level of sales stock specification is determined on the basis of records from years preceding the given year.

Calculation-based method of sales stock standardisation

The volume of sales stock ***expressed in physical units*** is influenced by an average daily movement of products from production to sales warehouses (*M*) and by the time of such product storage (C_s) [3].

a) In the case of continuous production and continuous product supply to sales warehouses:

$$N_s = M \cdot C_s \quad (24)$$

b) In the case of production characterised by irregular product supply to sales warehouses with the interval of several supplies per month [3]:

$$N_n = \frac{M_p \cdot \mathrm{C_s}}{\mathrm{D}} \qquad (25)$$

where:
Ns= Effective level of sales stock;
Nn= Effective level of stock with irregular product supply to warehouses;
Mp= Average amount of products handed over to sales warehouses;
D= Number of work days in a month;

b) The effective stock level expressed in days is calculated based on the following formula: [3]

$$N_d = \frac{N_s \cdot \mathrm{D}}{\mathrm{Z_z + P_v + Z_k}} \text{ or } N_d = \frac{N_s}{\mathrm{M_e}} \qquad (26)$$

where:
N_d= Effective level of sales stock expressed in days;
N_s= Effective level of sales stock expressed in physical units;
$\mathrm{P_v}$= *Average number of products handed over to sales warehouses;*
Z_z= Sales stock in warehouses at the beginning of a month;
Z_k= Sales stock in warehouses at the end of a month;
M_e= Average amount of products dispatched to customers each day;

Value-based effective level of sales stock [3]:

$$N_h = N_f \cdot \mathrm{VC} \qquad (27)$$

where:
N_h= Value-based effective level of sales stock;
Nf= Effective stock level expressed in physical units;
VC= Wholesale price;

The duration of product storage in sales warehouses (C_s) depends on many factors. Following the receipt of such products in warehouses it is necessary to divide them based on their types and store them in a relevant place in a warehouse [3].

The time necessary for the performance of these ***storage operations*** (C_o) is calculated as the sum of all time period necessary for individual operation performance:

$$C_o = C_1 + C_2 + C_3 + \ldots + C_i \qquad (28)$$

where:
$C_{1,2,3,\ldots i}$ = time periods necessary for each operation performance; [3]

The time necessary for product ***treatment*** (C_u) in sales warehouses can be specified as follows:

$$C_u = \sum \frac{M_s}{N_r \cdot \mathrm{P_r}} \text{ or } C_u = \sum \frac{M_s \cdot \mathrm{N_u}}{\mathrm{P_r}} \qquad (29)$$

where:
M_s= Amount of products to be treated in a single operation;
N_r= Effective performance of a single employee per given operation and per shift;
P_r= Number of employees carrying out this operation per shift;
N_u= Effective time period necessary for single product treatment; [3]

2.2.2 Sales Stock Balance

At the end of each period actual and planned balances of sales stock are specified by the following relation [3]:

$$Z_{pk} = Z_{sz} + V_p - D_p \qquad (30)$$

$$Z_{sk} = Z_{sz} + V_s - D_s \qquad (31)$$

where:
Z_{pk}= Planned balances of sales stock at the end of the period monitored;
Z_{sk}= Actual balances of sales stock at the end of the period monitored;
Z_{sz}= Actual balances of sales stock at the beginning of the period monitored;
V_p= Planned production in the period monitored;
V_s= Actual production in the period monitored;
D_p= Planned product deliveries;
D_s= Actual product deliveries;

The fulfilment of delivery plans is mainly influenced by the following three factors:

- Production plan fulfilment;
- Mobilisation of finished product stock;
- Transportation activities;

The percentage of their individual impact is specified in amounts and percentage and shows exceeded or not fulfilled delivery plans [3].

a) Production plan fulfilment

$$V_{vm} = V_s - V_p \text{ (MJ)} \qquad (32)$$

$$V_{vc} = \frac{(V_s - V_p)100}{D_p} (\%) \qquad (33)$$

where:
V_{vm}= Influence of production expressed as the number of products delivered;
V_{vc}= Influence of production expressed as the percentage of products delivered;
V_s= Actual number of manufactured products in the period monitored;

V_p= *Planned number of products to manufacture in the period monitored;* [3]

b) Mobilisation of finished product stock

$$V_{zm} = Z_{pk} - Z_{sk} \text{ (MJ)} \quad (34)$$

$$V_{zc} = \frac{(Z_{pk} - Z_{sk})100}{D_p} (\%) \quad (35)$$

where:
V_{zm}= *Influence of the mobilisation of delivered product stock expressed in mass units;*
V_{zc}= *Influence of the mobilisation of delivered products expressed as percentage;*
Z_{pk}= *Planned stock at the end of the period monitored,*
Z_{sk}= *Actual stock at the end of the period monitored;* [3]

c) Transportation activities

$$V_{dm} = D_{zs} - D_s \text{ (MJ)} \quad (36)$$

$$V_{dc} = \frac{(D_{zs} - D_s)100}{D_p} (\%) \quad (37)$$

where:
V_{dm}= *Influence of transportation expressed in mass units;*
V_{dc}= *Influence of transportation expressed as percentage;*
D_{zs}= *Actual source of deliveries calculated as follows* [3]:

$$D_{zs} = V_s + (Z_{sz} - Z_{sk}) \quad (38)$$

3 Conclusions

The theory of inventory management provides a wide range of management costs support and therefore it creates an important part of the analysis of logistics systems of companies in the market environment. Effective management of stocks, despite of extensive theoretical modelling techniques, is limited by a number of problems in specific conditions, which should be constantly solved by a management of particular companies. The easiest way is to manage stocks in an enterprise, which sale is not a subject of a strong seasonal influences over a longer period of time. Inventory management is an important factor to achieve better business performance. Inappropriate inventory levels are causing problems, the worst of which is the creation of excessive costs. In addition, overstocks bind a capital that could be used to finance other business needs, reducing stocks can increase productivity, but their lack may lead to the loss on the company's performance. Thus, the current trend is a large, or complete elimination of stocks.

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References

[1] BIGOŠ, P., KISS, I., RITÓK, J., KASTELOVIČ, E.: Materials flows and logistics II., Materiálové toky a logistika II., Košice: Elfa, 2008. (Original in Slovak)
[2] EMMETT, S.: Management of supplies, Řízení zásob, Brno: Computer Press a.s., 2008. (Original in Czech)
[3] HORČIAK, J.: Deliver-customer relationships in industry, Dodávateľsko-odberateľské vzťahy v priemysle, Bratislava, 1983. (Original in Slovak)
[4] LAMBERT, D., STOCK, J.R., ELLRAM, L.: Logistics, Logistika. Brno: CP Books a.s., 2005. (Original in Czech)
[5] MALINDŽÁK, D. et al.: Aplication of modeling and simulation in company logistics, Aplikácia modelovania a simulácie v logistike podniku, Košice: TU, FBERG, p. 286, 2009. (Original in Slovak)
[6] MALINDŽÁK, D. et al.: Modelling and simulation in logistics (theory of modeling and simulation), Modelovanie a simulácia v logistike (teória modelovania a simulácie), 1. edit., Košice: TU, p. 182, 2009. (Original in Slovak)
[7] ROSOVÁ, A.: Purchasing and supplying logistics, Logistika nákupu a zásobovania, Košice: Dekanát - Edičné stredisko, 2011. (Original in Slovak)
[8] ROSOVÁ, A.: Logistics of firm supply with application of alfa-omega matrx, Logistika zásobovania firmy s aplikáciou alfa-omega matice. In: Strojárstvo. Vol. 11, No. 7-8 (2007), p. 83/13-85/15, (2007). (Original in Slovak)
[9] SANIUK, A., SANIUK, S.: Application of the theory of constraints for resource management of micro and small enterprises, Zastosowanie teorii ograniczeń w zarządzaniu zasobami mikro i małych przedsiębiorstw, 355-363, Zeszyty Naukowe Uniwersytetu Szczecińskiego, 2010. (Original in Polish)
[10] SANIUK, A., SANIUK, S., WITKOWSKI, K.: Using Activity Based Costing in the metalworking processes, METAL 2011, TANGER, 2011.
[11] SCHULTE, G.: Logistics, Logistika, 1. edit., Praha, Victoria Publishing, p. 301, 1994. (Original in Czech)
[12] STRAKA, M.: Logistics of distribution, How effectively put product into the market, 1st edition, Bratislava, EPOS, p. 400, 2013. (Original in Slovak)

[13] VIESTOVÁ, K. et al.: Lexicon of logistics, Lexikón logistiky, 2nd edit., Bratislava: Iura Edition, p. 204, 2007. (Original in Slovak)

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