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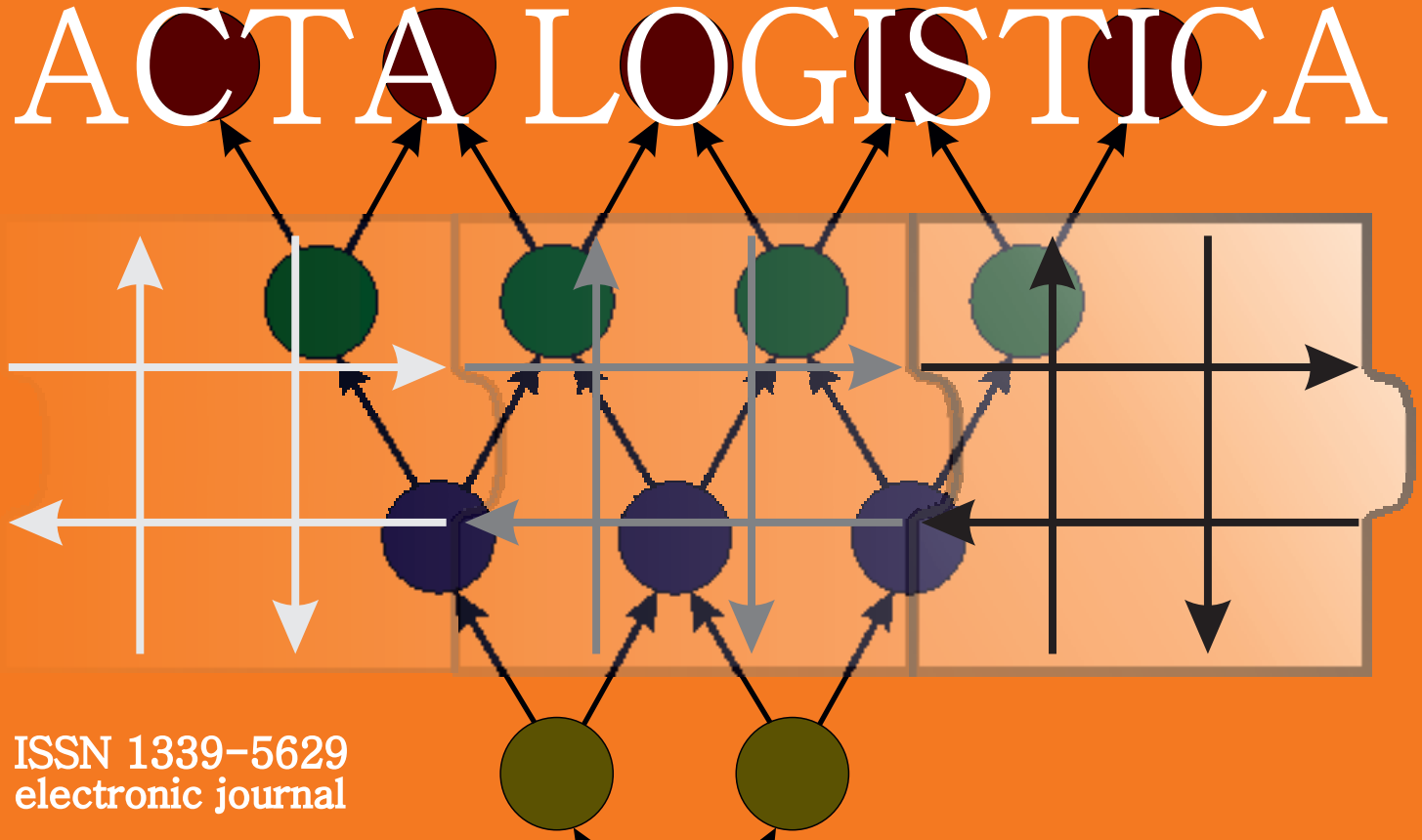

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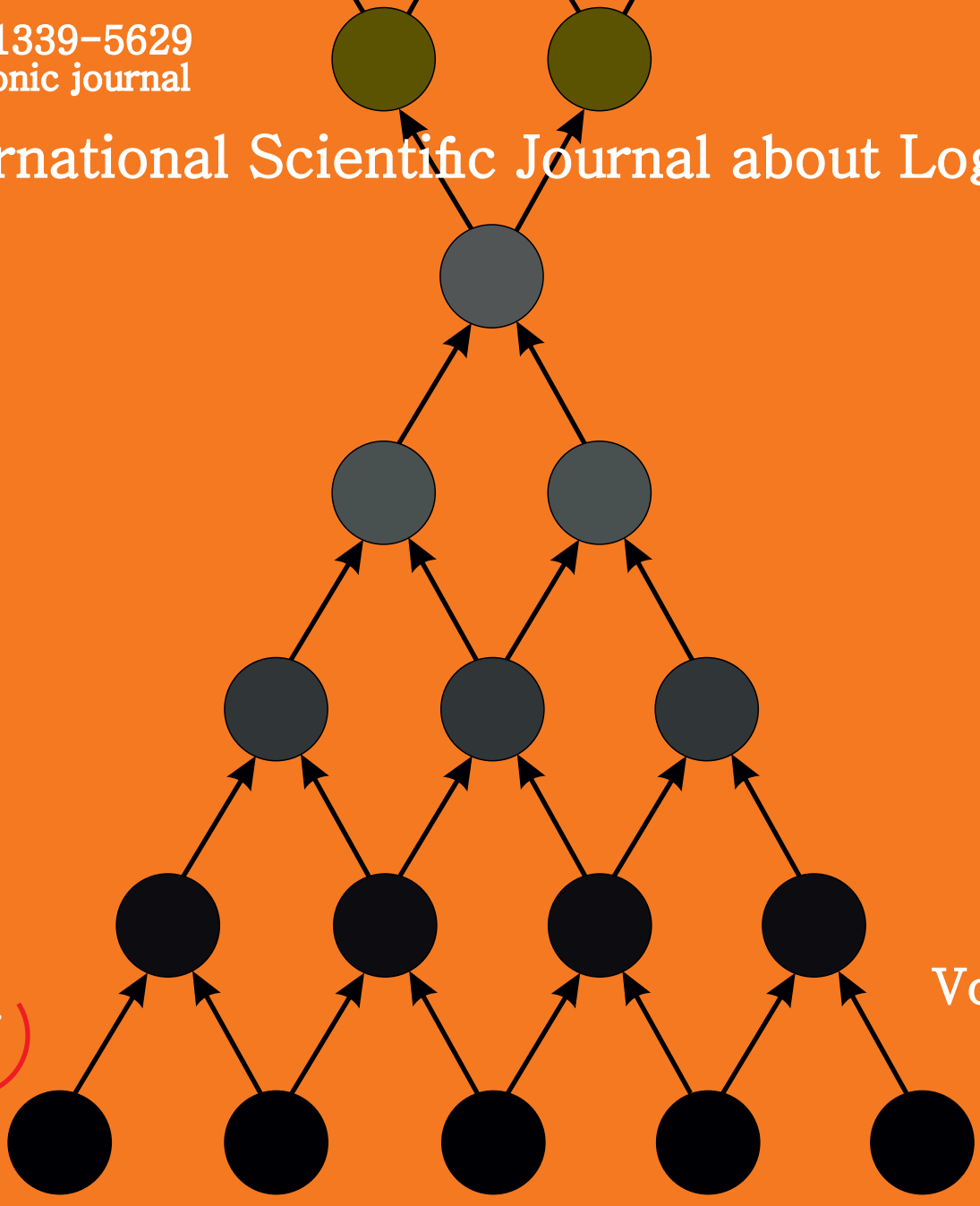

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EVALUATION OF SUPPLIERS' QUALITY AND SIGNIFICANCE BY METHODS BASED ON WEIGHTED ORDER

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Abstract: Slovakia has become one of the leading automobile manufacturers in Central Europe, mainly due to the presence of three global automakers - Volkswagen (Bratislava), PSA Peugeot Citroën (Trnava) and Kia Motors (Žilina). There is the automotive industry necessary for the development of the Slovak economy as decisive industry. Many businesses work right for the automotive industry. A substantial part of these companies is engaged in plastic products, such as the production of large-size plastic mouldings such as dashboard, car door trim and the like. These mouldings are produced on large-size injection moulding machines, with massive injection moulds. One of the problems of these companies is the handling of these massive forms, which can weigh tens of tons. The article is devoted to the design of the transport device, which is designed for the transport of this type of moulds, which is able to easily and safely secure moulds of various dimensions and transport them from the press to the mould warehouse, or vice versa from the mould warehouse to the injection press. There is the strength calculation of the structure is solved using FEM in conclusion.

1 Introduction

The inter-operative transport and storage is one of the limiting factors for the further development of assembly processes. The automotive industry is a decisive industry and a driving force for the development of the Slovak economy [1,2]. The development of progressive technical means for realization of inter-operational transport and storage is initiated mainly by the requirements of flexibly automated production [3,4]. A quick and flexible connection of individual assembly workplaces, systems and their functions as a whole by material flow is important.

A task of means for inter-operational transport and handling is to ensure material flow between individual assembly workplaces and systems. It is necessary to ensure the material flow of all kinds of objects, tools, jigs and materials necessary for the implementation of the assembly process. The inter-operative transport is designed as an integral part of the assembly process. It is necessary to ensure system coherence between the types and types of assembly, handling and transport equipment and their technical parameters [5-9].

Transport machines and handling equipment reach through all fields of the national economy by their commitment and activity. Each production process consists of handling, transport and ancillary work because only their joint and mutual interaction produces a product. Material handling is therefore an important part of any industrial process. Evaluated economic studies show the value of each of the sub-operations and work operations that follow and follow each other. They are realized by means of transport and handling equipment. Thus, not only operations and technological, operations are important for the realization of production, but also includes an average handling cost of 10 to 30%. Modern engineering production cannot do without perfectly solved material handling as well as means of transport for transportation [10-12].

For many years, the automotive industry has been the engine of the Slovak economy and directly employs approximately 120,000 people. After counting the money spent by both companies and people involved in the production of passenger cars, the number of dependent jobs will increase to 200,000. Last year, automobile production alone accounted for up to 44 percent of the Slovak industry and exports of passenger cars accounted for 35 percent of domestic exports. For several years Slovakia has been leading the number of cars produced per thousand inhabitants [1].

This article was created based on the requirement of a company working for the automotive industry. This company produces large-sized plastic mouldings such as dashboard, car door trim and the like. These mouldings are produced on large-size injection moulding machines, with massive injection moulds. One of the problems with this business was the handling of these massive forms, which can weigh tens of tons.

The material handling means can be divided into different aspects. In terms of the path travelled by the material being handled, these means are divided into free-moving material means, material-free moving material means and path-independent means. In terms of temporal continuity, the handling means can be divided into continuous and periodically operating means as well as cyclically operating means. In terms of the forces acting on the handling means, we can divide them into gravity, with mechanical force transfer and with transport in auxiliary medium. From the point of view of manipulated material, the manipulation means can be divided into loose materials, lump material and liquids and gases [13].

Transport trucks are the most used handling means of transport. They are used for a material transport and storage, in between object, inside object, in-process transport and in warehouses.

The article is devoted to this issue of transport equipment design which is designed for the large-size moulds transport. This device must be able to easily and safely secure the injection moulds of different dimensions and transport them from the press to the mould store or from the mould store to the injection moulding machine.

2 Characteristics and requirements given to handling equipment

The task was to design a transport device for transporting a mould from an injection moulding machine to a warehouse and vice versa from a warehouse to a press. It was an injection moulding machine of the type Engel duo 1500, with a clamping force of 1500 tons. This press can work with the largest mould size 1400 x 700 x 3750 mm, which can weigh up to 30 tons. It was therefore necessary to design a transport device, hereinafter referred to as a trolley, with a lifting capacity of 30 tonnes, with an adjustable arresting device for various mould sizes.

The transport truck design was inspired by road vehicles, namely low loaders for the transport of heavy civilian and military equipment, automatically controlled forklift trucks and construction solutions used in trucks.

The load-bearing structure shall be designed and assembled to withstand, with the appropriate degree of reliability, all the loads and influences which may be incurred during construction and operation during the proposed service life. To meet the appropriate usability requirements specified for the load-bearing structure or load-bearing element. The load-bearing structure shall be dimensioned to have adequate resistance, durability and usability [14-16].

The particular design situations shall be appropriate to the circumstances that may actually occur and where the load-bearing structure is required to perform its function. Design situations must be classified as:

- permanent design situations under which normal use is understood,
- temporary design situations, e.g. during transportation or assembly,
- extraordinary design situations, these are exceptionally the conditions to which the structure is exposed, e.g. earthquake and the like [17].

The design situations selected must be sufficiently rigorous and at the same time diverse to include all circumstances that may actually occur [18].

We know two types of limit states, namely the ultimate limit states and the serviceability limit states.

The ultimate limit state is that which is before the collapse of the structure. The load-bearing structure shall be checked for ultimate limit states where:

- loss of stability of the structure or any part thereof,
- failure of excessive deformation, transformation of the load-bearing structure or some of its parts into a movable mechanism, various types of material failure, loss of stability of the supports of the structure or foundations,
- fatigue or other time-dependent effects.

The serviceability limit state is considered to refer to the function of a given structure or load-bearing elements during normal use [19]. This includes large sags or large cracks. The verification of these limit states should be based on the following considerations:

- deformations that change the appearance of the structure or the serviceability of the structure,
- vibration which limits the fitness of the structure,
- permanent damage that may adversely affect the service life or performance of the structure.

The structure design according to limit states must be based on simulation models of structure and loads for particular limit states. It must be verified that none of the limit states is exceeded [14].

3 Design of transport equipment

3.1 Carrying steel structure

Carrying structures or transport truck frames can be welded or riveted from bent sheets or rolled steel profiles. Steel profiles are most often in the form of I, O, U, Z and the like. Some vehicle frames are made of round, square, rectangular, etc. tubes. with different wall thickness [20].

The frames are most commonly rectangular ribs, consisting of two longitudinal beams on which the crossbars are arranged. Such frames are popularly used in the production of commercial vehicles, semi-trailers,

trailers, etc. The individual parts of the frames are joined by welding or riveting [21-24].

It often happens that over time it is necessary to modify the device lifting platform, crane, etc. In this case, the vehicle frame needs to be strengthened at specific critical points. As often as possible, different reinforcements (profiles) are welded to the most stressed places of the frame [25].

The supporting steel structure (Figure 1) of the trolley is made by welding UPE 300 steel profiles, 15 mm thick steel plate and smaller 15 mm thick steel plates. To reduce the overall height of the trolley, UPE profiles at both ends are reduced by 185 mm. The individual parts are welded with a corner weld. The bottom plates serve for holding the spring bed. The relief holes are burned in the UPE profiles. The total weight of the beam is 2.1 tons and its dimensions are 4500 x 1800 x 315 mm. The material of UPE profiles and sheets is steel S355.

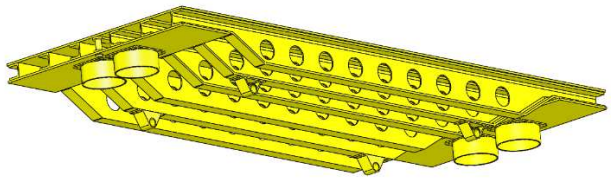

Figure 1 3D model of carrying steel structure

3.2 Front axle of transport truck

Driving the vehicle is used to maintain direction or change the direction of travel of the vehicle, if necessary. When cornering, each wheel describes a circle with a different radius but with the same centre. The correct steering geometry must be adhered to ensure safe steering of the vehicle when cornering. For geometrically correct rolling of the wheels, the extended axes of all wheel's rotation must intersect at a common point. This point is called the theoretical corner of the vehicle and, in the case of two-axle vehicles with steered front wheels, is located on the extended rear axle axis (pole line) [17, 26].

For Ackermann's regulation geometry (1), (2) (Figure 2) is given:

$$cotg\ \beta_1 = \frac{R+\frac{s}{2}}{L} \quad (1)$$

$$cotg\ \beta_2 = \frac{R-\frac{s}{2}}{L} \quad (2)$$

where: R- theoretical turning radius (m),
s – pin axis distance (m),
L – axles distance (m),
β_1, β_2 - outer and inner wheel angles (°).

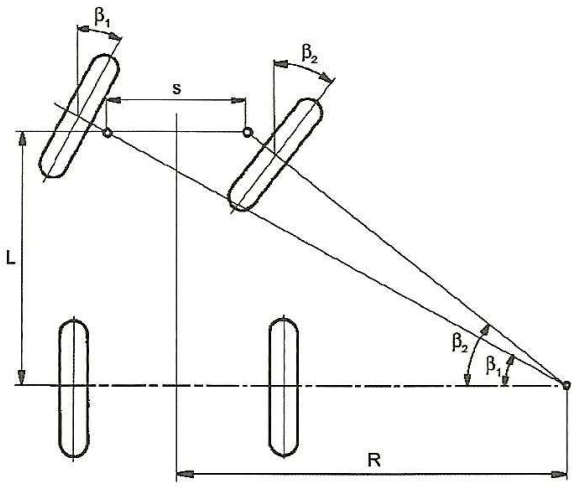

Figure 2 Theoretical car steering geometry [7]

The front axle (Figure 3) was designed as a suspended fixed axle with steered wheels and functional kinematics. The steering is provided by a trolley which is powered by the towing vehicle. The angle between the wheels at full turning is approximately 4 °, and the wheel turning radius is approximately 4.5 m (Figure 4).

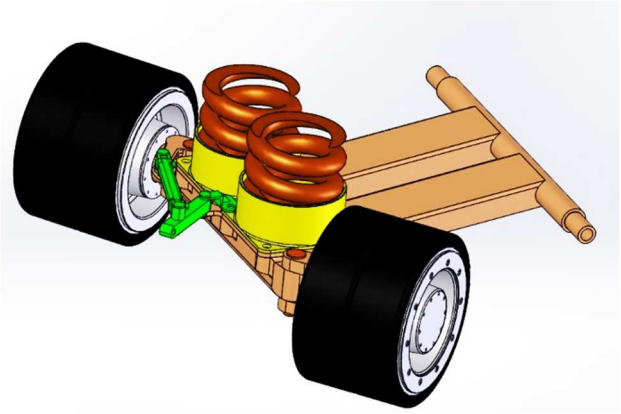

Figure 3 Front axle

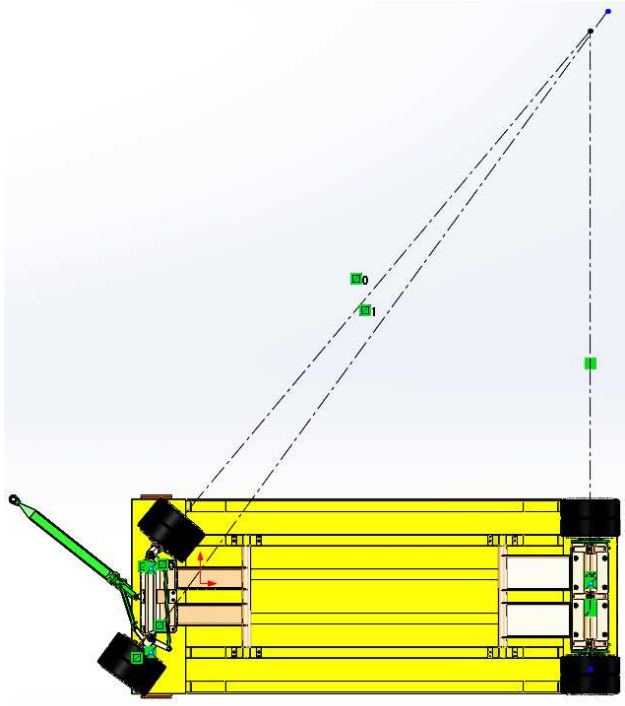

Figure 4 Axle kinematics

3.3 Rear axle of transport truck

The rear axle (Figure 5) was designed fixed with the wheels rotating. On the axle there is a directly mounted spring bed. The rear axle wheels are braked by separate track brakes.

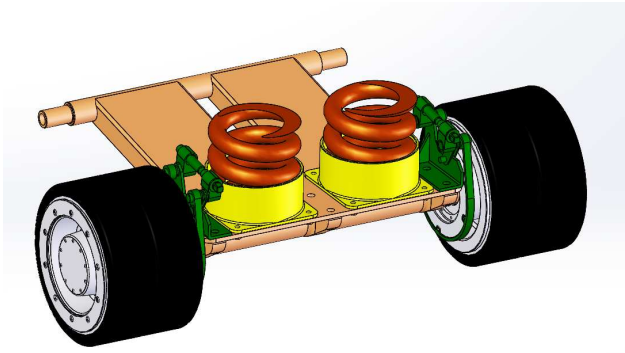

Figure 5 Rear axle

The wheel is designed as a hub on which a pair of wheeled tires is pressed. Wheel rings are designed as steel rings on which is vulcanized rubber. Each wheel is able to carry 6.4 tons, so a pair of hubs can carry 12.8 tons. The manufacturer guarantees the strength of wheels up to 6 km / h. Two sets of cylindrical roller bearings are used, the first is a pair of NJ220EDM bearings capable of absorbing radial and axial force, arranged in the "X", the second set is a pair of NU218EDM bearings that absorb only radial forces. Four bearings per wheel were used to distribute the load evenly to the pivot. The inner set of bearings is secured by KM nut and MB washer, as it is not stressed by axial force is secured by retaining rings. As a lubricant we considered a grease.

3.4 Locking fixtures

The rear locking device (Figure 6) works on the principle of a solid wall with sliding clamping lugs that slide in horizontal guides and are secured by simply tightening the screws. The jig and the jigs are welded. The rear arresting fixture is firmly screwed to the main beam.

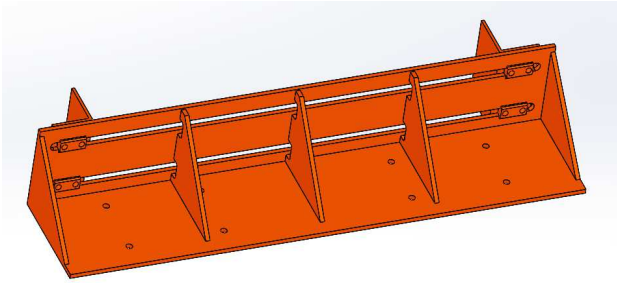

Figure 6 Rear locking device

The front locking device (Figure 7) works on the principle of a sliding wall with sliding clamps similar to the rear detent. The front jig is similar in a construction to the rear jig as it is also welded from 15mm sheets, the difference is that the front jig can be moved along the beam to transport moulds of other sizes. The front locking fixture has recesses on the lower plate to reduce sliding resistance and has a sliding guide with a lock on the sides.

Procedure for securing the mould:

1. The mould is placed on the trolley so that it touches the wall on the rear detent and so that it is approximately at the centre of the vehicle's width.
2. The side jigs of the rear jig are pushed to the mould and secured by tightening the screws.
3. The front locking fixture is pushed to the mould and its sliding lock is secured by tightening on both sides.
4. The side jigs of the front jig are pushed to the mould and secured by tightening the screws.

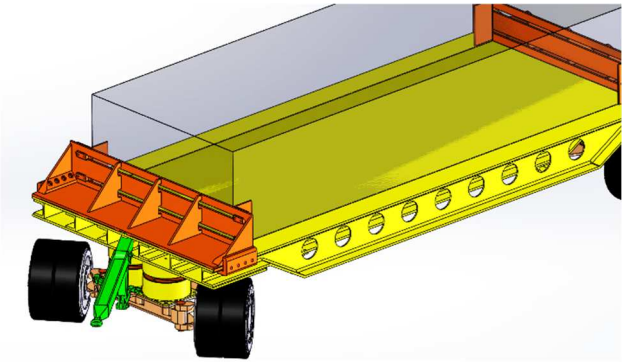

Figure 7 Front locking device

4 Strength and design calculations of transport equipment

The main beam is loaded with a continuous load which also represents the mould. For the sake of safety, a weight of 60 tons was taken into the account into the calculations, representing a fall from zero height, which could cause a double overload.

FEM analysis has shown the beam complies with the strength. The beam material is S355 steel with a yield point Re = 355 MPa, as shown in Figure 8, at a simulated load of 60 tons, the maximum local stress levels on the beam are about 160 MPa. The peak stress of 316 MPa does not actually arise, it is given by a constraint that does not allow rotation.

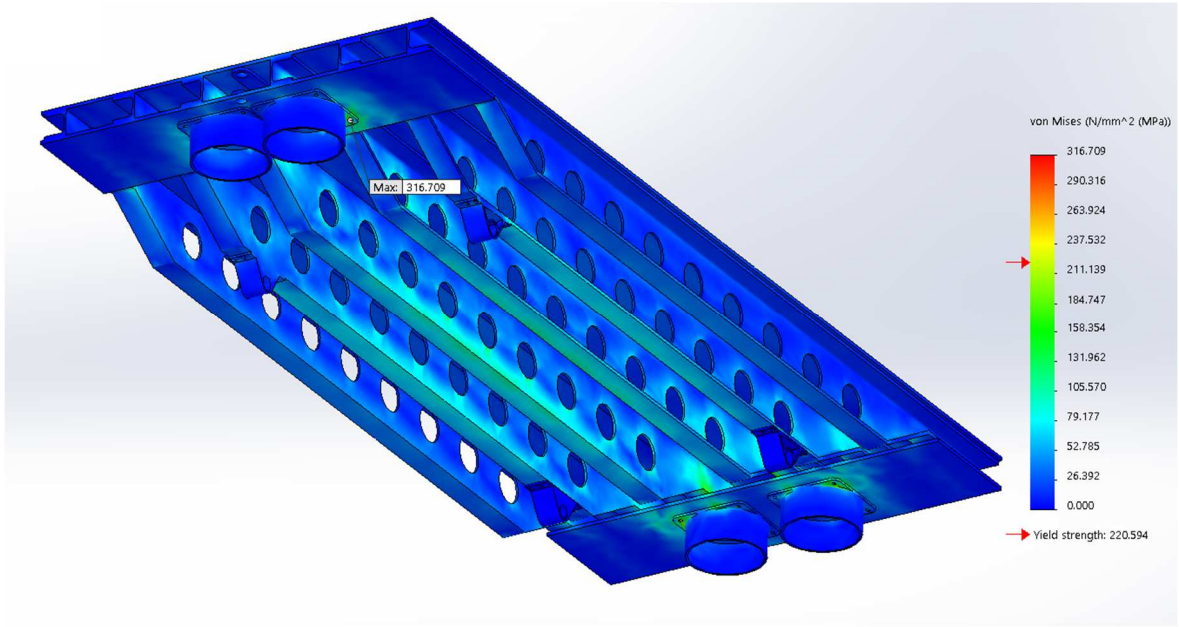

Figure 8 Results of FEM beam simulation

The simulation of the rear axle (Figure 9) represents an embedded beam, which is subjected to a force from below, it was considered an extreme case. Load per wheel of 18 tons, which incorporates double the weight of the mould and the weight of the trolley. The rear axle material is steel with a yield point Re = 850MPa.

Axle shaft complies with strength. In the extreme case, the average stress levels are about 400 MPa, the maximum 693 MPa does not actually occur, is given by the coupling. In normal operation, the values are halved.

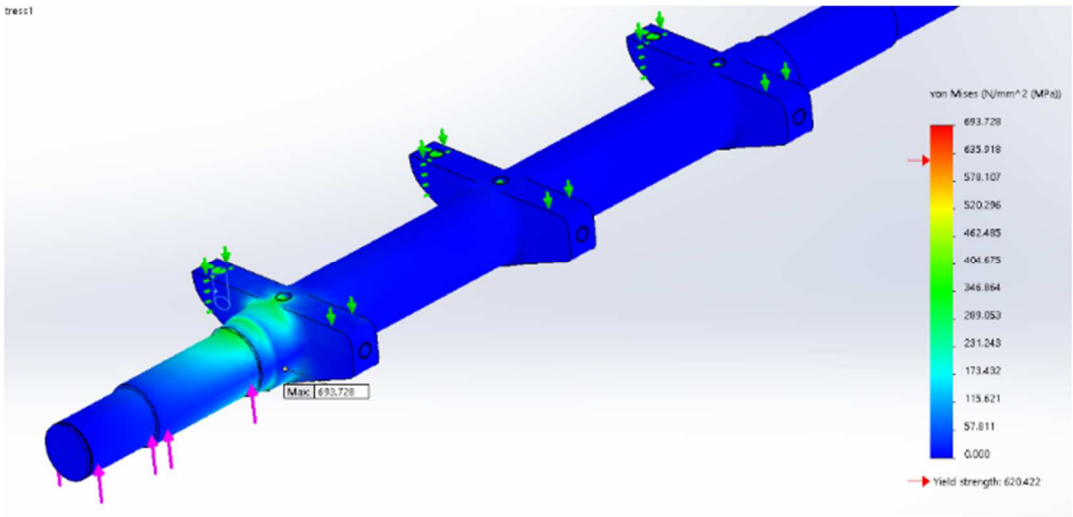

Figure 9 Rear axle beam simulation

When simulating the front axle (Figure 10), the load is the same as the gripping method, the difference being that it consists of several parts, and the pivot pin is in the turning position, causing additional bending moment.

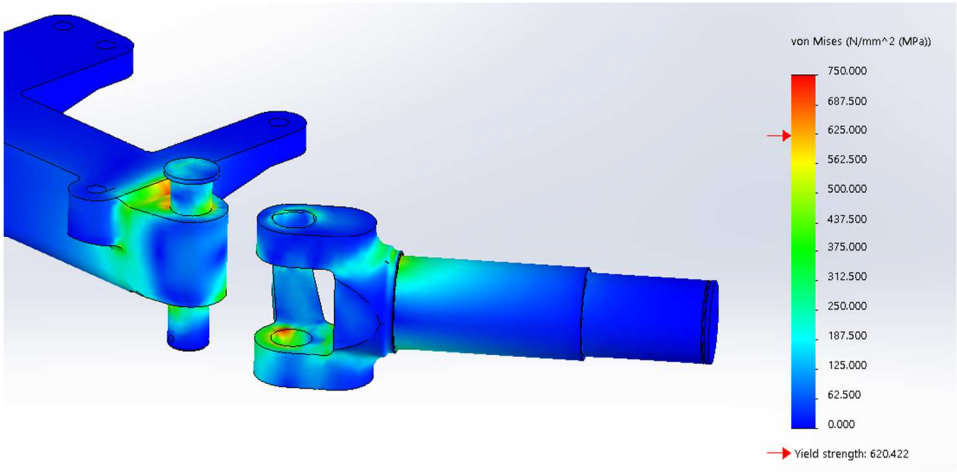

Figure 10 Front axle simulation

Parts of the front axle are strong, normal stress levels in the extreme case are around 400 MPa, the maximum of 750 MPa does not really occur, is given by the coupling. In normal operation, the values fall by half.

5 Conclusions

The task of means for inter-operational transport and handling is to ensure material flow between individual assembly workplaces and systems. An important role is played by the handling of heavy equipment, such as large-size injection moulds for the manufacture of plastic mouldings such as the dashboard, car door trim and the like.

The design of the transport equipment used to transport large-scale moulds plays an important role. The designed handling trolley is able to easily and safely secure moulds of various sizes and transport them from the press, to the mould store, or vice versa from the mould store to the injection moulding machine. The proposed load-bearing structure is sufficiently rigid, due to large bends and additional loads, and is not too heavy. Suspended rigid axles have been designed that are able to withstand double the overload of the structure without damaging them. The front axle steering has been designed according to the principle where the wheels follow Ackermann's geometry when turning. Mechanical adjustable locking of the injection mould preparation of various sizes has been proposed. The strength calculation of the designed structure was done using the finite element method.

The impact of a change in the application of the proposed transport equipment on the solution for inter-operation transport system is further research direction.

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USING OF OPTIMIZING METHODS IN INVENTORY MANAGEMENT OF THE COMPANY

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Abstract: Management of inventory presents an integral part of logistics and effective inventory management demands inventory optimizing since the stocks of the company bind financial resources and present high costs on stocking and maintenance of inventory. The aim of this contribution is to point out the possibilities of optimization the stocks of the mining company in the process of extracting granodiorite. For optimization of stocks - granodiorite we can use EOQ inventory optimization model is used, which sets the optimal amount of raw material extracted in relation to economic indicators such as storage costs, the cost of securing the extracted material in the quarry, insurance costs and other types of costs. By EOQ optimization model, we found that optimum granodiorite extraction should be 38 tons per hour of granodiorite, which would mean low costs for the company in relation to securing the raw material. This model allows planning interventions in the mining process in terms of cost optimization, which is an important economic indicator for the company. The advantage of this EOQ model is the obtaining of important information about the state of the extracted raw material in the quarry Hradbová as well as on the volume of storage costs of the extracted raw material. Management of stocks raw material and minimization of costs represent economic benefits for the mining company.

1 Introduction

Effective management of inventory in the company must be planned from the first activity that relates to stocks purchase. It is necessary to understand what stocks the company needs, in what volume, when to order stocks, how to transport stocks to the company, etc. All mentioned information must be followed up through planned information systems for the area of inventory management in the companies, which are presently very different, based on the principle of simulation, operation research, statistical methods, etc. [1]. During management of stocks level, we can use also quantitative methods of operation analysis that can have stochastic and deterministic character [2]. In the practice the most often used is the deterministic model of stock management without deficit, known as EOQ model – economic order quantity, introduced by Ford W. Harris in 1913 and lately R.H. Wilson develop the model [3].

Effective inventory management is necessary assumption the company could provide fluent production process or continual business supply. Stocks in the practice present many times property that binds financial means of the company and there is no possibility to transform stocks to the financial means rapidly. Modern inventory management should be based on three basic pillars, mainly value creation, shortening of the ongoing period and capacity using, as well as monitoring of stocks volume in relation to the economic indexes, as for example productivity and liquidity [1].

Inventory of the company must be planned, organized in the process of holding and stocking, controlled during expenditure to the consumption. The optimal volume of inventory at the stocks is the assumption of effective inventory management, decreasing of costs on stocking and holding, as well as using all supply capacities. Not necessary stocks bring the loss for the company and their ineffective using in further production process. Presently there is a trend of inventory management, orientated to the Japan approach JIT (Just in Time), which means maintaining stocks only in a volume that is demanded for the given production process. State of inventory at the stocks is decreasing and stocks are ordered by the operative way according to the need of the production process. But not all companies can use such approach and in case of necessity to stock inventory also a quantitative determination of optimal stocks volume presents a contribution [4].

2 Literature review

The topic of sustainable supply chains has evoked considerable interest from academics and practitioners. Ghadimi et al. (2019) revealed that the call for incorporating sustainability (i. e., economic, social, and environmental pillars) into supply chain operations has increased in recent years, mainly in connection with supply chain management [5]. Cost-effective supply chain management under various market, logistics and production uncertainties is a critical issue for companies in the industry. Uncertainties in the supply chain usually

increase the variance of profits (or costs) to the company, increasing the likelihood of decreased profit. New innovative technologies are required, improving the efficiency of the processes and the optimization of global supply chains (GSC) in order to establish sustainability in environmental, social, and economic aspects. Kovács and Illés (2019) formed the optimal combination of the suppliers, final assemblers, and service providers to achieve cost-effective, time-effective, and sustainable operation [6].

According to Kovács and Kot (2016) fast-changing market environment and fluctuating customer demands, as well as inventory management, require efficient operation of logistical processes [7]. Therefore, in connection with SCM inventory management is presently considered as a global operations strategy for achieving competitiveness of the company through finding flexibility and responsiveness. Inventory management is a basic element of production and financial management. It was proved that inventory in the current volatile environment are an important determinant of an organization's effectiveness and sustainability, on the one hand, and a guarantee of liquidity, on the other hand [8].

In many production environments where demand and lead times are variable, significant levels of safety stock inventory are required to assure timely production and delivery of the final product [9]. Safety stock levels are commonly introduced in the supply chain. In this connection Jung et al. (2004) used deterministic planning and scheduling models, which incorporate safety stock levels [10].

Inventory optimization is the process of ensuring the right product at the right place, right time, right quantity and right quality to meet the demand and supply of goods and or services. To optimize inventory management can be by classifying inventory and demand forecasting model for better prediction of demand to manage inventory [11]. Armenzoni et al. (2015) suggested the model, providing estimation of the optimal level of inventory the company should keep available, using 'traditional' and an 'advanced' approach for demand forecasting, which underline the efficiency of inventory management [12].

Also, the application of operations research methods and related models, for inventory management has been effectively searched by various authors [13]. For example, Bertrand and Fransoo (2002) give an overview of quantitative model-based research in inventory management, concluding that methodology of quantitative research offers a great opportunity for operations in inventory management [14]. But according Gunasekaran and Ngai (2004) there is gap in implementation of IT to inventory management [15].

Berling and Marklund (2013) presented an approximation model for optimizing inventory, motivated by close cooperation with a supply chain management of the company, using costs optimizing [16], when Andersson and Marklund (2000) used an approach, based on an approximate cost evaluation technique during inventory control [17]. The research is necessary to be done by exact cost evaluation. Moreover, inventory costs are strongly affected by the shape of the assumed LTD distribution, but it can be difficult to set the reorder point in an inventory system because often one does not have much knowledge of the lead-time demand (LTD) distribution [18].

Ogbo et al. (2014) took into consideration the relationship between effective system of inventory management and organization performance, showing that flexibility in inventory control management is an important approach to achieving organizational performance [19]. There is a relationship between operational feasibility, utility of inventory control management in the customer related issues of the organization and cost effectiveness technique are implemented to enhance the return on investment in the organization. Effective inventory control management is recognized as one of the areas, management of any organization should acquire capability.

Luo et al. (2015) investigated a purchase-inventory optimization problem arising from the operation management practice [20], suggested the model for the iron and steel industry. In the cost-oriented purchase problem, the demands during future planning periods are unknown, therefore new models are necessary. But there is still a gap in using of inventory optimization in the mining industry and extraction companies. Siponen et al. (2019) indicated that in inventory management there are shortages due to inadequate control and management policies and procedures [21]. There is necessary to develop inventory operations, including material management, supplier management and IS management [22]. This can lead to improvements in inventory control and productivity while reducing operational costs. The goal of the contribution is therefore to bring new important information about optimizing in inventory management in mining organizations.

3 Methodology

The goal of the deterministic model of inventory management in the company is the optimization of a basic parameter of the model, which means ordered volume of stocks – known as supply (Q) and level of stocks order (r), regarding economic criteria of all annual costs from supply process that must be minimized. **The model solves two basic questions:**

1. What volume of stocks to order? – the optimal volume of stocks (Q).
2. When to order the stocks? – determination of order level (r).

Basic starting points for EOQ (economic order quantity) model using are as follows:

1. Consumption is known, expressed per year – year presents a basic planed period.
2. Consumption during the year presents a continuous function in time, having uniform flow.
3. Delivery time is exactly known, always the same.
4. Volume of supply is not limited, taking place at the same time.
5. Stocking is not limited and there is no influence of aging.
6. Model is stationary; therefore, the volume of supply and delivery time are always the same.

Input parameters of the model present:

λ - intensity of stocks consumption – consumption of stocks for certain time interval, expressed in units of volume per time period of the year – as basic planed period. Consumption of stocks can have character of season consumption, which has non-stationary character, changing in time or not season consumption that has stationary character, not changing in time.

τ- delivery time – characterizing time delay – time between moment of stocks ordering and moment of supply to inventory.

Resulting parameters of the model present:

Q – optimal volume of order – ordered volume of stocks that must be equal supplied volume of stocks to the inventory. Value (Q) characterizes volume of stocks that are once supplied to the stock, while this volume is gradually consumed according to intensity of production process or demand claims.

r- level of stocks ordering – level of stocks, to which stocks would decrease, there is necessary to order supply of new stocks during in ahead agreed ordering and supplying conditions, with aim the ordered supply could come in time to the stock or in time, when real stock achieves level of insurance stocks.

r_t - time of ordering – determined according level of ordering, presenting time of stocks decrease under level of ordering.

Through mentioned model parameters there is possible to solve target question of the model for inventory management without deficit.

t_d - supply cycle – characterizing time between order arriving to the stock and moment of all stock's consumption. This index depends on intensity of stock consumption and volume of order.

v – turnover of stocks – inverse value of supply cycle, expressing number of cycles of stocks supply during the analysed period.

The purpose function of the deterministic model has cost character. The purpose function presents the function of total annual costs for management of inventory process, known as: **Nc (Q).** The goal of the function optimizing is finding of minimal value of annual costs on stocking, from a mathematical point of view it means searching for free extreme genuinely convex function (Figure 1).

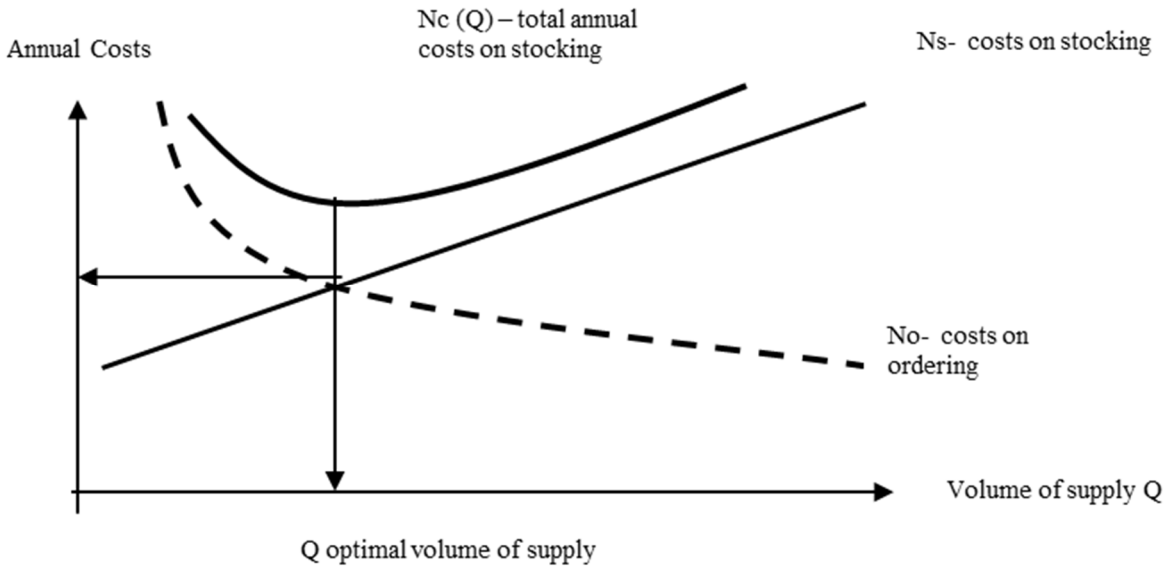

Figure 1 Expression of purpose function for deterministic model
Source: Ivaničová, Brezina, 1997 [23]

Purpose function of the deterministic model consists of the following parameters:

Costs of ordering (supply) (No) – costs, connected with one stock supply, for example, costs on ordering, telephone fees, fax, mailing, part of transport costs, consumption of office supplies, consumption of administrative supplies, costs on invoices liquidation, costs, connected with orders following, reclamation, exceptional costs, connected with damages, special interventions, organizational shortages during stocking, wages of employees that follow up income of supply, stocking, financing with suppliers, etc. Such costs for one supplied unit during a bigger volume of supplied stocks are decreasing. To this group of costs, there is not included ordering price of stocks. The level of the stocks must depend on a few supplies. Such costs are determined by the normative or statistical way [24].

Costs on stocking (Ns) – connected with stocking and maintenance of inventory, expressed in values per unit of stocks and time interval (day), dependent on stocking volume, which means they grow proportionally with volume of supply. Such costs are considerable, while free stocking spaces are further rent to someone, or when with higher stocks volume the company must pay for other rented spaces, electricity, heating, etc. Part of such costs are also interesting from credits for stocks payment, costs for losses, connected with inventory depreciation, damaging and destruction of costs, costs, connected with covering of other damages, insurance of stocks, costs for proper physical and chemical maintenance of stocks, costs on stocking spaces, maintenance of spaces, depreciation and repairs, manipulation stocks, connected with stocks transitions, etc.

Optimization of purpose function has a character of minimizing. Mathematically it means searching of a free extreme of a genuinely convex function. The minimum is found by derivation of purpose function (1), equal zero.

$$Nc(Q) = No + Ns$$
$$\frac{dNc(Q)}{dQ} = -\frac{\lambda}{Q^2} \times \boldsymbol{No} + \frac{Ns}{2} = \mathbf{0} \qquad (1)$$

By the mathematical expression of the purpose function we can determine the equation for the calculation of total costs on supply and stocking during optimal supplies followed (2):

$$N_C = \frac{\lambda}{Q_{opt}} \times No + \frac{Q_{opt}}{2} \times N_S \quad \text{(value units - €)} \qquad (2)$$

The purpose function expressed as the sum of the cost of ordering and of the cost of stocking creates the total cost. Total costs use the optimal parameter - optimal volume of stock based on the Wilson-Adler formula by equation 3.

3.1. Model EOQ (Economic order quantity)

Model EOQ means a solution of purpose function. We look for a minimum of total cost. We obtain information of total cost minimum and also about the optimal volume of stock. The calculation of the optimal volume of stock is known as Wilson-Andler equation (3). For this formula we need to know the intensity of stock consumption, ordering cost, stocking cost. That information is pointed out in financial accounting. The information is a very important source for the process of optimization of costs and volume of stocks.

$$Q_{\text{opt}} = \sqrt{\frac{2 \times \lambda \times No}{N_S}} \text{ (quantity units – pieces, kg...)} \qquad (3)$$

In assumption that supplies are determined in optimal level, we can derive following relations – optimizing indexes:

Average state of stocks during optimal supplies

The average state of stocks is determined according to formula 4 as the classical arithmetic mean. This indicator informs us of the average stock level in stock and provides us with information for securing insurance stocks and placing new orders. It is a basic indicator for planning the volume of insurance stocks.

$$\overline{Q} = \frac{Q}{2} \quad \textbf{(quantity units – pieces, kg, tones...)} \qquad (4)$$

Length of supply cycle during optimal supplies

The supply cycle is the time interval from the arrival of the stocks in the warehouse to the complete exhaustion of the stocks. It is expressed in time units. This indicator depends on the intensity of stock consumption (5).

$$td_{opt} = \frac{Q}{\lambda} \quad \text{(time units – } \textbf{day, month)} \qquad (5)$$

Turnover – optimal number of realized supply cycles during analysed period

Turnover of stock is the indicator that it identifies an optimal number of realized supply cycles during the analysed period. This indicator must be minimalized because a few turnovers of stock influences financial indicators and it increases costs.

Number of cycles in analysed period per year (6):

$$v = \frac{1}{td_{opt}} \qquad (6)$$

Question **When to order the stocks?** we can answer by calculation of the level of ordering (r) and determination of moment for supply ordering to the stock. Total costs are expressed as costs on supply and costs on stocking without acceptance of the purchase price and intensity of stock consumption. Total costs can be

calculated as a summary function of costs on supply and costs on stocking from the deterministic model of stocks management without a deficit. Total costs are determined for values of optimal supply, decreased by certain percentage and increased by a certain percentage. After the determination of ordering level, we can achieve the second goal of modelling stocks movement without deficit, mainly by answering the question: When to order stocks? Stocks must be ordered in a moment when decreasing under ordering level.

Level of stocks ordering (r)

The level of stock ordering (7) is a very important indicator because it shows deficit of stocks. This indicator expresses what time is needed for their ordering. At this moment company must order the stocks.

$$r = (\mu - m \times Q^*) \tag{7}$$

Coefficient (*m*)

Consumption during delivery time (8), which is presently an equal volume of supplies on the way (quantitative units).
Coefficient (*m*) is a number of supplies on the way before the moment of ordering.

$$m = \frac{\tau}{t_d} \tag{8}$$

Determination of value (*m*), when comparing delivery time and supply cycle, while the dividing is calculated to the biggest whole number integral factor, for example when $m = 2.5$, then $m = 2$, m is a dimensionless number.

4 Results

Optimizing the model for raw material in a mining company

In this contribution, we solved a problem with inventory in the quarry Hradová. By the EOQ model (equation 6) - Wilson Adler equation we looked for optimizing state of inventory raw material granodiorite in a mining company, which extract granodiorite by surface mining for the purpose of adjustment, used as an aggregate in construction. The extracted raw material is stored in the quarry and the mining company solves a place for the storage of raw material - granodiorite (figure 2). Place for store raw material - granodiorite is big problem for mining company, that must be solved. By the optimizing model, we can decrease volume of raw material for a store in the quarry Hradová.

Figure 2 Mining of granodiorite in Hradová quarry

The total process of mining is going from the dump of raw material that is transited by tunnel way to further processing to the material shredder with intensity 140 tons per hour. Average costs connected with a stocking of the aggregate fraction at the dump presents 5€ per ton and hour. Costs, connected with the material transition from the dump to tunnel flow of one aggregate supply, present 25€. The delivery time of aggregate is approximately 3 days. The goal of this contribution is to determine basic optimizing parameters of the process for stocking of adjusted aggregate (fraction) in the mining company.

Basic information for modelling was obtained from documents from financial accounting. Storage costs were determined by statistical methods from the previous reference period of the raw material storage. Demanded parameters for calculations are given in Table 1.

Table 1 Input parameters for EOQ model

Costs on ordering – (No)	**25 €**
Costs on stocking – (Ns)	**5 €/ton/hour**
Intensity of stocks consumption - (λ)	**140 ton/hour**
Delivery time - (τ)	**3 days = 72 hours**

The solution of the problem in the mining company problem will be realized through the mathematical model EOQ on the basis of which we will find out the optimal volume of stocks of raw material - granodiorite and the costs related to securing these stocks in the quarry Hradová. Calculation had been made according to algorithm of the model EOQ without stock deficit by the formula (3). The optimal volume of a fraction that enters the shredder is 38 tons.

$$Q_{\text{opt}} = \sqrt{\frac{2 \times \lambda \times No}{N_S}} = 37.417 \text{ tons}$$

We calculated the average volume of stocks during optimal supply by the formula (4). The volume of average stock represents the amount of the insurance stock in the warehouse, which will not represent a material deficit in the handling process of raw material.

$$\bar{Q} = \frac{Q}{2} = \frac{37.417}{2} = 18.7 \text{ tons}$$

We calculated length of supply cycle during optimal supplies by the formula (5).

$$td_{opt} = \frac{Q}{\lambda} = \frac{37.417}{140} = 0.267 \text{ hours}$$

We calculated turnover – optimal number of realized supply cycles during analysed period by the formula (6).

$$v = \frac{1}{td_{opt}} = \frac{1}{0.267} = 3.74 \text{ cycles per hour}$$

We calculated total costs of supply and stocking during optimal supplies by the formula (2).
The cost is related to the optimum stock of material that must be in the quarry for the further process of processing the material into fractions.

$$N_C = \frac{\lambda}{Q_{opt}} \times No + \frac{Q_{opt}}{2} \times N_S = 187.0829 \text{ Eur}$$

We calculated level of stocks ordering (r) by the formula (7,8).

To answer the question **When to order the stock?** we can answer by the way of calculations of ordering level (r) and by determination of moment for supply order to the inventory. **After the determination of ordering level, we can meet the second goal of the modelling of stocks transition without the deficit and to answer the question: When to order the stocks?** Stocks are ordered in time when they decrease under ordering level, which means in the case 15 tons.
We used calculation:

$$r = (\mu - m \; x \; Q^*) = 140 \times 72 - 269 \times 37.417 = 15 \text{ tons}$$

According to the calculations of optimizing parameters, we can state that the optimal volume of granodiorite is 38 tons, which should enter the shredder from the dump. If the level of material decreases to level 15 tons, there is necessary to provide material inflow from the dump by tunnel flow to shredder. The length of the supply cycle of the material, which means granodiorite to shredder presents 0.267 hour, which means material supply through the tunnel to the shredder from the dump is made averagely three times per hour. Total costs that could be achieved during optimal supplies of granodiorite in the shredder present 187 Eur per one supply of material from the dump to the shredder.

5 Discussion

Using quantitative models in the practice is necessary from the view of managerial decision and management of stocking processes. The companies are presently trying to minimize the level of their stocks, using operative inventory management with an aim to minimize stocks on stocking and inventory. Also, according to the model, there is possible to influence and manage stocks supply to the inventory and by this way to optimize costs on purchase and stocking. Decreasing of stock level presents for some companies' big problems since they have stocks, which are not saleable, useless. And the EOQ model is therefore the tool how the company could manage their stock situation and to order optimal volume of stock that are able to be consumed in the frame of the production process or to be sold in the frame of distribution or sale. The period of logistic management presently prioritizes the stocking, leading to decreasing of stocks situation, decreasing costs on stock maintenance, decreasing costs on stocking and principle of purchase marketing.

Systematic improvement of the stocking process brings improvement for the companies that lead to the permanent improvement of business outputs. The goal of improvement for stocking and supply processes is their optimizing and removing of wasting in processes, which is influenced by the quality and productivity of the company. Companies are presently trying to adapt to the rapidly changing conditions at the market and to react to the changes flexibly and effectively, and they must increase their performance. This is reflected mainly through main processes, such as a process of stocking and supplying.

This optimizing model is using in various areas of industry, in the area of agriculture, its use is important in business processes and services. We can use optimizing models also in nonmanufacturing sphere for example in health, education service, science, public management and we presented this optimizing model in article Energy solutions based on biomass and using of a quantitative optimization model for a biomass boiler in 2017 in Research Journal of Mining.

6 Conclusion

The aim of the paper was to point out the possibilities of optimizing the extracted raw material in the mining company for granodiorite mineral. By using the EOQ optimization model, we found that the optimum extraction of granodiorite should be 38 tons per hour of mineral extraction, which would mean low costs for the company in relation to securing the extracted raw material. At the same time, we found that if a company has less than 15 tonnes of mined granodiorite in the quarry, it must begin another cycle of granodiorite mining and management to meet sales needs and customer requirements.

We have optimized cost items because this way of extraction will extract granodiorite only by a plan, while the costs are optimized. The costs for the company represent the financial resources that the company must create in order to ensure the smooth operation of the extraction of granodiorite and its processing and securing in the stock of the extracted raw material. This model makes it possible to plan interventions in the mining process in terms of cost optimization, which is an important

economic indicator for the company. The main benefit of operational research models - EOQ that can be used in practice in decision making and management of the mining process are meeting customer expectations and requirements.

Inventory management creates an area for improvements in inventory control and productivity while reducing operational costs for storage, which presents a financial situation of the company. The main task in the area of stocks is minimalizing costs and reducing the volume of stocks at storage. The goal of the contribution was to bring new important information about optimizing inventory management in various companies and as an example we showed an optimizing model of stocks volume in the mining organization. The results of the contribution remove a gap in optimizing stock in the mining organization, remaining space for similar research of stock optimizing in special conditions of surface and underground mining.

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FLEET OPTIMIZATION BASED ON THE MONTE CARLO ALGORITHM

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Abstract: With the development of computers and software products, there is now greater use of quantitative methods in industrial enterprises when making managerial decisions. One of the most applicable solutions to computer simulation algorithms is the Monte Carlo method. The application of the Monte Carlo algorithm lies in finding a relation between the individual variables, which are the solutions to the problem and represent the characteristics of random processes reproducible on computers. The aim of this article is to show the application of simulations from the Monte Carlo algorithm using the example of optimising vehicle fleet capacity so that the total daily costs spent on transporting goods are minimal.

1 Introduction

Over the last two decades, there have been great advances in computer technology and these advances have also affected managerial decision-making [1]. Mathematical methods with the use of computer technologies have been increasingly used in most problems of managerial decision-making [2,3]. One of the most applicable methods of computer implementation is the Monte Carlo method [4]. A static, stochastic method uses random (pseudo-random) numbers in the course of the calculation [5]. In this article, its use will be shown while optimising vehicle fleet capacity so that the daily costs spent on transporting goods are minimal.

2. Monte Carlo simulation

The term Monte Carlo is widely used to denote a wide class of computing methods that use random sampling to obtain numerical solutions. Monte Carlo methods are ubiquitous in science and engineering; they are preferred due to their simplicity [6].

Monte Carlo methods are used to simulate the behaviour of physical or mathematical systems, especially when analytical solutions are difficult to obtain [7]. These methods are nondeterministic or stochastic. The applications of Monte Carlo methods are very diverse: these include physics, computer science, engineering, environmental sciences, finance, fleet management etc. And systems with uncertainties other than pure mathematical systems that require no uncertainty [8].

A random value of x is known as a random number. In practice, x values can be determined deterministically, and the random numbers so generated are known as pseudo-random numbers: such a pseudo-random number contains a limited number of digits, which means that the continuous uniform distribution is approximated by the discrete. Pseudorandom numbers are often used in simulation studies [9]. Monte Carlo methods require many pseudo-random numbers for computer processing.

Simulation models are usually used to decide on something that involves a risk, i.e. a model in which the behaviour of one or more components is not known with certainty. Bank lines or the number of trucks that arrive between specific time intervals are cases where a component that is not listed with confidence is considered a random variable and a probability distribution is used to simulate the behaviour of the random variable [10].

In the practical example used, the simulation is applied to the number of customer orders per day, operator intensity, and the simulated expected overtime operation.

3. The task

A company provides the transportation of goods based on customer orders according to the following rule:

Table 1 Day of ordering and the subsequent transport of the goods

Ordered on	Transported on
Monday	Tuesday
Tuesday	Wednesday
Wednesday	Thursday
Thursday	Friday
Friday	Monday

Orders are not received on Saturdays or Sundays and there is no transportation on these days. Transportation is carried out by using trucks. The daily cost of operating one truck is 600 € – provided the trucks operate 8 hours each day.

If an order requires overtime operation, i.e. an operation that exceeds the set 8-hour operational time, the costs for each overtime hour are 250 €.

Through statistical investigation for the assumption of a normal distribution of probability, the following data were determined:

- Data on the transport capacity of cars – on average, during an 8-hour running time, 1 car transports 80 orders with a standard deviation of 15 orders,
- Data on customer demand.

Table 2 Individual customer demands per respective days

Days	The average number of orders x	Standard deviation σ
Monday	7,800	800
Tuesday	6,400	700
Wednesday	5,500	600
Thursday	7,000	750
Friday	5,000	500

The business unit must set an optimal vehicle fleet capacity so that the total daily costs spent on transportation are minimal.

4. Analysis of the solution

From the substantive point of view, this is a task that belongs to the methodology of the queuing theory [11]. It is a simple task to determine the optimal dimension (size, capacity) of the operating system:

- Operating system = vehicle fleet that provides transportation services,
- Two main variables are assumed (variables crucial to solution of the task)
  - operation intensity = transport capacity of the vehicle,
  - the intensity of the requirements entering the operating system = the number of orders.
- Number of the contracts has the character of random variables with a normal distribution of probability.

Two extreme situations (two extreme variations in the capacity of the operating system) that lead to relatively high costs of the activity may occur in terms of optimisation:

- A heavily oversized operating system (too many vehicles):
  - high costs of the vehicle fleet,
  - costs of overtime work converge to zero; the requests do not queue.
- A heavily undersized operating system (the number of vehicles is too small):
  - low costs of the vehicle fleet,
  - high costs for overtime work; formation of request queues (possible loss of profit due to queues).

Between the extreme variants, there is a number of possible variants of dimensioning the vehicle fleet that are associated with the different daily costs of transportation [12,13]. Of the possible variants, it is necessary to choose the optimal variant - the one with the lowest daily costs for transportation.

The following applies (1) for the i-th variation of the operating system dimension:

$$N = N_V + N_M \quad (1)$$

N – daily costs for transportation,
N_V – daily costs for operating the vehicle fleet,
N_M – daily overtime cost.

5. The procedure of solving the task using a simulation of the Monte Carlo algorithm

For the assumption of normal probability distribution of both main variables:

1. The simulations (predictions) of the number of orders are performed according to the intensity of the requirements entering the operation. The simulation itself is in Table 3.

Table 3 Simulation of the number of orders

Day	Simulated value of the distribution function*)	Determinant variable t	Prediction**) of the number of contracts $x = \bar{x} + t \cdot \sigma$
Mon	0.88147	1.1	8,680
Tue	0.9970	2.7	8,290
Wed	0.11941	-1.1	4,840
Thu	0.78817	0.8	7,600
Fri	0.17061	-0.9	4,550

*) from the table of random numbers, we assume five-digit values for the distribution function of the normal probability distribution.

**) Prediction of the number of orders (2):

$$x = \bar{x} + t \cdot \sigma \quad (2)$$

For Monday: $x = 7{,}800 + 1.1 \times 800$ **x = 8,680**
For Tuesday: $x = 6{,}400 + 2.7 \times 700$ **x = 8,290**
For Wednesday: $x = 5{,}500 - 1.1 \times 600$ **x = 4,840**
For Thursday: $x = 7{,}000 + 0.8 \times 750$ **x = 7,600**
For Friday: $x = 5{,}000 - 0.9 \times 500$ **x = 4,550**

$\bar{x}$ – the average number of orders,
σ – determinant deviation.

2. A simulation of the operational intensity of the 8-hour transportation capacity for the chosen number of vehicles is carried out: 70, 80, ..., 110

n – the number of vehicles,
$\bar{x}$ – mean value of operational intensity,
$\bar{x}'$ – the average transport capacity of the fleet.

Determining the number of vehicles for the highest number of orders:

The highest number of orders = 7,800.
Determinant deviation = 800.
One vehicle transports an average of 80 orders per hour.
The total number of vehicles for the highest number of orders = (7,800 + 800)/80 = 110.

Determination of the number of vehicles for the lowest number of orders:

The lowest number of orders = 5,000.
Determinant deviation = 500.
One vehicle transports 80 orders per hour.
The total number of vehicles for the lowest number of orders = (5,000 + 500)/80 = 70.

In the following step (Table 4), a simulation of the operational intensity is performed.

Table 4 Simulation of operational intensity

The Number of vehicles n	Day	The simulated value of the distribution function of normal distribution	Determinant variable t	$\bar{x}' = n \cdot \bar{x}$	$\dot{\sigma} = \sqrt{n} \cdot \sigma$	Prediction of 8-hour transport capacity $\bar{x}' = x + t \cdot \dot{\sigma}$
70	Mon	0.33166	-0.4	5,600	126	5,550
	Tue	0.87094	1.1	5,600	126	5,739
	Wed	0.11120	-1.2	5,600	126	5,449
	Thu	0.22254	-0.7	5,600	126	5,512
	Fri	0.96023	1.7	5,600	126	5,814
80	Mon	0.76869	0.7	6,400	134	6,494
	Tue	0.39300	-0.2	6,400	134	6,373
	Wed	0.02982	-1.8	6,400	134	6,159
	Thu	0.57991	0.2	6,400	134	6,427
	Fri	0.94479	1.6	6,400	134	6,614
90	Mon	0.96023	1.7	7,200	142	7,441
	Tue	0.88936	1.2	7,200	142	7,370
	Wed	0.88936	-0.5	7,200	142	7,129
	Thu	0.55013	0.1	7,200	142	7,214
	Fri	0.10920	-1.2	7,200	142	7,030
100	Mon	0.26299	-0.6	8,000	150	7,910
	Tue	0.77806	0.7	8,000	150	8,105
	Wed	0.12446	-1.1	8,000	150	7,835
	Thu	0.23510	-0.7	8,000	150	7,895
	Fri	0.68774	0.4	8,000	150	8,060
110	Mon	0.48454	0	8,800	157	8,800
	Tue	0.65269	0.4	8,800	157	8,863
	Wed	0.18167	-0.9	8,800	157	8,659
	Thu	0.84631	1.0	8,800	157	8,957
	Fri	0.74108	0.6	8,800	157	8,894

Calculation example for $n = 70$

$$\bar{x}' = 70 \times 80 = 5.600$$

$$\dot{\sigma} = \sqrt{70} \cdot 15 = 126$$

3. The expected overtime is simulated (from the simulation of the number of orders and the eight-hour capacity of the fleet) in Table 5.

Table 5 Simulation of expected overtime operation

n		Day	Simulation		Prediction of expected overtime operation			
			The number of orders	8-hour capacity of the vehicle fleet	The number of pending orders	The number of overtime hours	The total number of overtime hours	The average number of daily overtime hours
70		Mon	7,800	5,550	2,250	225	445	89
		Tue	6,400	5,739	661	66		
		Wed	5,500	5,449	51	5		
		Thu	7,000	5,512	1,488	149		
		Fri	5,000	5,814	0	0		
80		Mon	7,800	6,494	1,306	131	191	38.2
		Tue	6,400	6,373	27	3		
		Wed	5,500	6,159	0	0		
		Thu	7,000	6,427	573	57		
		Fri	5,000	6,614	0	0		
90		Mon	7,800	7,441	359	36	36	7.2
		Tue	6,400	7,370	0	0		
		Wed	5,500	7,129	0	0		
		Thu	7,000	7,214	0	0		
		Fri	5,000	7,030	0	0		
100		Mon	7,800	7,910	0	0	0	0
		Tue	6,400	8,105	0	0		
		Wed	5,500	7,835	0	0		
		Thu	7,000	7,895	0	0		
		Fri	5,000	8,060	0	0		
110		Mon	7,800	8,800	0	0	0	0
		Tue	6,400	8,863	0	0		
		Wed	5,500	8,659	0	0		
		Thu	7,000	8,957	0	0		
		Fri	5,000	8,893	0	0		

6. The result of the task - recommended by the simulation calculations

A calculation of the total daily costs for transportation with the individual numbers of vehicles is shown below:

$N = N_V + N_M$

$N_{70} = 70 \times 600 + 89 \times 250 = 64{,}250$ €

$N_{80} = 80 \times 600 + 38.2 \times 250 = \mathbf{57{,}500}$ €

$N_{90} = 90 \times 600 + 7.2 \times 250 = \mathbf{58{,}500}$ €

$N_{100} = 100 \times 600 + 0 \times 250 = 60{,}000$ €

$N_{110} = 110 \times 600 + 0 \times 250 = 66{,}000$ €

Under the given conditions, the total daily transport costs will be minimised when operating 80 vehicles or 80 to 90 vehicles.

7. Conclusions

As seen from the article, in this case, the use of the Monte Carlo algorithm is very appropriate when dealing with the problem of optimal vehicle fleet capacity. It was found that the overall lowest daily transport costs are 57,500 € when using 80 trucks. In this case, MS Excel was used to generate pseudorandom numbers. Computers play an indispensable role at the application of simulations and not using them in today's field of quantitative methods of managerial decision-making is unimaginable.

Further research into fleet issues should focus on the use of telematics, which presents new possibilities to accelerate the processing of information throughout the process and increase customer satisfaction. Research trends consist in developing new efficient fleet management models, optimization and simulation models, and integrating them into the entire decision support system. Computational efficiency of methods can be increased by integrating precise algorithms and developing mechanisms based on mathematical programming principles. The use of artificial intelligence principles and methods is also the right direction.

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LOGISTICS OF CONTROLLING IMPLEMENTATION IN CONDITIONS OF MANUFACTURING ENTERPRISE

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Keywords: production costs, controlling, logistics implementation
Abstract: Market saturation creates a competitive environment among manufacturers, causing constant competition for customers. The offer affects the consumer by many factors, but we consider the selling price of the product to be the main influence factor. In order to achieve a competitive price of the product, it is necessary to know not only the market but mainly the production costs of the company. Since production costs form the largest part of the sales price of the product, it is important for the manufacturing company to monitor and regularly adjust these costs so that the price of the product is competitive in the domestic or foreign market. As the cost of production, which in this particular undertaking is based on internal analysis and accounting documents, accounts for the largest part of the sales price of the product, it is important that the manufacturing company monitors and regularly adjusts it so that the product price is competitive on the domestic or foreign market. The aim of the presented research was to analyse the internal financial statements of a particular manufacturing company, to point out the critical values of production costs and to find a suitable solution for their subsequent optimization. In order to achieve the tactical, short-term goals of the company on the domestic and mainly foreign market, it is necessary to regularly control the costs of the company using a suitably chosen implementation management logistics, which is currently a progressive tool of business development.

1 Introduction

The term controlling originated in the late 19th century in America as a system of rules in economic theory and practice. It originally referred to a specific type of planning and control in the area of accounting and finance. Over time, it has developed into other business functions. Later he penetrated Europe. In the 1960s, the first knowledge of controlling appeared in Germany, where it quickly spread, especially in large companies, and later became interested in medium and small businesses. The beginning of controlling in Slovakia arose after the revolution the 1989 [1]. Controlling represents an important role in the company management system, it influences the understanding of controlling role in management. The main role of managers in a company is to prepare an appropriate decision-making environment and to provide detailed and timely information [1]. Controlling creates a tool to help businesses maintain and achieve a predetermined goal [2]. In other words, to achieve the planned objectives by ensuring and using organizational resources. It monitors the difference between real power and standard power, i.e. deviation. It investigates why a deviation occurs between them and helps to propose and take corrective actions. The aim of controlling is to plan and facilitate business coordination [3]. By introducing of controlling, the company wants to achieve performance standards, compare real performance with these standards and, if necessary, take corrective measures. Performance standards are most often expressed in monetary terms, such as profit, loss, revenue, expense or other terms (units produced, number of defective products, quality level or customer service) [4]. At present, controlling is considered a subsystem of the management system, which is applied in large and small enterprises, institutions and banks, while not looking at the ownership, organizational and legal form. Controlling serves as a management tool and is first-class support for managers [1]. In theory and practice, it was formed into three basic concepts [5]:

- **Accounting concept** - help controlling fulfilment of goals and tasks through the specificity of orientation on information obtained from accounting. The obtained information comes from the accounting information system, represented mainly by financial and internal accounting. The main task of the concept is to focus accounting as a future-oriented managerial tool, with future-oriented calculation systems as a prerequisite.
- **The concept focused on information** - helps controlling the provision of the required information base of the company and expresses the

information goal. The concept is again based on accounting as the main source of management information, where the obtained information serves as information systems for management and economic consulting. Controlling acts as a support for business management with information. The information obtained is adjusted and coordinated for use in business management.

- **The concept focused on the management system** is the most comprehensive and eliminates the disproportionately narrowed space of controlling in the management of accounting, or management information system. Controlling is considered as a subsystem of the company radiation system. The role of the concept is to limit controlling in relation to the management system.

Controlling is introduced in the company for various reasons and different time aspects. In terms of the time, we divide Strategic controlling (long-term) and Operative controlling (short-term). Short-term operative controlling is then divided into Internal controlling, Financial controlling and Investment controlling. Strategic and operational controlling are interlinked functional areas that complement each other [4].

1.1 Cost controlling

The scope of corporate controlling provides several possibilities for controlling division. The basic and most important aspects of the division are: functional area (research, development, supply, production, sales), area of activity (complex, production-financial, financial), time horizon (strategic, operational) and control content (costs, performance, investments, marketing, personnel, environmental protection) [6].

The main factor of cost controlling in a company are costs. Costs are an important criterion for the company, which is necessary for assessing the effectiveness of the company and as a decision-making tool. Costs are incurred in each business unit, process, activity, employee, etc. [7]. It consists of a systemic approach to cost management in an enterprise, which observes costs incurred at specific business centres, with different business functions, observes costs through accounting and integrated systems. It analyses, plans and manages costs in the company, controls their incidence and influence on the economic result, economic efficiency of the company. It observes the basic strategic objective of the company, namely the development of the company through the maximum economy, which consists of cost-effective and efficient cost management and achieving economic efficiency in the form of profit [7].

Cost controlling is a system that deals with observation and evaluation of company costs, finding deficiencies in costing, costing, cost analysis and evaluation (Figure 1). It provides cost reduction and seeks viable cost savings options at all business levels and processes. Cost controlling is a necessary component in management accounting because it deals with cost accounting, calculations, budgeting, and tax accounting. The outputs of cost controlling are reflected in the financial management of the company, where the cost controlling occurs at the operational and tactical level of management, the results of which are applied in parts of the strategic controlling of the company [8].

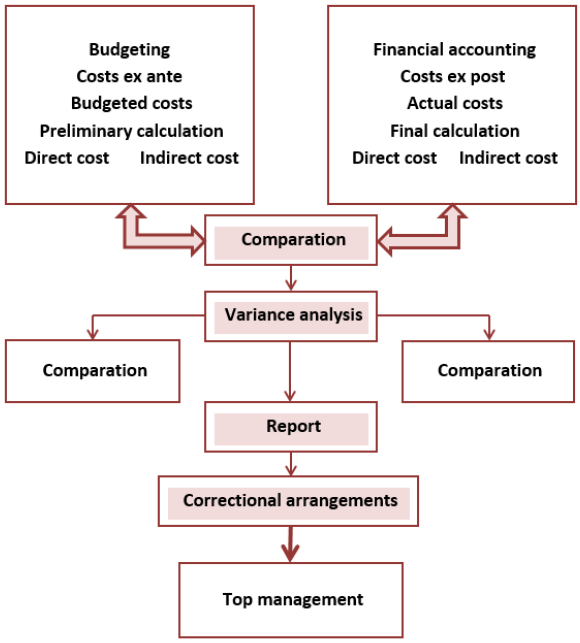

Figure 1 Ecological deficit / reserve, [2]

1.2 Internal cost controlling

Cost controlling belongs to in-plant controlling, whose main task is to inform the company about costs incurred in each area of business activity and help to make a profit. The secondary tasks are to improve planning, cost decision-making and capacity utilization of the enterprise, to continually innovate the company's calculation and cost system [7]. As a system, cost controlling helps the company to apply modern cost planning methods, organize costs and time to individual processes within the company, create a cost tracking overview, identify hidden cost savings points and address the company's financial situation [8]. Cost controlling is a practical tool that manages the business economy through a detailed system. The system consists of a detailed structured margin, which is a special part of economic management. It results from accounting data based on cost calculations. It optimizes from an enterprise-wide perspective and in terms of products, segments, and places of responsibility. It helps to solve the financial situation of the company and discovers hidden places to save the company costs. It is thus a means

of off-accounting processing of accounting data established for tactical economic decisions [8].

The calculation system consists of individual types of calculations and suitably selected calculation methods (Table 1). The purpose of the calculation is to identify and determine the costs that have been and will be consumed for a certain amount of performance in a given period. Types of calculations are divided in terms of time, method of compilation, cost structure, and utilization of production capacity [9]. Calculation methods are methods that observe and determine the actual cost of performance. For methods, it is necessary to know the subject of the calculation, the method of recalculating the cost of the costing object, the method of recalculating the cost per unit of costing and the cost structure [9].

Table 1 Calculation system [10]

Types of calculations	Calculation methods
1. In terms of time: - provisional - resulting	**1. Division calculation**
	2. Calculation in associated production
2. In terms of compilation: - total cost calculation - calculation of variable costs	**3. Surcharge calculation**
	4. Activity based costingactivity based costing - ABC
3. In terms of cost structure: - continuous - gradual	**5. Phase and step calculation**
	6. Custom calculation
4. In terms of production capacity utilization: - static - dynamic	**7. Differential calculation**
	8. Simple / tiered calculation of incomplete costs

2 Methodology

Through the values of production cost items, it is possible to evaluate the total production cost of the enterprise. By our research, the internal accounting documents of the joint stock enterprise with its registered office in the Slovak Republic were analysed. This enterprise operates in the field of industrial production - specifically the production of gate systems. By comparing these values, it was possible to define the order of the items and thus determine which item generates the highest costs for the company. The average cost of production is shown in the following tables (Table 2, Table 3, Table 4),

where:

ODC - other direct costs, MAT - material,
PO - production overhead,SO - supply overhead,
AO - assembly overhead.

An analysis of the cost items of the year 2016 revealed that the sum of average costs is 9075.26 €. The largest item (according to Table 2) is the sum of the average costs of consumed material, which represents 71.93% of the total cost of 6527.95 €.

Table 2 Calculation of production costs (2016) [authors own processing]

	Production costs items						
Product types:	Average ODC	Average MAT	Average wage	Average PO	Average SO	Average mounting	Average AO
A	34,42	831,67	32,16	106,36	82,80	19,67	77,93
B	0,00	2421,23	33,34	149,75	241,36	22,81	91,23
C	9,24	595,38	70,24	216,49	59,54	25,50	101,98
D	0,00	299,06	30,80	101,64	29,91	4,12	16,48
E	107,30	2380,61	89,32	294,76	238,06	52,02	208,08
Sum of average costs:	**150,96**	**6527,95**	**255,86**	**869,00**	**651,67**	**124,12**	**495,70**

An analysis of the cost items of the year 2017 found that the sum of the average cost was 6365.76 €. The largest item (according to Table 3) is the sum of the average cost of consumed material, which makes up 75.55% of the total cost of 4809.36 €.

Table 3 Calculation of production costs (2017) [authors own processing]

Production costs items							
Product types:	Average ODC	Average MAT	Average wage	Average PO	Average SO	Average mounting	Average AO
A	75,52	708,98	28,62	94,39	70,46	18,43	73,71
B	0,00	1951,05	22,01	74,13	194,48	14,35	57,41
C	0,00	282,19	55,08	181,77	28,22	15,45	61,80
D	0,00	167,64	31,94	105,41	16,76	3,43	13,73
E	0,00	1699,50	0,00	0,00	169,95	29,87	119,48
Sum of average costs:	**75,52**	**4809,36**	**137,65**	**455,70**	**479,87**	**81,53**	**326,13**

An analysis of the cost items of the year 2018 found that the sum of the average cost is 8 856.34 €. The largest item (according to Table 4) is the sum of the average cost of consumed material, which makes 82.71% of the total cost of 6 961.47 €.

Table 4 Calculation of production costs (2018) [authors own processing]

Production costs items							
Product types:	Average ODC	Average MAT	Average wage	Average PO	Average SO	Average mounting	Average AO
A	25,67	828,32	31,59	104,44	82,50	23,90	95,58
B	0,00	1330,30	25,46	83,61	130,13	12,76	51,04
C	0,00	353,58	51,89	171,25	35,38	10,63	41,20
D	0,00	230,37	34,52	113,90	23,54	16,23	64,90
E	0,00	4218,90	4,68	15,43	421,89	44,55	178,20
Sum of average costs:	**25,67**	**6961,47**	**148,14**	**488,63**	**693,44**	**108,07**	**430,92**

An analysis of the cost items of the production costs of the observed years (2016, 2017 and 2018) revealed that for enterprise the average cost of consumed material causes the highest cost of production for each year. Average material costs comprise the largest part of the company's production costs and consist of 71.93% in 2016, 75.55% in 2017 and 82.71% in 2018.

Based on a comparison of the analysed values (Figure 2), it was found that the average material costs increase each year as a percentage. The percentage increase in material costs is almost 11% over the three years of the observed period (the difference between 2018 and 2016, 82.71% - 71.92% = 10.78%).

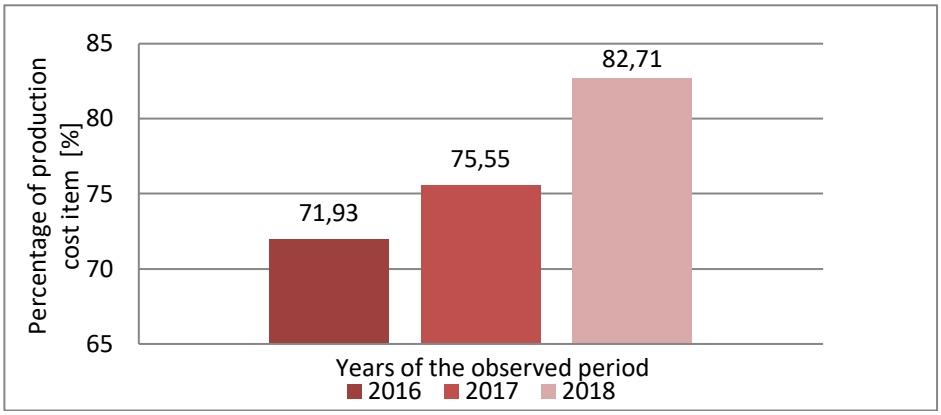

Figure 2 Comparison of the analysed values [authors own processing]

3 Results

Implementation of controlling in the enterprise is a very important and necessary step for the company to meet the predetermined goal of exporting products to neighbouring countries such as Austria, France, Germany, Switzerland, and possibly Norway and Finland [11]. The introduction of controlling will be used mainly for controlling production costs in order to reduce their value and optimize the material economy. The cost of consumed production material represents the largest part of the cost, proportionally containing up to 70 – 80% of the total cost of production. In order to reduce these costs, it is necessary to know the entire material flow, from material design, manufacturer and supplier selection, through purchasing, material storage, processing and treatment to the final product and the management and recycling of material waste. Cost reduction is an important factor for the company in 2019, as it plans to increase production in 2020 and start exporting its products abroad. Therefore, it is necessary to adopt a predictive approach to the implementation of controlling, which is mandatory for workers and management. Based on the complicated algorithm of controlling into the company management system, it is necessary to divide the implementation into these four essential stages, based on the preparation, design, introduction, and realization.

3.1 The first stage - preparations of controlling

Preparing the introduction of controlling is a fundamental and essential stage for the company, whose main task is to attract and convince the management of company for the need to use controlling. It is important to obtain management approval to start implementation. Management consists of prudent advisors and senior management who are accustomed to certain standards and any change in their subconscious raise's uncertainty. Given the new goal of the company, it is necessary to create and implement a new management concept with a focus on the foreign market. The foreign market has its standards and qualities, so it is necessary to know the market requirements perfectly [11,12]. Competitive position on the foreign market can be achieved only by quality work, goodwill, and satisfied customers.

The role of controlling is to meet the set goal therefore, it is necessary to define and precisely set the objective of controlling implementation in the company. The main goal in this particular company is to achieve a reduction in the manufacturing costs of the company, which was revealed by a financial analysis of internal costs. Specifically, these are the average costs of consumed materials for the period 2016 - 2018, which are part of the calculation of production costs. Production costs need to be cut short, ideally year 2019/2020.

The next step of the first stage is to train each employee on the introduction and use of controlling, to familiarize them with the controlling objective and next year's 2020 plan. To give employees a detailed idea of creating lower sub-tiers of corporate division management and incorporate them into the organizational structure of each management level.

Trained employees need to create a continuing education program, through which employees will acquire sufficient knowledge and knowledge of the use of controlling. Sufficient education will only be achieved through active participation in training sessions that will be held for individual corporate levels of management, from managers, economic departments, through managers of gateway operations to the actual production operations.

The preparation stage is an analytical-diagnostic stage that analyses the current state of the achieved results in the company and points out the need for the implementation of controlling, the current shortcomings for achieving the target and the need to reduce production costs. By analysing the current state of the division managers obtain an overview of the economic state of the division, which can be used to determine in detail the ways and methods of reducing production costs and thus eliminate unwanted problems that affect the achievement of the division's products export to the foreign market.

3.2 Second stage - projecting of controlling

The second stage of design is needed to define in detail the options for remedying the current situation and creates the procedures needed to reduce business costs. Controlling is necessary to monitor the analysed high average cost of consumed material. Define each area using consumed material. The cost of consumed material is influenced by several factors. It is necessary to focus on every step that deals with the material. To find out the correctness of the material utilization design in the technological process, to verify the methods of material purchase and supplier's choice, to analyse the methods of material processing and methods of material waste management. By defining corrective actions, a controlling plan will be created to help reduce production costs. It shall determine the remedial action of each process of handling purchased, transforming and marketing material [12]. It is necessary to reach new suppliers of materials and get a new quotation for the purchase of new material, check the technical designs and production processes of manufactured products in order to simplify their production and handling of materials, pay attention to the inconvenience of production and supervise ways of using.

After the processing and application of remedial measures, it is important to continually re-evaluate the results obtained, i.e. knowledge of material handling, and consequently to derive further sub-measures that guide the achievement of the objective.

This is followed by the design and projecting of the system of business and strategic planning. Changes are made in the organizational structure of the company, the choice of appropriate management style is required. It is important to take into account the initiative, suggestions, and decisions of senior executives. In an enterprise, it is

necessary to change the authoritative style of management to collective and thus prove to all employees that the set goal can only be proved by collective work. Evaluate the collective work by rebuilding the motivational system of additional employee evaluation, change the corporate culture.

The last step of the second stage is to change the control-planning system of the company and make the implementation of an information system conditional on the interconnection of all divisions in the company. Using the information system, the company will have an overview of all divisions at the same time and will be able to create a material flow between divisions, thereby optimizing the material inventory and directing material logistics. For the company is a suitable SAP information system, which includes, among other modules, a controlling module.

3.3 The third stage - the introduction of controlling

The penultimate stage consists of the introduction of controlling into the company, where the selected controlling team is already implementing practical controlling applications based on the selected concept. The chosen concept consists of optimization methods to reduce costs and material consumption. Controlling team is professionally educated and has practical experience in using controlling. The team is also complemented by external workers who are also part of the other divisions of the company and provide the team with a summary of enterprise.

Before starting the implementation, it is necessary to identify the main controller who supervises and is responsible for the overall course and changes caused by the implementation and function of controlling as well as for the functioning of the complete system. After fulfilling these steps, the decision to start work on corporate controlling is accepted. Acceptance is subject to the overall size of the enterprise.

3.4 The fourth stage - the realization of controlling

The realization stage is the last stage of the implementation of the controlling system of the company, in which the actual processes of reducing the production costs focused on consumed material through of controlling are already carried out. New methods of material utilization and processing are used, so a new material management system is applied in the company. Changes in the economy are due to the change in material suppliers, the processing of waste and scrap material, which reduces the analysed average cost of consumed material. By reducing the cost of consumed material, the total production costs of the company are also reduced in proportion.

For the long-term functioning of the controlling system in the company, it is necessary to constantly repeat the evaluation of the effectiveness of controlling methods in order to maintain competitiveness in the domestic and foreign markets in the long term [13,14]. For the progressive operation of the company with regard to building a continuously increasing competitiveness, it is necessary to implement controlling throughout the company.

After achieving the set objectives, it is necessary to evaluate the effectiveness of the whole implementation and to compare the assumptions received with the achieved results, or to deduce future changes in controlling.

The last step of the last phase of implementation is the systematic completion of the overall project, where the implementation team compares the achieved result with the required initial target of the company [15]. It is necessary to evaluate the achieved results, production quality, meeting deadlines and the overall success of the implementation team. The overall success of controlling implementation in the company can only be assessed and determined to be correct several years after its introduction. At the end of this phase, future business prospects need to be determined at this stage.

4 Conclusions

The production costs of the company, the largest part of the total internal costs. Therefore, in order to achieve business goals and maintain market competitiveness, production costs need to be constantly monitored and reduced. The main objective of this work was to investigate the internal costs of the enterprise. By examining the financial statements of previous years 2016 - 2018, we created well-arranged tables of internal costs, which show the average cost of each item of the calculation formula for each type of products sold and the sum of the average cost of each item of the calculation formula for the whole year for all types of products simultaneously. Subsequently, for a more detailed analysis, we chose only those items of the calculation formula that constitute the production costs of the corporate division. By analysing the items of production cost, we have made a comparison of items that pointed to the item with the highest value of average production costs for each one observed year. The highest cost of production for each observation year for the enterprise is caused by the item of the average cost of consumed material, which represents 71.93 - 82.71% of the total cost of production. By comparing the average cost of consumed material, we found out that the cost of the material increases annually as a percentage. The cost of consumed material has increased by up to 11% over the observation period, so costs need to be constantly monitored and reduced. For this reason, we have identified opportunities for the company to reduce costs and recommend the implementation of controlling described in four stages of implementation.

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IMPACT OF LEGAL STANDARDS ON LOGISTICS MANAGEMENT IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Keywords: legal standard, logistics management, sustainable development, Commonwealth of Independent States, industry
Abstract: In the global context, logistics plays a key and sometimes a decisive role in the industrial development of countries. The legal regulation remains one of the important ways to solve the logistics tasks by enterprises efficiently. The purpose of this study is to assess the impact of legal norms on logistics of enterprises to support sustainable development. The article examines the state of logistics in the members of the Commonwealth of Independent States and their legal norms that affect the countries sustainable development. The research methodology is a survey of companies' managers and lawyers. The Kruskal-Wallis test, ANOVA analysis, Tukey's HSD test are used. Logistics management in enterprises should contribute to the protection of both environmental and social sustainability, because the growing number of customers supporting socially responsible enterprises is observed.

1 Introduction

The development of supply chains regulation methods in logistics, including the regulatory framework, has direct and indirect impact on the activities of logistics entities, creation of document flows, implementation of logistics operations and functions. Logistic activities are subject to existing laws and by-laws, and there is also a need for methods of centralized, unified regulation of logistics chains as a set of subjects, objects, and logistics activities to promote material, information, financial, and other flows from the starting point to the destination. The logistic approach to managing economic processes is based on the operation of information standards, business and other regulatory acts in the field of logistics. Today, all countries of the world must comply with international and national laws and regulations. There are several international standards and regulations that are likely to be followed soon by all companies. One example is the United Nations Framework Convention on Climate Change, whose goal is to decrease atmospheric greenhouse gas concentrations. Currently, this task is the most urgent for all companies in order to timely react, meet all legislative, and market requirements. In particular, they have to develop environmental programs and collaborate with the government to improve the environmental guidelines and standards.

2 Literature review

Paradigm of sustainability is supposed to base all human actions. It "pervades the environmental, social, political, economic and cultural discourse from the local to the "global" level in both the public and private sectors" [1]. Self-regulation of social and environmental impacts by enterprises is being promoted as a solution to the regulatory problems that developing countries face. The international legal norms can help governments of developing countries since the globalization brings many potential opportunities for of businesses in developing countries [2]. At the same time, this creates a significant regulatory problem. In recent years, pressure has increased on private sectors to take responsibility for social and environmental issues. The critical attitude towards private enterprises and their impact on society often prevail. To solve this ambiguity, the International Organization for Standardization has published a standard that contains recommendations for integrating social responsibility into governance processes [3]. The international standards can improve the accountability, promote and guide corporate responsibility, provide enterprises with ways to systematically evaluate and measure their social and environmental parameters [4]. Over the past few years, due to global changes, many researchers expect new directions in the management of enterprise logistics. Guoyi and Chen [5] argue that, with the advent of new economies such as the information economy and network economics, logistics has gained new knowledge, new technologies and new managerial thought,

and the logistics industry is developing in the direction of specialization and scale. New technologies can affect the industry structure by creating new sectors or eliminating others [6]. But with the increase in the volume of logistics, changes in logistics management and a wide range of logistics tools and instruments, the environmental impact of the logistics system is becoming more serious. In their studies, Kovács and Kot [7] define logistics as the planning, organization, and coordination of flows of materials, information, energy, money, and values within a logistics system. As Jigang [8] pointed out, logistics is now playing an increasingly important role in economic and social development, the rapid growth of science and technology and the growth of the global economy. The development of logistics is also very important for improving the quality and efficiency of the national economy, optimizing the distribution of resources, improving investment conditions, promoting industrial restructuring and increasing economic power. The importance and influence of logistics is also noted by other authors and states that the quality and accessibility of the services offered by the logistics sector are of great importance for economic growth and increasing the employment potential, as well as the ecological situation of the country [9-11]. Ming-Lang and other researchers [12] emphasize that the industrial sector, thanks to its role in society, has made a significant contribution to environmental pollution and its operation. The rapid industrialization of many countries in Asia and, accompanied with increasing levels of water, air and land pollution raise concerns about the volatility of current growth patterns. Effective supply chain management is, in particular, to ensure the highest possible quality of customer service and the desire to minimize costs arising from the flow between the links [13]. The greening of supply chain management complies with environmental, social and ethical standards in supply chains. For example, the ongoing promotion of Chinese cleaner production strategies is mainly based on the Cleaner Production Promotion Act of China. The concept of Cleaner Production is accepted by the United Nations as a holistic approach of a "source-oriented preventive thinking". [14]. Tightening greenhouse gas emission standards in Asia put also increasing pressure on petrochemical and steel industries in Korea [15]. Sustainable industrial development of the Republic of Kazakhstan requires new legal norms that will regulate all these sectors. Therefore, innovation and logistics management are becoming the basis for the company's development in Kazakhstan [16] as one of the priority sectors of the economy is industry. The positive dynamics of the economic and social subsystem, but the negative environmental subsystem in one of the largest cities of Kazakhstan also deteriorate the sustainable development [17]. When consumers optimize their behaviour by maximizing the utility from consumption legal regulation can help to predict their behaviour [18].

2.1 The importance of legal standards in logistics management in the CIS countries

The business environment in Kazakhstan is relatively stable and transparent compared to other countries of the Commonwealth of Independent States (CIS). As a country in transition, both internal stakeholders and the government continue to pay more attention to the economic and legal responsibility for the sustainability of business organizations. Civil society and non-governmental organizations, on the other hand, argue that business organizations should focus more on ethical and discretionary responsibilities in Kazakhstan [19]. In Kazakhstan, a new law on the green economy is currently being approved by the Parliament. The law contains all the previously adopted rules for the use of renewable energy sources and provides a new regulatory framework. In particular, the law guarantees the connection to the grids, its use and expansion of the grids for renewable energy producers [20]. Sustainable development is necessary to achieve the goals of the Development Strategy of Kazakhstan until 2030, and Kazakhstan is a member and an active participant in the UN Commission on Sustainable Development, the Environment for Europe and Environment and Sustainable Development for Asia processes, the regional Eurasian network of the World Council of entrepreneurs for sustainable development. Based on the German sustainable development strategy, which is based on the EU sustainable development plan, five areas of activity are identified: reducing transport and emissions, reducing land use, choosing a carrier taking into account sustainable aspects, constantly improving working conditions and continuing education [21]. The impact of logistics on the competitive advantage of the parties, as well as the risk associated with changing working conditions, increase the importance of trust in a partner [22]. Sustainable logistics – one of the topics mentioned in the Sustainable Development Strategy - propose many strategies and practices that can support sustainable development [23]. The vast territory of Kazakhstan and small population make integration and globalization as one of the priorities in the country's development. The freight turnover of transport enterprises (without pipelines) on average in the CIS countries is growing every year. The leaders among the CIS are Kazakhstan, Belarus, Uzbekistan. Cargo turnover in Kazakhstan has grown over the past 10 years from 369.8 billion ton-km by 61.2% to the level of 596.1 billion ton-km in 2018. Income of enterprises in the past year amounted to 250.4 billion tenge, including from the transportation of goods - 148.9 billion tenge (the entire amount falls on freight road transport) and 101.5 billion tenge (Figure 1).

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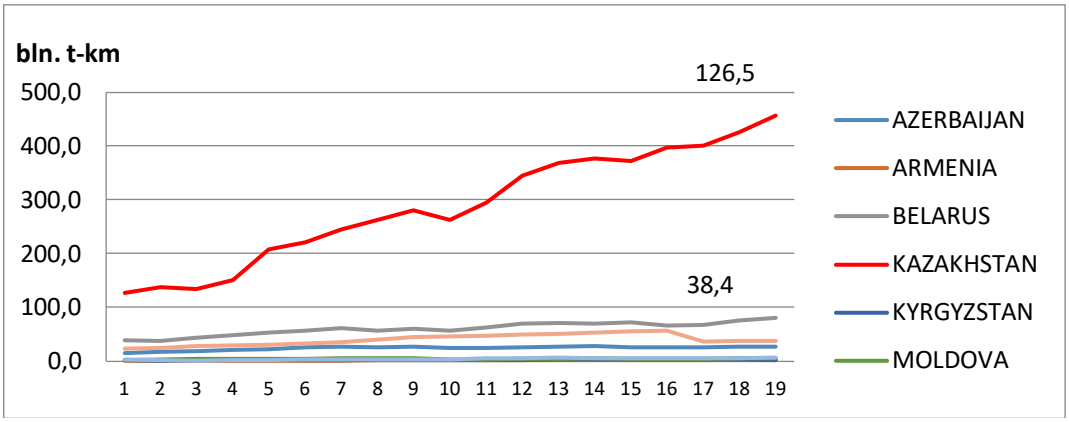

Figure 1 Freight turnover of transport (excluding pipelines)

UNCTAD is supporting the sustainability of freight transport systems based on data from relevant research and analytical work, as well as strategic recommendations based on consensus building and field experience. The main tools and mechanisms developed by UNCTAD to facilitate the transition to sustainable freight transport systems are presented in the UNCTAD Sustainable Transport and Finance Toolkit and include a methodology for assessing gaps and expanding the capacity to plan, develop and implement strategies for sustainable transport and finance; a package of training and capacity-building measures, including case studies, best practices and resources; and an online portal to facilitate the exchange of information and partnerships. All three components are flexible and allow you to make innovative solutions that are appropriate to local conditions and the specific needs of users. The flexibility of these tools makes it possible to set priorities and goals, taking into account the special criteria and needs of various beneficiaries [24].

Mining industry is the most profitable for the economies of CIS countries. The largest taxpayers of the CIS countries are mining enterprises and these payments are growing from year to year (Table 1).

Table 1 The largest enterprises are taxpayers of the CIS

№	Country	Industry	Company
1.	Russia	Oil and gas	PJSC Rosneft Oil Company
2.	Kazakhstan	Oil and gas	Tengizchevroil LLP
3.	Kyrgyzstan	Mining industry	CJSC Kumtor Gold
4.	Belarus	Gas industry	OJSC Gazprom Transgaz
5.	Armenia	Industry	Zangezur Copper-Molybdenum Plant
6.	Uzbekistan	Mining industry	Navoi Mining and Metallurgical Plant

According to the CIS International Statistics Committee, the largest oil producing countries are Kazakhstan first, Azerbaijan is second, and Uzbekistan is third (Figure 2).

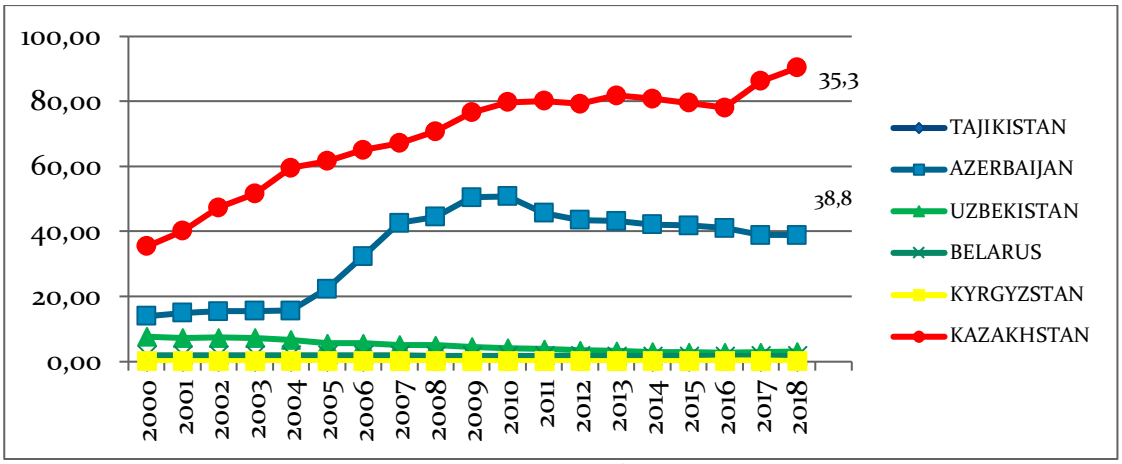

Figure 2 Production of petroleum, mln. tenge

The bulk of the country's budget in 2018 was made by enterprises involved in oil and gas extraction. Last year, oil and gas companies in Kazakhstan provided 87% of the country's 30 largest taxpayers tax revenues. In with these indicators, it can be revealed that, each year, the volume of new industrial waste is growing. In connection with the development of the mining, processing and heavy industries, Kazakhstan produces significant volume of industrial waste that must be managed in accordance with international best practice. At the same time, these efforts often generate considerable environmental conflicts, decreasing the sustainability of the environment [25]. Thus, Kazakhstan actually needs to rebuild an integrated waste management system, since the organizational and legal framework, in fact, are absent. There are not enough norms for rational waste management, and responsibility for the construction and operation of an integrated system is not distributed. "The Kazakhstan-2050 Strategy: a New Political Course of a Successful State" sets clear guidelines for building a stable and effective model of the economy based on the country's transition to a green development path.

3 Methods

Online survey method is used to study the attitude of stakeholders to the logistics management and legal requirements. The questionnaire is compiled for two interested parties - lawyers and managers. The questionnaire includes information on international standards applicable to support sustainable development, on legal norms affecting logistics management, an assessment of new principles introduced into management in connection with sustainable development. The asymmetric 5-point Likert scale is taken to measure the relative importance of each statement: 1-Unimportant, 2-Not very important, 3-Moderately important, 4-Important, 5-Very important. Statistical tests are powerful data analysis tools. To obtain a significant difference, the Kruskal-Wallis test is used. The Kruskal-Wallis test is a nonparametric alternative to the one-way ANOVA test for independent measurements. It is based on ranking data, not on calculations using averages and variances. The Kruskal-Wallis test is a nonparametric statistical test that evaluates whether two or more samples are taken from the same distribution. It is commonly used in various fields [26]. One-way ANOVA analysis is used to assess the marginal discrepancy between groups, and Tukey's HSD criterion was used for comparative studies. The Tukey multiple comparison test is used to determine which group the difference arises from as a result of the one-way ANOVA. In addition, logistic regression analysis can be used. Logistic regression is used to predict the likelihood of an event from the values of many features. Multilevel models of logistic regression make it possible to take into account the clustering of subjects in clusters of units of a higher level when assessing the impact of the characteristics of the subject and the cluster on the results of the subject [27]. The questionnaire is compiled in Russian, since Russian is the generally accepted language of communication in Kazakhstan and the CIS countries, but the questionnaire was translated into English to check for inconsistencies and possible translation errors. Online - questionnaire was sent to more than 400 respondents. To identify accurate results, an equal number of two groups was used, and additional questions were added to the company's managers to assess the importance of the legal norms of sustainable development for their enterprise.

4 Results

The total number of respondents is 214. Of these, 125 respondents are lawyers, 89 respondents are company managers. The survey participants 57% are women and 43% are men. 56% were from the public sector and 44% from the private sector. Of the private sector, 33% are international companies, 17% are joint-stock companies, 46% are limited liability partnerships.

According to the questionnaire, the answers of the respondents of two groups to the question on the impact of international standards on logistics management in the field of sustainable development, which can successfully influence, gave a significant difference in the results of the Kruskal-Wallis test. Enterprise managers pointed that international standards that are not laws, they do not oblige enterprises to fully implement the norms. Most lawyers pointed that international standards are mandatory requirements. According to lawyers a company can achieve its goals with the help of obligations. The p-value is 0.00114 (Table 2). The result is significant at $p < 0.05$. 46% of the total sample support international standards and "light" laws, 54% support international laws and mandatory laws (Figure 3).

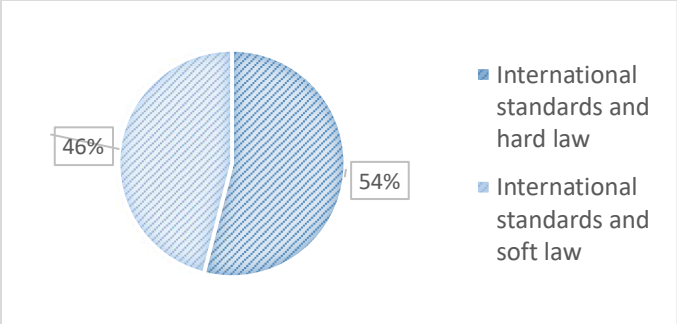

Figure 3 The impact of international standards and legal norms on logistics management

44% of the total number of respondents assessed necessity to change the traditional methods of logistics management as "moderately important". In relation to two groups, it is "very Important" for 61% of lawyers, 39% - for enterprise managers. The difference between the two groups is confirmed by One-way ANOVA and Tukey's HSD Test.

Table 2 The statistics values

Source	Sum of squares SS	Degrees of freedom vv	Mean square MS	F statistic	p-value
Between-treatments	10.8764	1	10.8764	6.3249	0.0128
Within-treatments	302.6517	176	1.7196		
Total	313.5281	177			

The f-ratio value is 6.32492. The p-value is 0.012801. The result is significant at $p < 0.05$. The p-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05, suggesting that the one is significantly different (Table 3).

Table 3 The results of the statistics

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
Managers and Lawyers	3.5567	0.0128028	$p < 0.05$

The study of standards implies not only a consideration of their adoption and production, but also a study of their role and contribution to global economic governance, as well as their attitude to more stringent forms of law. The study of important aspects, which should include legal norms to increase the efficiency of enterprise logistics management has shown the following results: 87% - show the principles based on standards, in second place 69% - technology standards, 63% - certification standards, 25% - reporting standards (Figure 4). Typically, the enterprises introduce only the minimum mandatory changes according to national environmental regulations.

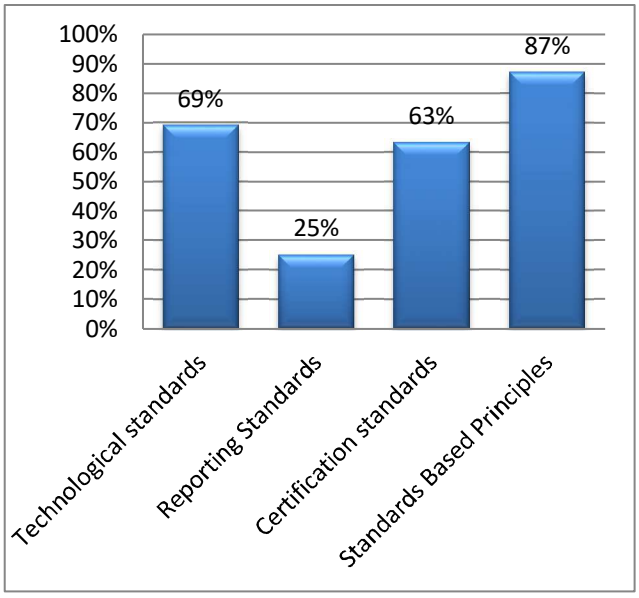

Figure 4 Aspects that should include legal provisions

Answers of company managers an assessment of the importance of the legal norms of sustainable development for their enterprise gives the following results: most managers of them 42% - "Moderately important", 38% - "Important", 19% - "Not important". According to the survey results, legal norms to improve efficiency is one of the main principles of companies. To the question "what do their company do to achieve their goals by legal norms" the following answer options were offered: provide resources to the company - strategies, management provide favourable conditions due to the pressure from the government, with the help of the cultural characteristics of the company, compliance with norms and adoption of environmental standards. Most managers (40%) indicated the culture of the company, 24% indicated the company's strategy, 36% - indicated legal requirement. Business see environmental regulation as unjustified economic burden that threatens its profitability, while competitive groups pay considerable attention to the adoption of environmental laws. Obviously, the market is changing the course of development in managing the enterprise and in all its activities.

5 Discussion and Conclusion

The concept of sustainability encounters widely into legal framework. It is reflected in an increasing number of international official documents. The legal nature of sustainable development depends on two preconditions: legal sphere and penetration into one of the recognized sources of international law. Companies can no longer ignore environmental changes and must be prepared for all new market conditions. According to the results of the questionnaire, enterprise managers and lawyers believe that, for effective logistics management and for maintaining the country's sustainable development, international standards that are characteristic of light legal norms are most influential. The reporting on sustainability support reflects global best practices for publically economic, environmental, and social impacts [28]. As indicated by respondents Principles based on international standards should be integrated into legal norms for effective management. The respondents make it clear that any country has its own characteristics and different legal

norms that must be taken into account. Development of logistics in the CIS countries takes place in accordance with international principles but has its own characteristics. Lawyers consider changing the traditional management approaches according to the requirements of legal norms to be very important, but at the same time it remains moderately important for managers. The people of Kazakhstan are accustomed to live in strict rules and regulations, and state legislation always gives priority to everyday life. Technological standards are an important aspect of the rule of law that supports sustainable development. Current research has some limitations. First of all, the data used can reduce the accuracy of forecasting. Secondly, among the participants there are only enterprise managers and lawyers who make the result quite difficult to generalize. Further research will help overcome this shortcoming by using longitudinal data to improve the accuracy of forecasting the impact of international standards and legal norms on logistics management.

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THE BLACK OCEAN STRATEGY IN THAILAND LOGISTIC INDUSTRY THE CASE STUDY OF USED CAR SECTOR

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Keywords: Black ocean strategy, logistic industry, auto market, small and medium enterprise, cost and pricing
Abstract: The logistic is the core of Thai economy. While many business authors are focused on blue ocean strategy in pursuit of tapping into uncontested market space by using differentiation and low cost. There is another strategy that are most commonly use but not much revealed in the literature. It is named black ocean strategy and commonly use in logistic industry. It is the secret mantra from the past which still widely use in today business world. This paper has focus on used car sector as a part of logistic industry to study the viable of this strategy and found that black ocean is commonly used by used car companies. Since the automotive tax in Thailand is pretty high many logistic companies prefer to go for used car which is more economy. The study found that black ocean strategy is the viable tools to reduce the purchasing cost as well as increase the selling price for both logistic buyer and purchaser.

1 Introduction

Thailand is the main logistic hub of ASEAN. The location of Thailand is in the centre where it connects with Laos, Myanmar, Cambodia, Malaysia, and Vietnam; make Thailand at the logistic hub of the region (GMS: Greater Mekong Sub-region). According to the World Bank's Logistics Performance Index 2018 Thailand ranking has rose from 45th in the year 2016 to the 32nd in the year 2018. It is only second to Singapore in the same region.

The growth in logistic industry required vehicle, which in term boots automotive sector as an important part of Thailand economy. Albeit the growth of automotive industry, the taxation system for cars in Thailand is a bit confusing, which in term make the car retail price extremely high in this country. Since reducing the logistics time and costs is one target of Thailand [1], to reduce the operation cost several local logistic company use second hand cars, and motorcycles. However, the pricing and cost structure for second-hand cars is much more complicated than the first-hand car. In the situation where negotiations are more complex black ocean strategy tends to be another tool that Thai used car sellers are applied.

The purpose of this paper is to study the existing of black ocean strategy in used car industry where logistic company may concern and be able to align the strategy when purchase the second-hand car.

2 Literature review

2.1 Strategy

Strategy is "στρατηγια" (stratégia) in Greek. The original meaning of this word in Greek means supreme commander of the troops [2]. It first noted in 18th century as the "art of general", as well as, the "art of arrangement of troops" [3].

The strategy for art of general address (1) Vision: where the troop are going (2) Mission: how the troop act and do in order to reach the destination (3) Competitive Advantage: how the troop will acquire their superior advantage than their opponent (4) Tactics: what will be the troop's man oeuvres to move, and (5) and Sustainability: how the troop remain survive [3, 4].

The concept of strategy has transfer from military to business. It is how the company influential the forthcoming

business opportunity and reaching the required ends with their existing resources [5].
Strategy is the combination of mission, vision, people and structure [3]. It is the pattern that integrates company's major goals, policies and sequential actions into a solid whole [6]. People and structure are two main elements that drive the organization. And the firmware that imprinted inside people and structure is "culture". Culture can facilitate the firm to achieve (or avoiding) from reaching their goals and their visions [7].

Company strategy tries to create competitive advantage that allows companies to outperform its competitors. Strategic management should consider how to build and sustaining the competitive advantage [8].
The company is facing hard time through competitive and dynamic environment in order to attain sustainable competitive advantage company is applying dynamic capabilities [9, 10].

2.2 *Sustainable competitive advantage and Dynamic capabilities*

It has been said that successful organizations must have dynamic capabilities [9] which is the company's ability to adapt to the changes that they are facing in the business environment [11]. It is also the pattern of decisions that affected the capability of the company to reach their long-term goals and objectives [12]. The term capabilities refer to a company's ability to exploits it resources [13].

The competitiveness may the cause of resource or products. However, analysing a company from the resource side has more benefit, since resources is anything that might be thought of as a strengths or weaknesses of a given company [14].

The concept of competitiveness is focused on how to detect the precise strategy at the accurate amount of resource distribution [15]. And the dynamic capabilities theory is resource-based view [16], where the company can use resources to gain competitive advantage. It has been suggested by Barney in his VRIO framework that the resource that increase the company's competencies must have value, rareness, imitability, and organization [17].

The sustainable competitive advantage can be function as how to measure strategy index, as well as transformational leadership approach (Figure 1), sense and respond (S&R) monitoring technique, and how to transform leadership [18]. According to Bradley and Nolan it is better for company apply sense and respond technique to reply to the world where it is harder to effectively make decisions and implement them under uncertain business situations in the new economy [19, 20, 21, 22].

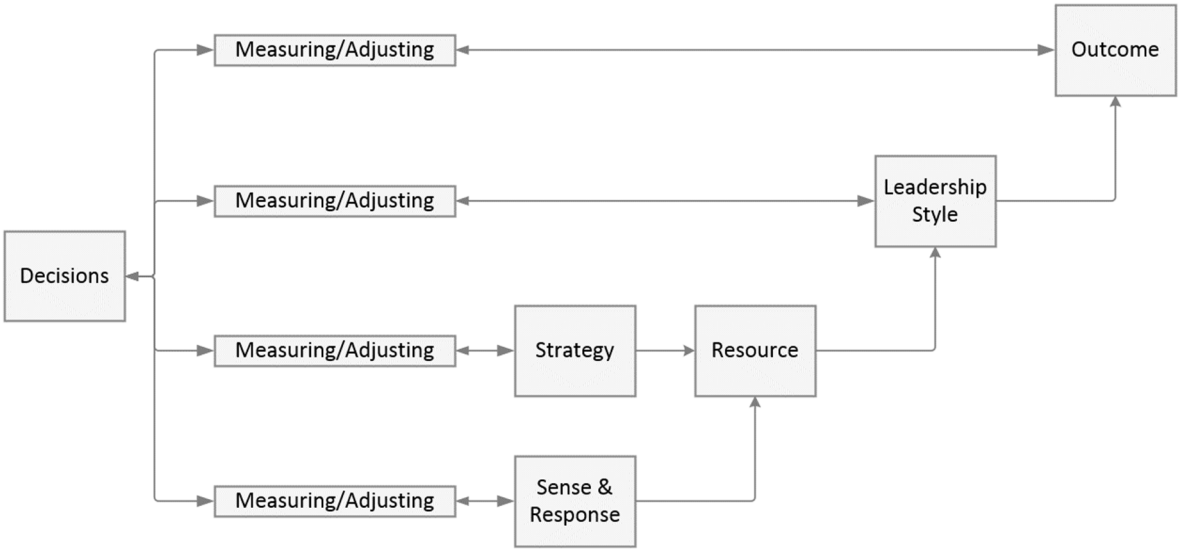

Figure 1 The benefits of implementing sustainable competitive advantage adapted from Liu, 2013, p. 2829

The excellence model by Sivusuo, Sivusuo, and Takala, 2018 suggested that in order to develop sustainable competitive advantage there are two driven: norm-driven or competitiveness (basics), and value driven or competitive advantage (excellence).

The norm-driven side is the elements for attaining ordinary outcomes and can be influenced by the organization itself such as management and organization structure. The value-drive side is the elements for attaining excellency and to lead opportunities.

The role of entrepreneurial actions and innovations is crucial for dynamic capabilities in term of value-driven side [11]. Currently, company must be innovative, initiative and brave for doing something different [10].

2.3 Colour of Ocean Strategy

Several literatures mentioned the strategy in term of two main colour "Red" and "Blue" (Figure 2). It is the different point of view for strategic management [23]. Red Ocean Strategy represents all the businesses that presently exist in the well define or current market space, where the business borders are acknowledged, and the company need to be beat competitors by their superior advantage (competitive advantage). According to Michael E. Porter, the company is recommended to achieve differentiation, cost leadership, or focus strategy with the intention of gain competitive advantage [8] and to survive. On the other hand, Blue Ocean Strategy were suggested the company should rather find uncontested market space where competition irrelevant [24], which in turn competitive advantage may not important.

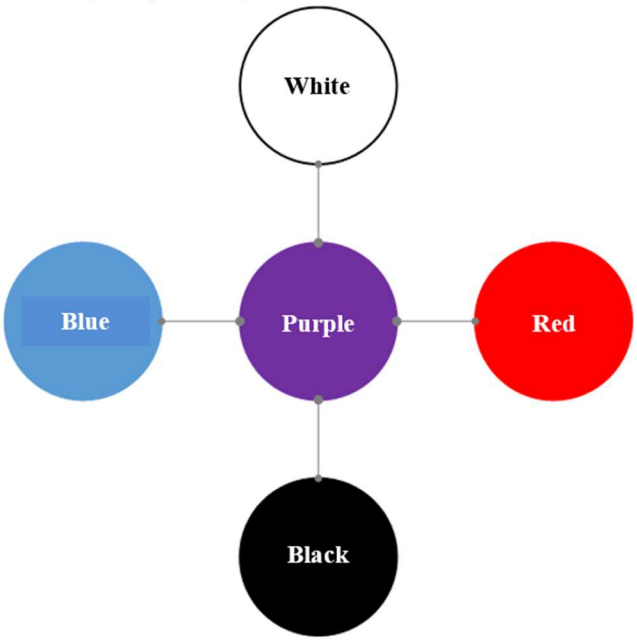

Figure 2 Ocean Strategy Frontier adapted from Nithisathian, black Ocean Strategy: Empirical Research, 2016

There are 2 more Thai literature that view the colour of ocean strategy differently. There are three more colours added "Purple, White, and Black" ocean strategy.

"Purple ocean strategy" believed that no strategy is dynamic and company may change the colour of their ocean strategy to match with the circumstances [23].

The Ocean strategy frontier can utilize together with type of business strategy. Literature has classified business strategy into four types prospectors: who prefer to create changes, defenders: who focusing on maturing market, analysers: who apply strategy between prospector and defender, and reactors: who response to the strategy of competitors. [25]. Prospectors may move toward blue ocean strategy, while defenders try to stick on red ocean strategy. Purple ocean may be the area where analysers and reactor try to fit in before moving toward other direction.

In addition to blue, purple and red ocean strategy there are another two strategies which are white and black ocean. For "White ocean strategy" and "Black ocean strategy" are more dealing with the role of entrepreneurial actions and innovations of the company. White ocean strategy viewed that entrepreneurs should role the company to support corporate social responsibility [26], while Black ocean strategy suggested the entrepreneur should take advantage from social norms [23].

2.3.1 White Ocean Strategy

The White Ocean strategy proposed by Thai business executive and syndicated columnist Danai Chanchaochai [26]. He has addressed the Buddhism managing approach, and highlights the humanity first formerly looking to oneself. This concept is connected to the concept of corporate social responsibility (CSR) and also the concept of "Marketing 3.0" by Philip Kotler et. al that view the market shifted toward the human spirit [27]. The concept of White Ocean strategy by Chanchaochai [26] focus on 7 key main activities comprised of (1) Net positive impact on society, (2) long-term goal and macro view, (3) People, Planet, Profit, and Passion, (4) The World of abundance and sharing, (5) Integrity, (6) Individual social responsibility, and (7) setting the World new benchmark.

In the other side of the coin literature stated that company mostly does not understand the benefit of corporate social responsibility and just use it as a kind of corporate public relation [28, 29, 30]. A Marxist point of view to the concept of capitalism suggested that "business morals and ethics are unbearable since the capitalism itself inclines to generate materialistic, over-reaching, and unprincipled business conduct" [31, p. 565]. Carroll [32] stated that before anything else, profit purpose was recognized as the main motivation for entrepreneurship. The term profit purpose was soon developed to profit maximization, where all business tasks are predicted upon the financial concern of the organization. This is the foundation, the first, and the basic form of CSR which comprises of 1) economic level of CRS, 2) legal level of CSR, 3) ethical level of CRS, and 4) philanthropic level of CSR.

2.3.2 Black Ocean Strategy

Aithal and Suresh Kumar [33] stated that Atharva-Veda is an ancient Indian philosophy to guarantee that the company or person is reaching the objective or goal. The Black ocean strategy is not framing to confront the competition or developing uncontested market space but strategy in low ethical environment. They have proposed the investment versus perceived risk matrix (Figure 3).

HIGH	Red Ocean Strategy	Black Ocean Strategy
LOW	Blue Ocean Strategy	Green Ocean Strategy
⇧ Investment in the Business / Perceived Risk ⇨	LOW	HIGH

Figure 3 Investment versus perceived risk matrix

Aithal and Suresh Kumar [33] suggested that Black ocean strategy will be implemented with the following condition: 1) need for existence 2) going to lose large amount of investment 3) the company is having a big trouble, and 4) the happen of uncommon chance.

According to Aithal and Suresh Kumar [33] there are 6 steps of adopting Black Ocean Strategy (Figure 4) 1) Problem recognition 2) Expect the resolution 3) Investigation for possibilities answer 4) Select the finest solution 5) try to reach the goal, and 6) seldomly use the black ocean strategy.

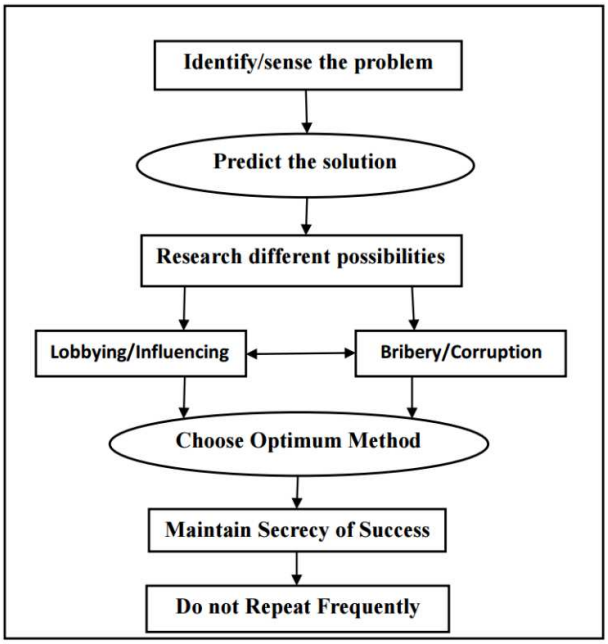

Figure 4 Block diagram various steps involved in the procedure of adopting black ocean strategy

Kittichok Nithisathian [23] suggested that Black Ocean strategy is the capability to compensate the company earlier than reimbursing to the other. Black Ocean strategy is focus on opportunity both as a tool to access and manage the opportunity. Also, trust is the main area that Black Ocean strategy dealing with.

Trust is frequently observed in today's literature [34]. It is considered to be the main concern of today business alliance [35], can impact individuals to align with the company interests. Trust is the magnet that combines all parties together, it can generates robust communities as well as active businesses result [36], it can create as well as damage any kind of human connection [37].

Nithisathian, et al., [38] argued that in currently business environment deliberate cheats are usually use hope as an instrument to betray, while opportunistic parties try to take benefit or gain when they become trusted. Black Ocean strategy is dealing with trust by create "trust trap". The trust trap formed by thoughtful cheat and opportunistic is extremely harmful. Trust trap can make an untruthful memory, which has a long-term outcome [39]. It is important for firm to use White ocean strategy while also cautious relationship with business partner who may use Black ocean strategy is suggested.

The core concept of Black Ocean strategy is the ability of the firm to "manage" audience attitude (create trust) as well as able to "execute" strategy without concern the impact to another party [23].

Recent study of Black Ocean strategy found that several opportunistic try to build a "White" reputation, while truly apply "Black" ocean strategy. This is the habit to gain trust while able to use trust trap simultaneously. The "White" ocean strategy and "The Black" ocean strategy may be the other side of the coin or may be unable to separate [40].

2.3.3 Black and White Ocean Strategy

Carroll [32] suggested three ethical management approaches (Table 1) which comprises of 1) immoral approach, 2) amoral approach, and 3) moral approach).

Table 1 Three Moral types and Orientation Toward Customer by Caroll (1991)

Approaches	Description
Immoral Approach	Ethical is not mentioned. And company try to take opportunity from customer whenever possible.
Amoral Approach	The decision is based on profit rather than ethical consequences.
Moral Approach	Both parties are work with fairness. Customer's satisfaction are highest goal of the company.

2.4 Used Car Industry and Logistic in Thailand

Thailand is being the logistic hub of ASEAN due to the logistic location. However, Thailand are facing major problem on both basic infrastructure and supply-chain management. The quality of road in Thailand is sub-standard to neighbour country like Singapore and Malaysia in term of infrastructure, punctuality, planning, management systems as well as technology. And that is a lot of work for Thailand to develop. In term of supply-chain management Thailand still need a good

understanding mainly from small and medium size logistic firm to formulate good logistic plans and strategies.

The used-car markets is a small part of supply-chain management but important for Thailand logistic management. Though it may consider as a reverse logistics system, it is a good approach to reduce the initial investment cost. Although the use of second-hand car can be purchase for a fraction of the cost of a new car it require a lot of maintenance, however many used car dealer does not replace some components before selling and it may cost a big problem for logistic system when the car is on service [41].

The finding from the State shows the number of second hand cars consumption three folds of new car, and this number is higher in Thailand where the price of new car is skyrocket [42]. In Thailand, where population is around 60 million, there are around 1 - 1.5 million used car circulate in the market [43]. Only in the year 2018 there are around 1,020,000 used cars sold with the growth rate more than 17% [44]. This is a big industry in Thailand, however Office of the consumer Protection Board (OTPB) reported that there are more than 129 cases complain about unconditioned car sold [45].

3 Methodology

In this study, the methodology that researcher has applied is the 'constructive approach'. It is applied study science in order to find of new understanding in the normative form [46]. It is both empirical and normative types of research. It is a problem-solving methodology by the construction of diagrams, models, organizations, plans, and etc.

The constructive research comprises of 6 main tasks comprises of (1) finding the potential problem that need to be answer, (2) obtaining the in depth understanding of the issue , (3) come up with the creative solution or idea, (4) presenting how the idea is feasible, (5) showing the connection between theory and research finding and (6) inspecting the area of applicability of the answer [46].

In order to demonstrate how the solution is workable, researcher has applied qualitative research method to conduct the in-depth interview. Since the goal of qualitative research and in-depth interview is to acquire the in-dept understands [47].

According to the rules of thumb-based approach the grounded theory of action research required, 20 – 30 of the cases [47]. Thus, the researcher selects sampling size for this research at 20 used car companies plus 10 additional cases.

The sampling selection was through snowball selection technique. The snowball or chain sampling technique is the approach to identify cases from respondents who know people who understand what cases are information-rich [48]. The respondents are an owner or a sale manager of the company.

The interview was conducted in Bangkok during November 2018 to March 2019. As the guidelines for length of interviews for 20 respondents is 30 minutes to 1 hour [47], researcher has conducted the interview with the approximately 1 – 2 hours interview time per person. Some respondents need to interview more than one time in order to get more in-depth information.

4 Finding

The researcher found the existing of black ocean strategy in Thai logistic and used car industry. As mentioned earlier black ocean strategy discussed about (1) ability to manage attitude (AMA): ability of the firm to "manage" audience attitude (create trust), and (2) ability to execute strategy (AES): ability of the firm to "execute" strategy without concern the impact to another party. There are many extents in logistic and used car industry that involved with black ocean strategy.

4.1 Imported Car

Started from the source of used car. The current research showed that many developed countries export the used vehicles (that create pollution) to poorer countries [49]. For example, more than 99% of all automobile imported to Kenya are all used from Japan and Europe. Many of these used vehicles release high levels of pollution which intern impacts the climate as well as the health of people.

Though, Thailand might not face the problem of imported used car. Thailand have become a dumping ground for vehicle trashed from Japan, and Europe. Recent report showed that Thailand imported 167,000 tons of plastic and 100,000 tokens of high-tech waste in 2017 [50].

Although, used spare part, and vehicle trash imported to Thailand can caused several kinds of problem, the number of imports is still skyrocket. This can be considered as ability to executive strategy (AES) for both importer and exporter for this segment.

4.2 Used Car Industry

According to the in-depth interview, researcher found that logistic and used car company apply both "ability to manage attitude", and "ability to executive strategy" on their used car industry supply chain for both customer and supplier.

Research found that used car company is the only expert in this business, where the car seller and the car buyer are mostly lack of experience in trading used car. This give the competitive advantage for used car company to deal with both customer and supplier.

4.2.1 Ability to manage attitude (AMA)

AMA toward seller: According to the interview many strategies has been applied in order to reduce the price of car purchased no matter that strategy is ethical or unethical. For example, (1) *criticism* on used car imperfection is the most common strategy that apply by both seller and buyer. In most case, used car sell to the used car company can be

repair at a little cost. But most of the used car company will manage the attitude of seller and make them accept the imperfection of their car in order to reduce the price. (2) *Time pressure* is another strategy that commonly use. The used car company will force to seller to sell the car right now. If they do not want to sell and come back on other time the price will go even lower. This is the method to make irrational decision by seller as well as prevent the seller to try to sell the car to another used car company. (3) *Non-verbal communication,* such as lack of interest on the car, look at the watch frequently to state that do not have much time, and keep the seller waiting can make the seller feel uncomfortable, and lose their guard on the negotiation.

AMA toward buyer: The interview result showed that the used car company try to encourage buyer to buy the car as highest price as possible, as well as try to up sell, and cross sell without concern about buyer budget. Some of the respondent admitted that they (1) *sell a pup.* The odometer is the common adjusted, and many times they did not inform the buyer that the car used to have accident. The product modification may (2) *add value* to the car, but intern it means that the car may have some hidden problem. For example, used car company will add car decoration set to hide some defect. Used car company may change the tires and scrub the car to make it look new, in order to sell the car as the higher price. Some respondents admitted that (3) *do not tell all the defect*, which might reduce the value and attractiveness of the car.

4.2.2 Ability to execute strategy (AES)

AES toward seller: Researcher found that most of seller have financial problem. And they need quick money to solve their problem. According to the empirical study major problem are (1) do not have money to pay school tuition fee, (2) need money for other financial problem, and (3) need money to go back home during the new year (Songkran). Thus, used car selling by owner is seasonal in Thailand, where school and holiday is the major factor that impact the price of used car purchased by the used car company. Most of the respondents stated that they do not feel anything when they crush the price from the seller. Only some of them stated that they feel guilty in the beginning. But the more they are in this industry, they feel this is common practice if you want to survive in this industry. Several respondents show self-advocacy toward squeeze the price from the needy such as: if I am not doing this other used car company will do the same, if I give them good price, they might laugh at me, if I give them high price and I cannot sell I might be the one who are in the big problem.

AES toward buyer: The are many ASE toward buyer. For example, the used car company try to get the highest price as possible. The respondent stated that the best car for the buyer is the car that is dead stock. For them they are happy to sell the car that is dead stock than the car that can sell quickly. Since, it can increase their cash flow as well as reduce the risk of sunk cost. Thus, they will encourage the buyer to buy the dead stock more than the quick item. The used car company will recommend buyer to buy unnecessary option such as insurance and instalment in expecting the higher income, etc.

4.3 Logistic Industry

Although the respondents in this research are used car company, there are several finding that related to the logistic industry in Thailand and around the world that related to AMA and AES. This is not validating the existing of AMA and AES but also recognized that the black ocean is not only limited to used card industry.

4.3.1 Ability to manage attitude (AMA)

Respondent explained that the car industry in Thailand will provide no cost for normal factory scheduled maintenance in order to gain trust from the buyer. But in reality, it is another way to make more revenue for their car dealer. Since after the scheduled maintenance at the car dealer workshop, the owner will receive the bad news that many auto parts need to be replaced. And those parts are not covered in the no cost maintenance plan.

This kind of AMA is commonly found in Thailand. It is the result of trust toward car dealer who give the scheduled maintenance, plus the poor car knowledge by car owner make AMA is easy on Thai car industry.

4.3.2 Ability to execute strategy (AES)

The case of Volkswagen in the year 2015 may be one good case of AES in car industry. In September, 2015 the Environmental Protection Agency (EPA) has found that Volkswagen cars that sold in United State for more than 482,000 cars had a “defeat software” to test carbon dioxide emission levels of their diesel engines, which in turn showed better performance than reality [51]. The engine emitted nitrogen oxide pollutants more than 40 times above the United State law. By using AES Volkswagen is not only ignore the impact of the United State law, but also the environment, and the trust from their customers.

If this case has not been caught Volkswagen will gain competitive advantage from their competitor in term of cost leadership (selling cheaper diesel engine than the competitors). This was a very big news for the year 2015. However, in the year 2019 European commission finds not only Volkswagen but also other German automakers (Daimler and BMW) that illegally colluded on emissions technology [52]. This finding also suggested that AES is a common practice for the car industry in order to gain competitive advantage.

The case of poor quality of bus and trucks that generate smog in Bangkok. According to the research there are more than 2.5 million diesel-powered buses and trucks on Bangkok city road [53]. Diesel-powered produce a large number of PM2.5 particulate matter that harm people health and environment. However, changing the buses and the trucks may cost a lot of money for company. The

logistic company use AES and remain using diesel engine to avoid increase the logistic cost.

5 Recommendation and Conclusion

This paper has conducted the in-depth interview with people in logistic and used car industry. And found that black ocean strategy is exist. The focus of this paper is based on used car industry, anyhow researcher believe that black ocean is applied on all part of supply chain.

While, the use of ability to manage attitude (AMA) and the use of ability to executive strategy (AES) can sharpen the strategy, consider as a part of competitive advantage as well as strengthen the cost leadership position of the logistic company, it may also reduce the CSR perception, and value of the logistic firm.

The logistic company may need to think wisely before applying black ocean strategy on their partners and stakeholders.

On the other hand, since black ocean strategy is normally applying in supply chain network, the logistic company must be aware of AMA and AES and be cautious in all business practices.

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Keywords: energy-saving, metallurgical enterprise, logistics management, resource flow
Abstract: The multilevel model for the formation and assessment of resource flows of a metallurgical enterprise is presented, which, at the logistics positions, reconcile the enterprise flow processes at all management levels, providing procedures for regulating the parameters of material and financial flows due to parametric and structural coordination in the short period of time and system coordination and adaptation of goals in the long term period. Drawing on the theory of logistics, it is possible to define the resource flow in project management as an aggregate of the enterprise's own and attracted resources, considering in the process of interconnected and interdependent changes and movements carried out to achieve the objectives of the project. Optimization models of rational options selection for attracting additional resources, which allow implementing energy-saving projects under conditions of suspending finances at definite time periods due to a change in the project implementation schedule are described.

1 Introduction

Metallurgical enterprises are large consumers of electric and thermal energy [1,2], therefore, solving energy conservation problems is impossible without the development of a comprehensive program and projects portfolio in the main areas of energy conservation with their mandatory coordination with the development program of the main production.

The metallurgical industry characterized by the complexity of processes and it's important to provide their efficiency [3], productivity [4], and continuous improvement [5,6]. Therefore, process planning, simulation tools, and implementation techniques are the first-priority issues for the industry [7-9], particularly within the Industry 4.0 strategy [10,11]. The trend for enterprises is the development and implementation of process-oriented management systems that support the life-cycle of products [12,13] and satisfy the requirements of the market [14].

This in its turn, requires an integrated approach to the formation of an effective system for resource flows managing of projects and programs aimed at selecting the volume, cost and time of attracting some resources to the corresponding parameters of other resources; multi-project dynamic planning of the realizability of various complexity work on scarce resources accounting risks; balancing the flow and usage of resources [15,16].

Project resourcing management is a target impact of process participants on the variable characteristics of resource flows to achieve their goals by reallocating resources [17]. The object of actions in the project's resourcing management system is the process of movement of resource flows aggregate, the subject (matter) is a closed cycle of resources' spending and renewal, and the performer is the participants of the project management process. This position reflects a systematic approach to the formation and management of resource flows aggregate, which should ensure the optimal ratio of cost and quality of service of internal and external consumers due to the

dynamic stability of the integral characteristics and indicators of each flow, synergies of their aggregate and adaptability in the external environment. Flow processes are the main objects of the study of logistics. The specificity of logistics is as follows: the choice of a single function to manage disparate material and other flows; integration of individual parts of the logistics chain into a single system that provides effective management of flow-through material and other flows. The concept of logistics is a system of views on improving the efficiency of enterprises based on the optimization of flow processes.

One of the most important and difficult stages of managing the resource flows of a project portfolio is its optimization [18]. Enterprise resource optimization in the process of project management consists of the selection of indicators reflecting efficiency, a measuring tools system of consumed resources and optimization methods (of solution options at resource flows management).

The most common methods to obtain optimal values of financial or resource markers are linear and nonlinear programming [19]. Difficulties of such models' implementation in practical situations are often associated with the choice of a specific type of target function from a variety of known ones, as well as with the complexity of determining and processing preferences.

Complex planning tasks, as a rule, are differed by extremely computational complexity, and the search for an "optimal" solution cannot be completed within a reasonable time. In addition, several goals that often conflict with each other, are usually pursued at the same time (lowering the volume of overdue works, increasing the resource utilization ratio, etc.).

Thus, in practice, it is necessary to find a satisfactory (rational) solution in which these goals are balanced and can be obtained with minimal computational expenditures. Therefore, in practice, heuristic algorithms of scheduling within the limited resources are used.

Tasks of constructing calendar plans for project implementation, which are mainly associated with the distribution of limited resources, constitute a significant part of the models and methods of project management [20].

The tasks of accounting and distribution of resources are reduced to the construction of such resource consumption schedules for all works of the pre-investment and investment stages of the project. They satisfy the accepted criteria of achieving the set goals and which are the best. Depending on the accepted criterion of optimality of goals, one can distinguish [19]: the tasks of minimizing deviation from the given deadlines (or minimizing the deadlines themselves) of the implementation of the complex of works or a group of complexes at limited resources; tasks of minimizing the need for resources at specified deadlines; tasks with mixed criteria.

An analysis of the existing methods and models of resource flows management of the enterprise project portfolio showed that an integrated approach is required for the formation of an effective system for managing the resource flows of the portfolio of energy saving of the metallurgical enterprise that is aimed at selecting the volume, cost and time of attracting one kind of resources to the corresponding parameters of another kind of resources.

2 Methodology

The essence of the process of increasing the energy efficiency of production lies in the reduction of energy-specific consumption for production, rationalization of energy use regimes, change the structure of energy consumption, increase of environmental efficiency of production [21,22]. Purposeful conceptual management of the process of the resource base and expenditure obligations' formation is necessary for effective management of the resource flows of the energy-saving projects portfolio of a metallurgical enterprise, the outline representation of which is shown in Figure 1.

The main objective of effective management of financial flows is the complete and punctual provision of the necessary volume of financial resources to the set dates from guaranteed sources of financing. The object of this provision within the enterprise is the process of financing of the enterprise project activities in order to increase realization and efficiency and optimization of the movement of financial flows of the enterprise in order to increase its financial stability on the whole. Hence, when forming the investment resources of a portfolio of enterprise development projects, one should calculate the impact of their formation on financial stability and current solvency.

For the implementation of the concept of financial flows effective management, it is necessary to solve problems, associated with the structuring of the underlying flows, determining their characteristics, choice of instruments of action, development of response mechanism to changes of the internal and external environment parameters.

Modeling of financial processes helps to understand the general relationship of the characteristics of flows and determine the points at which control action should be directed.

The main task in the development of a model for financial flows management is the organization of movement of financial flows in a rational, for the enterprise and its projects portfolio, way. Flow control is carried out through the control of their speed, power, direction, periodicity, and other parameters. In this case, it is important to optimize the consistency of flows among themselves, i.e. the movement of the financial flows must be interfaced with information, material and other flows in a certain way.

Therefore, the resource flow management system should provide the maximum positive balance of financial flows, allowing composing a financial strength supply for the portfolio of energy-saving projects of the enterprise.

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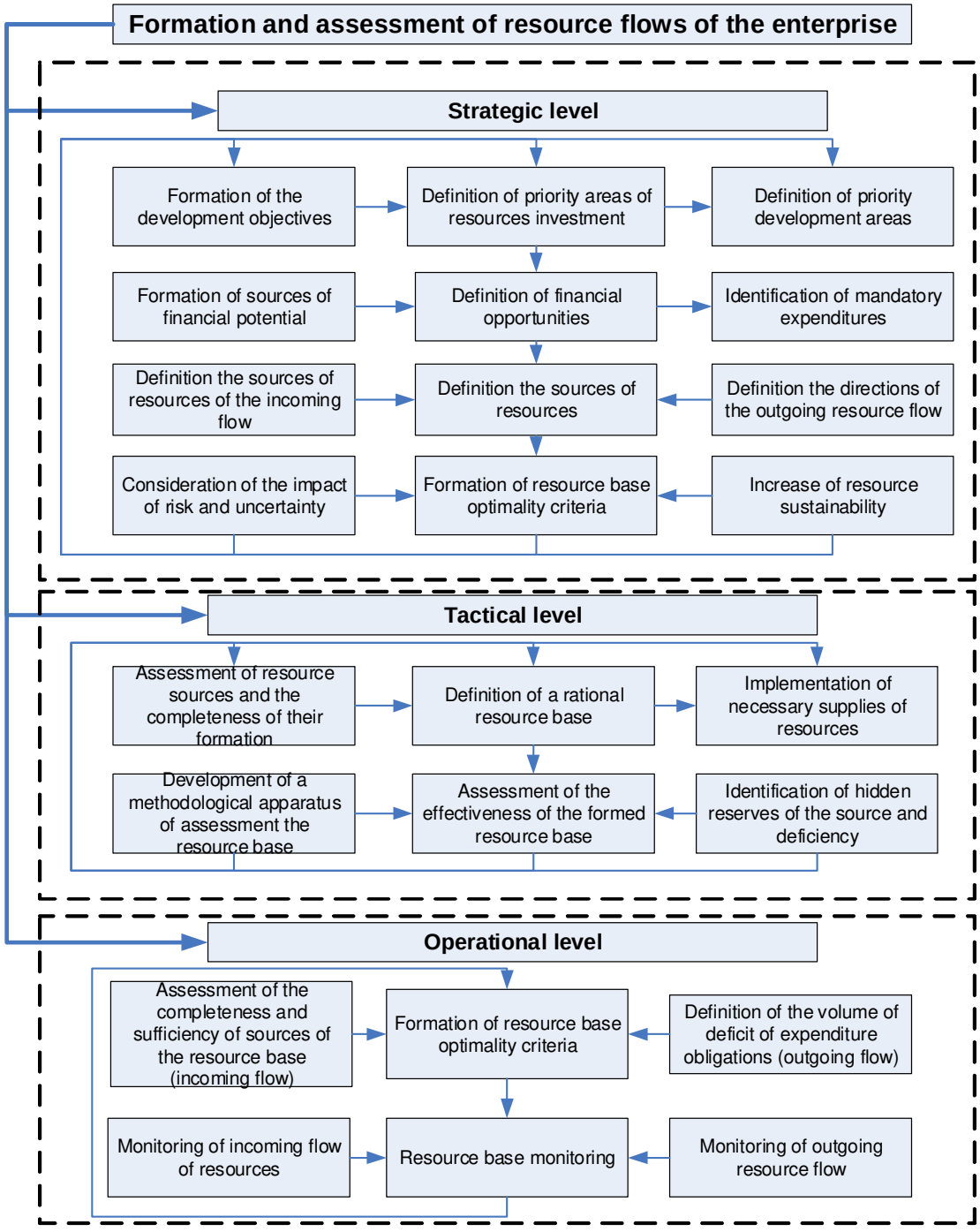

Figure 1 Multilevel model of formation and estimation of enterprises resource flows

The main sources of financing of the energy-saving project for various types of resource deficiencies are to be defined:

- in case of technology deficiency, possible ways to attract additional investment are: credit activities, the additional issue of securities;
- in case of equipment deficiency, possible ways to attract additional investment are: credit activities; stocks and bonds; leasing (installment purchase);
- in case of personnel deficiency, possible ways to attract additional investment are: credit activities; short-term bonds;
- in case of resources deficiency for the implementation of business processes, possible ways of attracting additional investments are credit activities, short-term bonds.

When implementing energy-saving projects at domestic metallurgy enterprises in modern conditions

there is often a deficiency of financial resources and as a result, companies cannot ensure the dynamics and plans of the energy strategy even on the basis of frontier capabilities (Figure 2).

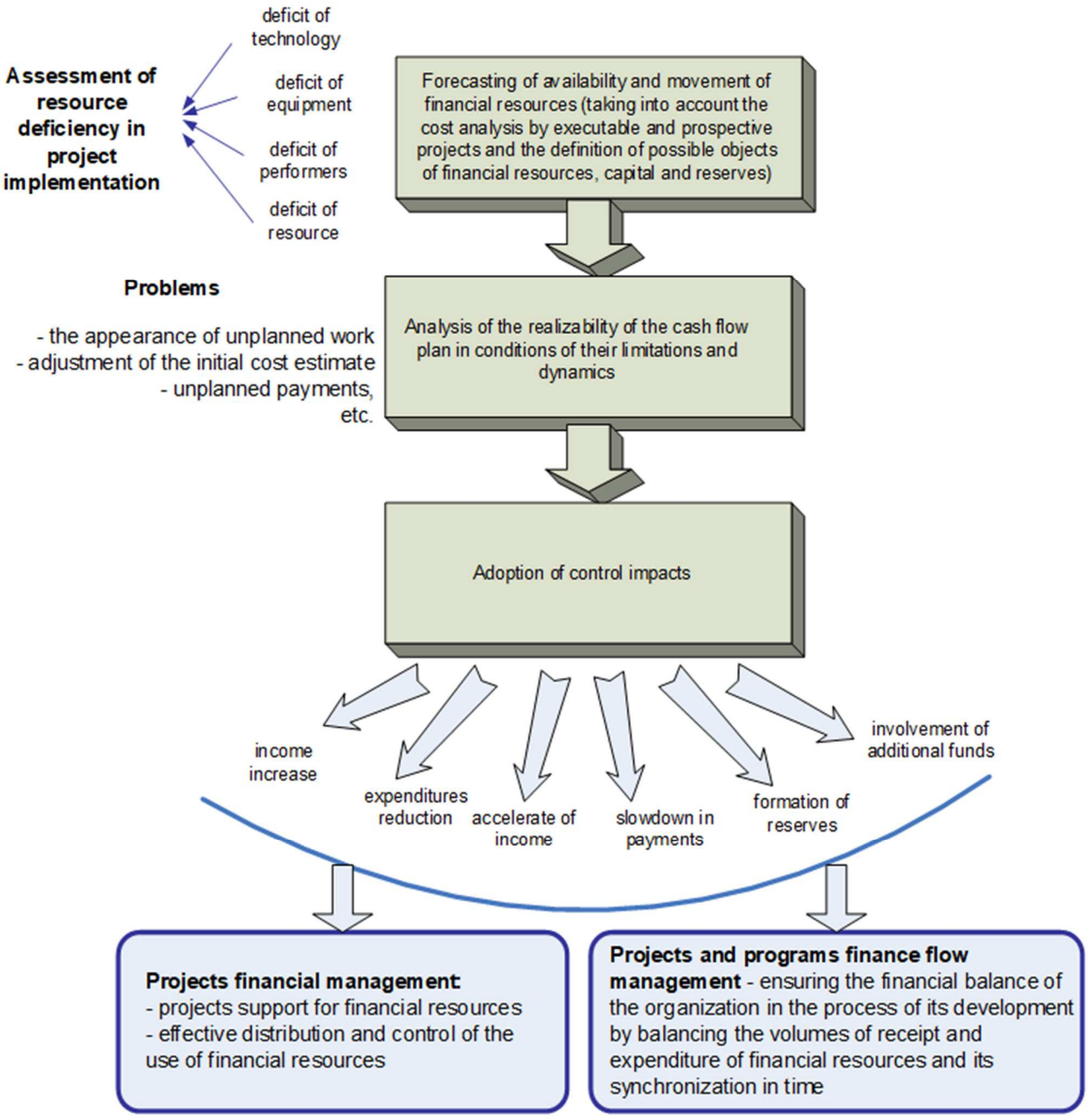

Figure 2 Extended scheme of management of financial flows while projects' portfolio realization

The deficiency of financial resources and the urgent necessity of energy-efficient re-equipment make it urgent optimization of the capital structure and reduction of risks, as well as provision of financial needs with appropriate sources (own and loan).

The search for financing options for the portfolio of energy-saving projects can be formulated as the task of choosing the ratio of types of financing from available own, loan and attracted funds, in which it is necessary to obtain the maximum value of the net present income and the minimum risk level.

Thus, the formation of an energy-saving portfolio should be based on the selection of projects. Four key objectives should be taken into account, deciding on the acceptability of one or another source of project financing: maximization of energy efficiency; maximization of profit generated by the project; minimization of cost for attracting

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a particular source of funding; reduction of risks that accompany the implementation of each specific project.

It is assumed that all the resources necessary for the implementation of projects are presented in terms of value. Figure 3 shows the scheme of optimization of the financing of the energy-saving projects portfolio of the enterprise. The proposed system allows optimizing the financing of the project within a consistent and parallel scheme of work performance under conditions of finance deficiency.

In the case of a consistent work performance option, in the event of a finances deficiency, it is proposed to move the deadlines of work performance for future periods, i.e. "Freeze" the stages without affecting the sequence of their implementation.

Also, partial financing is possible with this option, i.e. when the shared payment of work depends on the availability of financial resources.

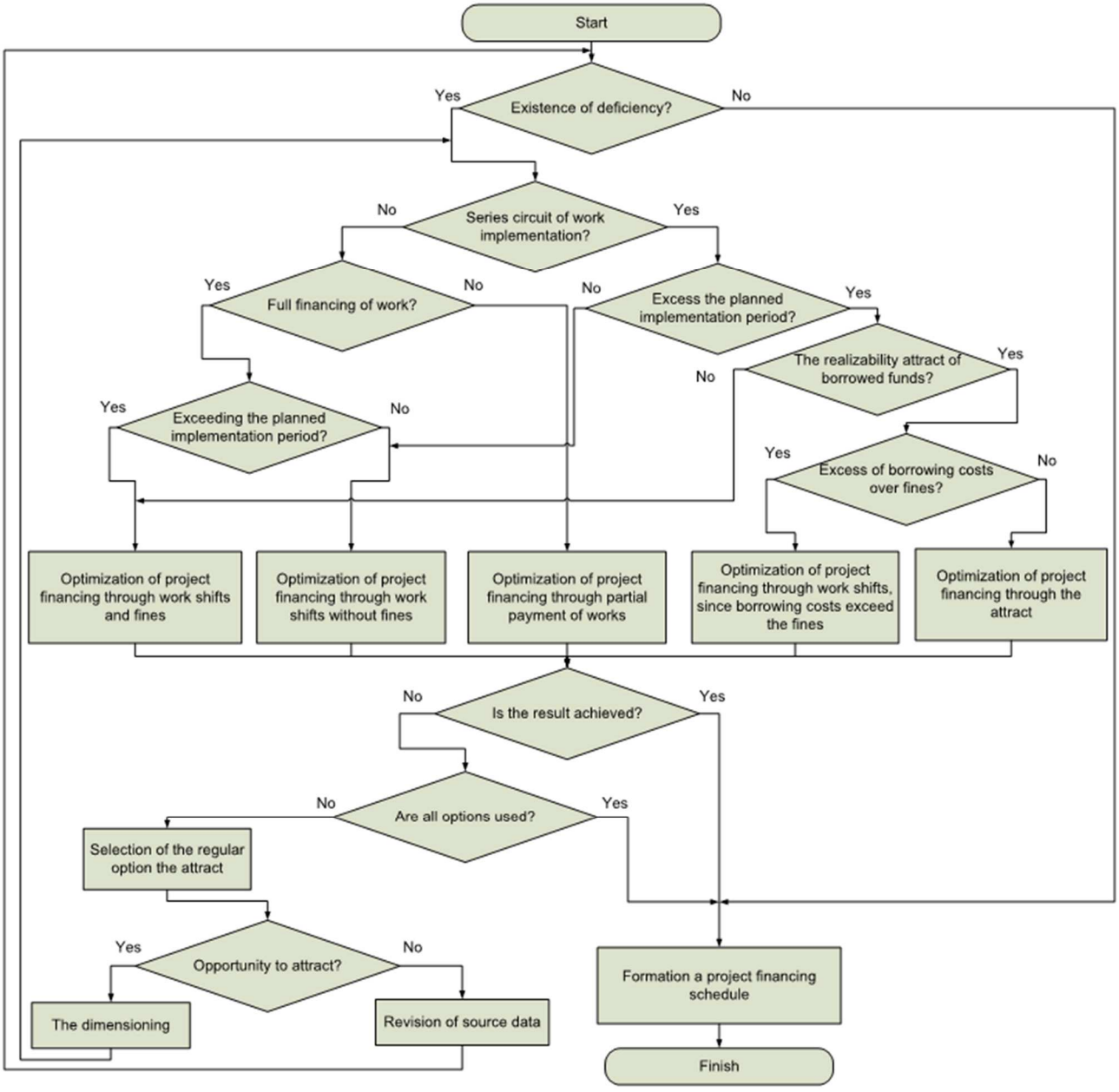

Figure 3 Optimization scheme of enterprise projects' portfolio financing

In the second option, in case of deficiency of financial resources, it is proposed to convert the planed version of the implementation schedule, including branches with parallel execution of work stages, using changes in the financing of the project stages, including the delaying of financing till later period, attracting of loan finances and accounting for penalties (losses caused by the "freezing" of

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the works will be taken into account in the model through a penalty simulated by the penalty function).

The metallurgical enterprise project portfolio will be associated with the vector PPR (project portfolio review) which in its size corresponds to the number of projects in a great number of projects under consideration $P=\{P_1,P_2,...,P_n\}$, which values are binary pp_i, where 1 means that i - project is included in the portfolio, 0 means that i -project is not included in the portfolio. Thus, for example, projects that cannot be excluded from the portfolio under any conditions are set this way.

Each project that is a part of the portfolio $i \in P$ is a management object and has a number of characteristics that require clarification and formalization. The totality of energy efficiency projects of a metallurgical enterprise, or project portfolio is also a management object and has parameters such as profitability, risk, implementation time, required resources, etc. Moreover, the implementation of each project affects the implementation of other projects included in the portfolio, and thereby affects the parameters of the entire project portfolio. Taking into account the absolute significance of the characteristics of each of the projects included in the portfolio, it should be noted that the strategic competitiveness and development of the enterprise depend on the characteristics of the entire project portfolio.

The project can formally be presented in accordance with the directions of increasing energy efficiency of an enterprise in the form of a combination of the following components (1):

$$P_i=\langle X_i,W_i,R_i\rangle, \quad (1)$$

where X_i – vector of initial characterization i -project; W_i – is the vector of characteristics of the attractiveness and feasibility of the project; R_i is total project risk..

The vector of initial characteristics of the project can be represented as (2)

$$X_i=\langle C_i,Y_i,S_i,H_i,T_i,R_i,I_i\rangle, \quad (2)$$

where C_i – the objectives of the project; Y_i – a complex of work on the project; S_i – required financial investments in the project; H_i – a resource intensity of the project; T_i – the expected time of the project implementation; I_i – a vector of mutual influence on other projects in the portfolio. In the vector of mutual influence I_i coefficients are put down, which can take values from 0 to 1, showing the level of dependence of project i on other projects portfolio.

The analysis significant step is the grouping of the projects into a portfolio on the following aspects: from the point of view of energy efficiency goals, finances, conditions (resources).

Attractiveness indicators along with realization are used for this realization which in complex reflect the capacity of project implementation at the particular enterprise, considering the enterprise's activity strategic directions, resource, financial and temporary support (3).

$$W_i=\langle SC_i,E_i,SR_i,HR_i\rangle, \quad (3)$$

where SC_i – index of conformity to the enterprise strategic goals and to the improvement of energy efficiency during the project implementation; E_i – project economics indicators; SR_i – project financial realization; HR_i – project resource realization.

The objectives of the project C_i are formulated as a set of indicators indicating their values that should be achieved as a result of the project $\{K_j^{P_i}\}$.

Further, it is possible to implement a comparison of the values of the energy efficiency strategy indicators $\{K_j^{Str_i}\}$ with the corresponding project parameters $\{K_j^{P_i}\}$.

The compliance indicator $SC_j^{Str_i}$ is considered for all strategic goals in the four projections indicated.

If the parameter $K_j^{Str_i}$ is absent in the project description, and then the compliance indicator $SC_j^{Str_i}$ or the strategic goal Str_i is zero.

Otherwise, the target values of this indicator in the project $K_t^{P_i}$ and the strategy $K_t^{Str_i}$ are compared taking into account the current value (at the time t) of this indicator for the enterprise (4) K_t^E:

$$SC_t^{Str_i}=\frac{K_t^{Str_i}-K_t^E}{K_t^{P_i}-K_t^E}. \quad (4)$$

The strategic conformity of the project with respect to the energy efficiency strategy Str_i can be calculated by averaging the estimates by individual indicators after determining the conformity assessments according to individual parameters (5):

$$SC^{Str_i}=\frac{1}{N_{KPI}^{Str_i}}\sum_{t=1}^{N_{KPI}^{Str_i}}SC_t^{Str_i}, \quad (5)$$

where $N_{KPI}^{Str_i}$ – is the number of indicators in the description of the strategy Str_i.

This is suitable if only one strategic objective is assigned to each project. In reality, a situation with several goals is possible. In this case, after determining conformity assessments by each goal, the strategic conformity of the

project P_i can be calculated by averaging the assessments SC^{Str_i} by individual indicators. The importance of strategic objectives by introducing weight coefficients, which can be obtained by expert way using the method of analysis of hierarchies or a pair comparisons method should be taken into account. In case N_i^{Str} of strategic goals is associated with each portfolio project, the compliance index is calculated as follows (6)

$$SC_i = \frac{1}{N_i^{Str}} \sum_{k=1}^{N_i^{Str}} w^{\mathrm{Str}_k} SC^{Str_k}, \quad (6)$$

where w^{Str_k} – strategic objectives importance, wherein $\sum_k w_k^{\mathrm{Str}_i} = 1$.

Thus, an index of conformity of the project of the energy efficiency strategy is formed $SC_i \in [0,1]$, its values are interpreted as follows: $SC_i = 1$, if the project is fully in line with the strategy; $SC_i = 0$, if the project is not in line with the strategy; $0 < SC_i < 1$, if the project is partially in line with the strategy and is related to the development of the strategic potential of the enterprise.

Now consider the project financial realization. Denoting S^S – the volume of financing of the projects portfolio from its own resources. If $S_{PR} > S^S$ (significantly, as a rule) then the difference $D_{PR} = S_{PR} - S^S$, that represents the deficiency of funds for the project portfolio is funded by extrabudgetary sources – loans or raised funds, which naturally increase the value of the project portfolio.

In general, the structure of the expenditure of the project can be presented as a table, the fields of which reflect the payment of work j at a point in time t, for this it might be used $X_i = \left\| x_{ji}^t \right\|$ – matrix of financing of i-project, an element of which x_{ji}^t characterizes the payment of work j at a point in time t, where $\forall j, \forall t \;\; 0 \le x_{ij}^t \le 1$, $\sum_{t=1}^{T} x_{ij}^t = 1$.

NPV_i – net present value will be used as the main indicator for determining the economic efficiency of the project.

The net present value of the project is calculated (7):

$$NPV_i = \sum_{t=1}^{T} \frac{R_i - S_i}{(1+d_t)^t}, \quad (7)$$

where R_i, S_i – income and expenditure of funds in the project i during the projected period a $t = 1...T$; d_t – the discount rate in time t. It is obvious that for all projects that meet the necessary conditions of efficiency $NPV_i > 0$.

The financial resources flow is carried out in three types of activity: operational; investment; financial (Figure 4). Whatever source of financing is chosen, the amounts of finances received from the sources of funding and the amounts of finances paid to them should be indicated. Thus, the value of the discounted financial flow *NPV* will be adjusted depending on the type of funds involved.

The financing of the project works in absolute/monetary units is presented in the form of a matrix $C_i = \left\| C_{ij} \cdot x_{ij}^t \right\|$, where C_{ij} – the amount of money required for the payment of j-project's work.

In case of a deficiency, it is proposed to postpone payment of work and supplies for future periods, i.e. "freezing" the stages without affecting the relationship among their implementation, as a result of it the amount of delay for each job I_{ij}, is determined, which is calculated as the difference between the planned and actual end of work.

Losses caused by the "freezing" of works are taken into account in the model through the penalty, which is modeled by the penalty function $PN(E)$ and is subtracted from the pure, discounted *NPV* flow at all stages of the project. The penalty function for non-performance of obligations in time depends on the time of delay and comprises an additional amount of finances, sourced from the planned income. In general, the penalty function can be represented as follows (8):

$$PN(E) = \sum_{t=1}^{L} \frac{E^t}{(1+d)^{t+T}}, \quad (8)$$

where E^t – the amount of the penalty in absolute terms for the delay of the project in each of the periods under consideration; L – project delay term.

Since not all the delays in completing work lead to a delay in the entire project, not each delay will cause a penalty. This can be taken into account in the model using the concept of time reserve. Each project work corresponds to a full reserve of time for its implementation T_{ij}^f. Therefore, if the shift of work does not exceed the reserved time of its implementation ($I_{ij} \le T_{ij}^f$), that is, there is no delay in the implementation of the entire project, i.e. the enterprise implementing the project is not subject to penalty sanctions. If the shift exceeds the reserved time ($I_{ij} > T_{ij}^f$), then there is a delay in the completion of the project, therefore, the enterprise bears additional expenditures, which are modeled by the penalty function. These conditions can be described mathematically through the stability indicator и u_{ij} as follows (9):

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$$u_{ij} = \begin{cases} 0, \ if \ \forall j = 1,..,n_i^p \ \ l_{ij} \le T_{ij}^f \\ 1, \ if \ \forall j = 1,..,n_i^p \ \ l_{ij} > T_{ij}^f \end{cases}. \quad (9)$$

In case of timely financing of the project work, the matrix X_i will be square-shaped; in case of untimely, it will be rectangular-shaped. Columns in the number L will be added to the source square-shaped matrix in case of untimely funding to the duration of the critical path T (10):

$$L_i = \sum_{j=1}^{n_i^p} (l_{ij} - T_{ij}^f) \cdot u_{ij}, \quad (10)$$

where L_i – project delay.

Elimination of the deficiency (a situation when there is a temporary shortage of financial resources necessary to finance expenditures) is possible not only by means of a "freezing" of the stages of the project but also by means of attraction of loan funds.

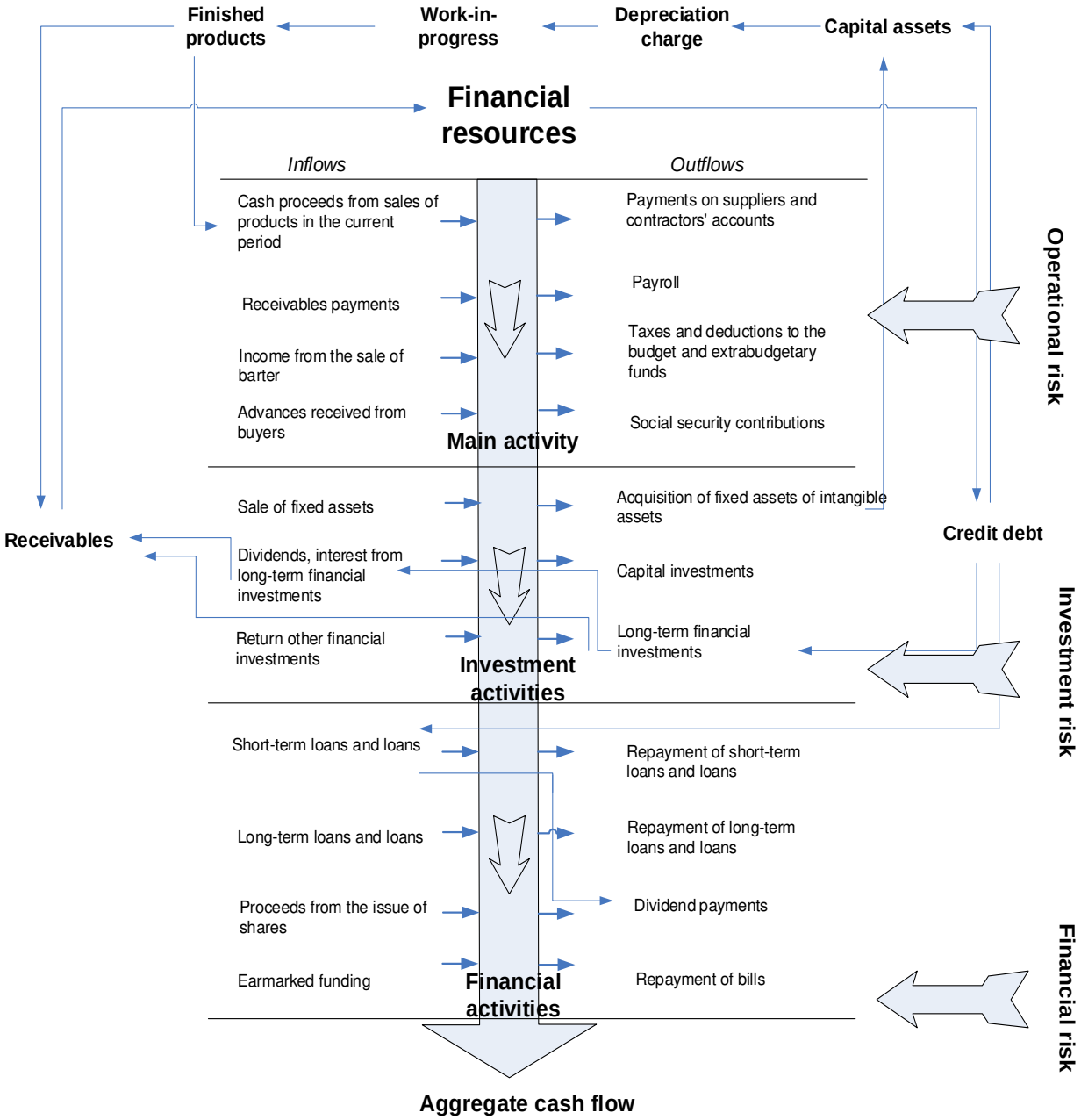

Figure 4 Formation of financial flow at the enterprise

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The loan should cover not only the current deficiency but also provide the necessary minimum balance of the company's funds in each period. The choice of any other funding source will only affect the *NPV* calculation (11). The selected funding source set at each stage should ensure that funds are sufficient to finance the project.

By solving the problem, we can find a combination of financing sources in which the optimal portfolio will be obtained. The overall objective is to choose a portfolio PR_0, that has maximum efficiency

$$\sum_{i \in PR} NPV_i \rightarrow \max . \quad (11)$$

To solve the problem, a method of optimization of the project financing schedule, which is based on a heuristic algorithm, is proposed (Figure 5).

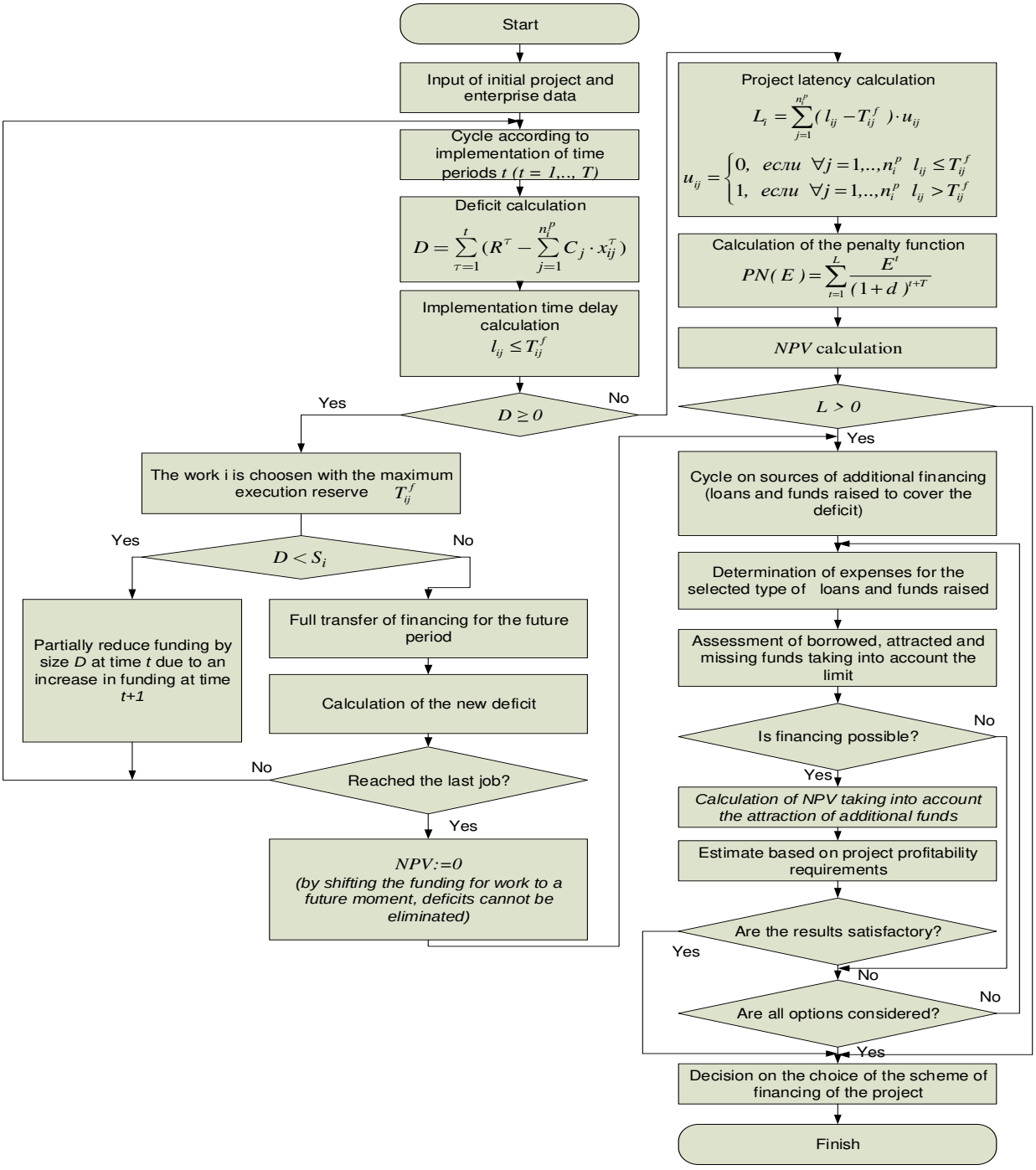

Figure 5 Scheme of optimization of financing of enterprise projects portfolio

3 Results and discussion

With the help of the proposed approach and models, the project portfolio for the energy saving of PJSC Dneprospetsstal (Zaporizhzhia) was formed, which included promising projects in accordance with the energy strategy. Thus, in the period from 2016 till 2018, the enterprise implemented energy-saving projects, some of which are presented in Table 1. It shows the purpose of the project, estimated and actual expenditures, as well as indexes of energy efficiency.

Table 1 Resource-saving results for the implementation of the energy-saving project portfolio

Project title	Project objective	The essence of the project	Predicted investments, thousand UAH	Actual expenditures, thousand UAH	Deviation	Energy efficiency
Thermal shop. Modernization of chamber furnace №10 with the replacement of lining, burners and automated control system	Reduce fuel consumption for heating and heat treatment of metal	Removal of existing furnaces. Works on restoration of foundation, energy supply to the furnaces. Manufacture, delivery, and installation of metal constructions of the furnace, lining, gas-burner equipment, natural gas, and air pipelines through the furnace, control and measuring devices and automation, cable routing through the furnace and connection. Startup and commissioning.	5518,3	5432,0	-86,0	*Savings on gas consumption - 426.4t.t/year* Annual economic effect 2566.3 thousand UAH
Heat recovery of waste gases from the GCF unit of the steelmaking shop SPC-2	Increase of energy security level of the enterprise, reduction of thermal energy expenditures and reduction of expenditures of non-productive nature	Installation of heat recovery system of waste gases from the GCF unit. The heat generated, will allow providing heating and water supply with hot water of SPC-2, the building of the substation	959,6	846,6	-113,1	*Savings on steam consumption - 652Gcal/year Saving on the consumption of hot water - 1880Gcal/year Annual economic effect 1630,23 thousand UAH*
Construction of a local electric boiler house based on nitrogen station	Increase of energy security level of the enterprise, reduction of thermal energy expenditures	Construction of a local electric boiler house with a thermal capacity of 270 kW for heating and hot water supply based on nitrogen station of the EC	1086,3	875,68	-210,21	Savings on steam consumption - 1074Gcal/year Energy efficiency savings of 154.5kWt/h Energy efficiency savings of 92,7kWt/hr Annual economic effect 570.76 thousand UAH
Total					-409,31	4767,29

In particular, within the frames of the first project from the table, the heating and thermal furnaces were modernized, which allowed to reduce the fuel consumption for heating and heat treatment of the metal by means of application of high-efficiency thermal insulation and impulse combustion control; automation of all heat processing processes, ensuring temperature maintenance with a mini-scale deviation.

The second and the third projects in the table are connected with the fact that PJSC Dneprospetsstal was buying steam and hot water for technological and sanitary needs at OJSC Zaporizhstal since it was the only supplier of steam and hot water in that part of the industrial site, Where the Dneprospetsstal plant is located. From the heat networks "Zaporozhstal" steam and hot water through distribution networks of the plant "Dneprospetsstal" came to consumers. One of the significant shortcomings of such a scheme was significant heat loss during transportation. This is because of the long-distance of the heat transport system, low thermal insulation properties of thermal insulation materials, significant wear of heat transport systems. In addition, dependence on a single supplier reduced the level of the enterprise's energy security, and the constant growth of the cost of heat energy increased non-production expenditures. The transition to an alternative method of heating of buildings and obtaining hot water in the second project through recycling the heat of the waste gases from the gas-oxygen refining unit (GCF), and in the third project through building a local electric boiler house allowed: to increase the level of energy security of the enterprise; to reduce the cost of heat energy; to reduce expenditures of non-productive nature.

4 Conclusions

The multilevel model of formation and estimation of resource flows of the enterprise is presented, which links the flow processes of the enterprise at all levels of management, providing procedures for regulating parameters of material and financial flows through parametric and structural coordination in the short-term period and system harmonization and adaptation of goals in the long term period.

The model of choice of directions of product development through the realization of projects taking into account the possibility of attraction of additional investments is considered.

Optimization models for selection of rational options for attracting additional investments are developed: a model with a delay in the execution of works, allowing to implement projects in conditions of suspension of financing in separate periods of time by means of a "freezing" of works; a model with partial financing of works, providing implementation of the project in conditions of delay of financing; a model with a parallel scheme of execution of works, taking into account the attraction of loans funds and the function of fines.

Further research will be focused on the development of an agent-based simulation model for analyzing the energy management processes of a metallurgical enterprise while implementing a portfolio of energy-saving projects. Using this model will allow analyzing projects consistently in order to identify the possibility of their implementation at the enterprise, to coordinate project implementation plans and enterprise plans at various planning levels.

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MODEL OF STOCK CONTROL AT SCRAP PROCESSING ENTERPRISES

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Keywords: stock control, safety stock, oligopsony, scrap processing enterprises
Abstract: For the effective functioning of scrap processing enterprises and optimization of the production capacities it is necessary to predict the optimal level of production stock based on logistical approaches and studying the demand for products. The paper proposes the model of stock control at scrap processing enterprises. It is considered that scrap processing enterprises are often functioning at the oligopsony market. It has been determined that the scrap market is a typical example of the oligopsony market. In the oligopsony market, enterprises are usually in a state that can be considered a state of equilibrium, when none of the market players is profitable to break this balance. Changes in market prices or price policies should be deliberate and justified. The relation of pricing models and stock control models at enterprises are considered. By regulating its price, the company can significantly and quickly change the number of scrap stocks. It is stated that an enterprise having its pricing system should track the number of scrap stocks. The method of stock controlling at the enterprise by changing its pricing policy is proposed. The model considers the expected value of demand, the price elasticity of supply and demand, storage costs, the stock volume at the warehouse and the specific loss due to unsatisfied demand. The inventory management model is based on modern models of scrap price forecasting, is an optimization model and is based on it proposed the algorithm for the functioning of the computer-aided system of stock control.

1 Introduction

One of the problems of improving the enterprise is related to the efficiency of its stock control. An unreasonable largeness of stocks can lead to freezing the assets of the enterprise [1]. Moreover, it is associated with high storage costs and the risk of moral and physical depreciation [2]. On the contrary, the low level of stock can lead to the situation when the enterprise will not be ready to meet the current demand and it will lose a part of its clients [3] which will have a significant impact on the financial state.

Processes of stock control are the component part of the enterprise control system; that is why, their efficiency is characterized by such an important criterion as the value of costs appearing within the stock control. Independently applied traditional parameters – volume of stocks, resource turnover, continuity of supply – cannot unambiguously determine the level of increasing the effectiveness of the system of stock control, since they are the part of the common criterion – costs.

Models of stock control are differently specified depending on their application area. Evidently, it is determined by the specific feature of the market itself. For instance, "Ferrous and nonferrous scrap markets, when regional rather than global in scope, may have many sellers but only a few buyers, and so provide examples of oligopsony" [4].

The specifics of the oligopsony market are that the number of buyers in the market is limited and the market is usually already divided. If one of the oligopsony companies starts to change its price policy, it can cause a reaction of competitors, so often in such market changes are rare. It is usually not advantageous for any of the players to upset the balance.

We are considering a stock management model for scrap processing enterprises based on price policy. The purpose of this paper is to develop a model of stock control at scrap processing enterprises, in particular, and for the players of the oligopsonic market as a whole.

2 Methodology

Nowadays it is impossible to increase the efficiency of the enterprise control in general without application of the advanced computer-aided systems and software products [2]. Experience shows that computer-aided systems of the enterprise control are expensive; and not every enterprise can afford to implement them in practice.

Let us apply the model of stock control with the continuous control of the level of stock; this system means that every time when the stock level is reduced to the level r, the order for the quantity Q is applied. In our case the essence of the order of the quantity Q is to provide such terms of the contract which would allow for replenishing the raw stock by the quantity Q.

Problems related to the issues of stock control have been studied by many scientists and experts [2,5-8]. These authors developed a number of methods and models of stock control to be used by enterprises and various resources. Let us consider some of them.

The main systems of stock control are the system with continuous control and the system with periodic check-ups [8].

Within the periodic check-up system, the stock estimation is made periodically (once a day, week, month); and depending on the level of the available stock the order of a definite batch of products is submitted.

If a computer-aided system of accounting is available, the system of stock control can be based on the model of stock control with the continuous control of the level of stock; this system means that every time when the stock level is reduced to the level *r*, the order for the quantity *Q* is applied. To develop a computer-aided system of stock control, the model with the continuous control was chosen which was proposed by Hadley and Whitin [8] and corrected by the excess demand. Moreover, this model is modified by the value of transport expenses and differential discounts depending on the order volume.

The latter condition is extremely important for any enterprise since the possibility of buying a greater volume of products at a lower price helps to reduce the costs. In certain cases, the reduction turns to be essential.

Advanced models differ significantly by complexity from those existing two decades ago. Liang-Tu Chen and Chun-Chin Wei (2009) state in [9] that "The objective of the model is to jointly determine the optimal selling price, base-stock level, and inventory cycle over an infinite planning horizon so that the net profit per time unit in the channel is maximized. The profit-maximizing problem is formulated as a multivariate optimization model, solved by an iterative search process combined with an enumeration scheme. In addition, the saving-sharing mechanisms, through return, target sales rebate, and feature price discount, will also be developed so that win-win can be achieved between vendor and buyer. Special emphasis is placed on the comparative study between the proposed optimization models that are based on the coordinated and decentralized policies between vendor and buyer in the channel".

The proposed model is based on the possibilities of modern economic, mathematical and econometric devices. The inventory management model is based on a model of the relationship between global metal prices and scrap prices of this metal [10-18]. Because metal scrap prices change more slowly than metal prices on the world market, we can predict prices. Knowing about the upcoming price change, we have the opportunity to manage stocks. The article has developed a stock management model that optimizes the potential benefits.

2 3 Result and discussion

To build a model of stock control at oligopsony, the scrap metal market uses the approaches of authors studying macroeconomic systemic changes. [2,7,10,15,19].

Similarly, let us consider the model taking into account the necessity of simultaneous tracking the change of volume and prices in time, but let us introduce certain allowances without loss of generality: unsatisfied demand is accumulated, distribution of demand-supply values within the considered time unit is stationary (unchangeable) in time.

In order to determine the function reflecting the total costs referred to the time unit, the following designations are introduced.

$f(Q_D)$ is the density for distribution of demand D within the delivery time,

$M[Q_{Dt+1}]$ is the expected value of demand between time instants *t* and *t*+1,

$h(\varphi_i)$ are storage costs (per unit of product within the time unit),

p is the specific loss due to unsatisfied demand (per unit of the product within the time unit),

$M[Q_{St+1}]$ is the expected supply,

$Q_S = E(x)$ is the function of supply variation from the price x,

φ_i is the stock volume at the warehouse at the instant *i*.

The optimization criterion is the cost function within the time unit which is combined of:

1. Expected storage costs. The average level of stock between time instants *t* and *t*+1 is $M[\varphi_i]$, where $i = [t, t+1]$.

Therefore, the expected storage costs per time unit are $h(\varphi_i) \cdot M[\varphi_i]$.

2. The cost of necessary stock volume for meeting the consumer demand. The initial proposition should be the tendency to the equality $M[Q_{Dt+1}] = \varphi_t + M[Q_{St+1}]$; however, both Q_{Dt+1} and Q_{St+1} are random values with the corresponding distribution functions. Without loss of generality, let us consider only the period for which the demand for raw material is known ($\hat{Q}_{Dt+1}$). Under specific functioning of scrap processing enterprises, it does not impose any restrictions for the stated task as a whole, since consumers of the scrap processing products make contracts with the limited time of obligation discharge. Then the cost of the necessary stock volume for meeting the consumer demand is equal to the cost of the stock volume $\hat{Q}_{Dt+1} - \varphi_t$. It should be noted, that within solving the task of stock control it is required to support the insured stock level at the warehouse. Therefore, introduction of the system of stock control will lead to the following situation: after production meets the demand for raw materials, there should be the insured reserve φ_{cmp} at the warehouse. Therefore, the cost of the necessary stock volume for meeting the consumer demand should be equal to $x(\hat{Q}_{Dt+1} - \varphi_t + \varphi_{cmp})$; and in case when $\varphi_t < \varphi_{cmp}$, the stock level should be supplemented up to the insured level.

3. Expected losses related to the unsatisfied demand. The deficiency appears at $Q_{Dt+1} > \varphi_t + Q_{St+1}$. If a scrap processing enterprise sets the price by following a certain enterprise policy that provides the long-term demand-supply equilibrium, then a random value $Q_{Dt+1} - Q_{St+1}$ should be considered. The enterprise is interested in diffusing all random impacts on the result of its activity. Formation of the price policy is one of its stimulating tools. As a result, many authors note the dependence of scrap prices at the local market (in particular, in Russia, on world prices of metal [10-20].

With account of the stated above, the expected losses per time unit will be equal to (1):

$$S = \int_{\varphi_t+\varphi_{cmp}}^{\infty} (Q_{Dt+1} - Q_{St+1} - (\varphi_t + \varphi_{cmp}))\, f(Q_{Dt+1} - Q_{St+1})\, d(Q_{Dt+1} - Q_{St+1}) \quad (1)$$

Since the model implies that p is proportional to the deficiency volume, the expected losses related to the unsatisfied demand are equal to pS.

The resultant function of total losses per time unit TC is the following (2)

$$TC = h(\varphi_i) \cdot \mathrm{M}[\varphi_i] + x_i \cdot (\hat{Q}_{Dt+1} - \varphi_i + \varphi_{cmp}) + pS \quad (2).$$

The first component in this equation for scrap processing enterprises is mainly the constant value equal to the cost of warehouse keeping; the second component is the function of the price for raw material (scrap), the third component is characterized by the random value $Q_{Dt+1} - Q_{St+1}$ which changes its parameters within variation of the scrap price x.

Therefore, the problem of stock control at the scrap processing enterprise is reduced to solving the following task (3):

$$\hat{Q}_{Dt+1} \cdot y - TC \to \max \quad (3).$$

In order to make the probability of losses related to the unsatisfied demand not exceeding 0.1% the value φ_{cmp} should be chosen so that $P(Q_{Dt+1} - Q_{St+1} \geq \varphi_{cmp}) \leq 0.1\%$; that is, to choose x so that the distribution function for the random value $Q_{Dt+1} - Q_{St+1}$ could meet the condition $F_{Q_{Dt+1}-Q_{St+1}}(\varphi_{cmp}) \leq 0.1\%$. In this case, the main expenses will be related to keeping the insured stock volume that in turn is reduced as the uncertainty related to $Q_{Dt+1} - Q_{St+1}$ is decreased, which can be achieved by the effective choice of x.

One should also take into account the specific features of enterprises for which the system is developed. Since the demand and supply for scrap are seasonal, it should be in some way considered.

Basing on statistic data, one should assess the influence of the season pattern and choose such a system of pricing for contracts that will allow for minimizing the dispersion $Q_{Dt+1} - Q_{St+1}$ which will in turn decrease the costs of formation and keeping the necessary stock level.

The algorithm for functioning of the computer-aided system of stock control is as follows:

1. In accordance with the pre-assigned sampling, the dependence of $Q_{Dt+1} - Q_{St+1}$ on x (scrap price) and y (price of metal at the world market) is determined, or, to be exact, it is the character of the random value $Q_{Dt+1} - Q_{St+1}$ depending on the deviation of x from the long-term equilibrium.

2. The deviation of the observed stock level from the insured level is assessed within the enterprise functioning; if it is thought that this error has distribution different from the expected one, one should return to p.1.

The long-term equilibrium implies a certain model of pricing at the enterprise. In fact, the scrap price at the market is often changed due to variations of metal prices in the world with some delay (time lag) [12-15]. If certain rules are laid into the pricing policy, such a model should generate a long-term equilibrium of demand and supply. However, another price can be formed at the market and the enterprise itself can set the price different from the model one, for instance, in the lack of scrap at the enterprise it can raise the price. The enterprise stock value turns to be the observable value and the criterion of the state of the stock control system at the enterprise, while the price is the parameter which can be changed to correct the stock value.

4 Conclusion

Therefore, the model of stock control at scrap processing enterprises is proposed. It is taken into account that scrap processing enterprises are often functioning at the oligopsony market. The proposed model accounts the advanced models of pricing at scrap processing enterprises and considers the situation that metal prices in the world influence the scrap prices but with a certain delay (time lag). It turns out that the enterprise having its own pricing system should track the quantity of scrap stocks. The enterprise stock value is both the observable value and the criterion of the state of the stock control system at the enterprise, while the price is the parameter which can be changed to correct the stock value. The model can be applied by enterprises in other oligopsony markets (especially raw materials) and markets where the company's pricing policy affects the level of inventory in the enterprise.

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