Motivations for Long-Term Business Relations in the FMCG Sector

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Abstract: This study shows the result of a recent survey which focuses on corporate networks and long-term business contracts that constitute the main elements of networks. Within this context we examine the incentives for long-term customer and supplier relations in Hungarian corporate practice in the system of contacts for domestic and multinational chain stores and their suppliers as well as the areas of co-operation and characteristic features of businesses with differing motivations in respect of their long-term market relationships. This study is justified by the subjective opinion of the authors, pursuant to which the network of corporate relations may be examined through market relations. The most important such relationships are long-term partnerships related to business activity in the supply chain, constituting long-term fundamental connections in the corporate relations network.

Keywords: Supply chain management, logistics, partnership, cooperation, motivation, FMCG sector.

1. Introduction

The success of business ventures has been an emerging topic for researchers. Several scientists agree that it is influenced more and more not only by their own performance but the performance of their business partners and the success is dependent on their relationship, see: [1],[2]. Other studies state that factors such as the size of the company matter as well [3]. In this study we will focus on business relations which may become important value-adding factors, contributing to success, may also be value-destructive if the performance and/or cooperation of partners is inappropriate or the management of the relationship is unsuccessful or simply just too expensive (inefficient).

Among types of corporate network relationships in order to expose differences in attitude and values represented by businesses the study concentrates on long-term business contracts and motivations for such. The study presents the most characteristic areas of cooperation with partners, and the most important features of company groups with differing motivations in respect of long-term business relations as developed using cluster analysis. The results obtained are – when appropriate - cross-checked with results of the research programme "Competing with the World 2004-2006", coordinated by Prof. Attila Chikán, BCE (Budapest Corvinus University).

Our paper is based on the data from our survey of 110 businesses of FMCG supply chain members. The survey was conducted between September 2008 and February 2009, with the help of students majoring in Logistics at Szent István University and at Budapest Business School. 24% of these businesses are large commercial chain stores. (In the food sector 13% of the sample are traders, 24% are producers. In the non-food sector 33% of the sample is involved in trading and 6% in manufacturing.)

2. Long-term business relations

Figure 1 illustrates the study's results for the ratio of businesses' long-term sales and purchasing relationships. In comparison with the results of the BCE 2004 survey [8] it may be stated that the ratios had improved by 2009 in particular on the supplier side where the ratio of businesses with long-term contracts is under 20%, having fallen from 41% in 2004 to below 14%. Almost one third of businesses on the sales sector have a share of less than 20% with regard to long-term contracts (45% in 2004), constituting businesses that strive to adopt a multifaceted approach. On the other hand, more than 61% of sales and purchasing is carried out on the basis of long-term contracts for almost half all businesses, representing a considerable improvement by comparison with 2004 values, where the ratio was almost one third. At the same time, such sales transactions currently represent more than 81% in around one fifth of businesses, and a similar share of purchasing trade for almost one third of companies. By comparison with 2004 this shows a significant improvement on the purchasing side given that the share of businesses holding more than 81% long-term purchasing contracts was less than 13% at that time. This demonstrates that businesses, acting as customers, had previously tried to avoid excessive commitments but that this approach has now changed.

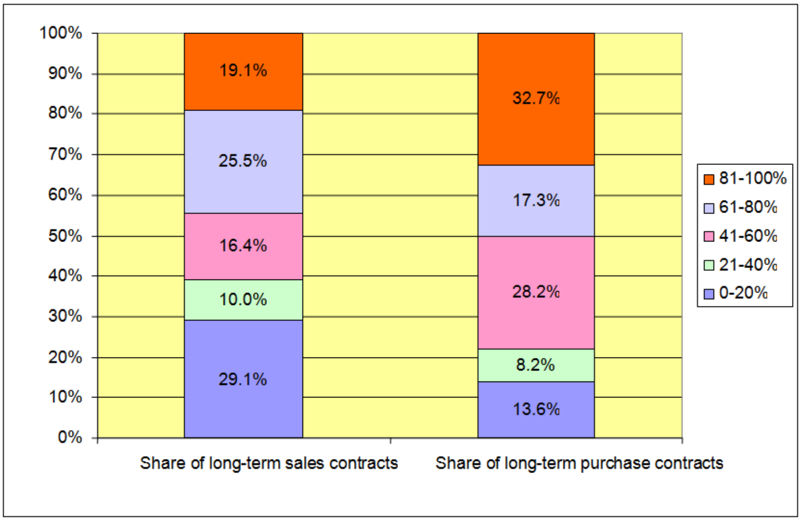

Figure 1. Share of sales and purchases carried out based on long-term contracts, 2009 (Source: personal compilation)

In summary therefore, based on results from the two surveys, there has been a certain degree of realignment in the ratio of long-term market relationships towards larger-scale application. This confirms that long-term market relations represent substantial links to corporate relation networks regarded by companies as important in implementing corporate strategy.

3. Motivations for long-term business relations

Table 1 shows current reasons for concluding long-term contracts with customers. With regard to ranking it may be ascertained that the demand for stability, computability and cost reduction provides the greatest incentive for businesses to conclude long-term agreements with customers. These criteria are important, or particularly important, for more than 60% of businesses. In 2004, managers essentially highlighted the same criteria [8] but their importance fell slightly by comparison with 2004. In summary this means that traditional operational factors related to corporate functions continue to shelter in the background of concluding long-term customer contracts. On the other hand, in case of “modern cooperation factors” [4] linked to business relations - such as joint problem solving, common strategy, and development cooperation - the situation has not changed compared to the previous survey these factors remain less characteristic reasons for concluding long-term contracts with customers. To some extent this refers to the lack of a strategic approach in respect of partnerships, since the factors indicated by businesses - related to corporate operation - as most motivating may also be the criteria in a short-term relationship. Nevertheless it may be said that the importance of these factors - with the exception of the opportunity for development cooperation - has increased by comparison with 2004, with nearly 48% of businesses (32% in 2004) regarding the common strategy option, and almost 47% (29% in 2004) regarding the opportunity for joint problem-solving as important or of decisive significance in developing long-term customer contracts.

Table 1. Motivations for long-term customer relationships, 2009 (Source: personal compilation)

	Average valuation	"of decisive significance" (5)	"Important" (4) and "of decisive significance" (5)	Standard deviation
1. Stable gross revenue	3.59	45.7%	83.0%	1.73
2. Provisional knowledge of anticipated quantity and quality expectations	3.48	43.6%	74.5%	1.73
3. Stable capacity utilisation	3.38	37.2%	72.3%	1.71
4. Customer reliability	3.30	23.4%	70.2%	1.59
5. Future additional contracts	3.29	25.8%	74.2%	1.67
6. Calculable contracts	3.22	25.8%	72.0%	1.69
7. More favourable supply and storage options	3.12	29.8%	61.7%	1.71
8. Cost-reduction options	3.02	21.3%	57.5%	1.64
9. Exclusion of competitors	3.01	24.7%	60.2%	1.70
…				
13. Joint problem-solving opportunity	2.87	16.0%	46.8%	1.56
…				
16. Common strategy option with the customer	2.78	16.3%	47.8%	1.62
17. More reliable information	2.77	16.1%	49.6%	1.65
18. Development cooperation options	2.47	10.6%	31.9%	1.51
19. Sharing the best industrial sector solutions	2.44	8.6%	24.7%	1.46

Table 2 contains the current most characteristic motivations for concluding long-term purchase contracts with suppliers. This reveals - as on the customer side - that motives related to the demand for stability, computability and cost savings constitute the most important criteria in business value judgments[1] . With regard to cooperation factors it

[1] [1] The same was also true in 2004. [8] Their current outstanding average value - over 4.00 - and the fact by comparison with 2004 that a substantially larger share of businesses assessed these motives as important or of decisive significance shows that these factors are currently being given a more accentuated role in business operations. By comparison with the 2004 results it can also be said that cooperation factors have emerged among the most characteristic reasons for long-term

should be highlighted that - in case of customer and supplier relations - the ratio of businesses considering the joint problem-solving and common strategy option important, or of decisive significance, has now increased while on the supplier side the ratio of businesses that still consider the development cooperation option important, or of decisive significance, also shows considerable growth, since this ratio increased by almost 24% in case of the common strategy option, and by 19% for the development cooperation option.

Table 2. Motivations for long-term supplier relations, 2009 (Source: personal compilation)

	Average valuation	"of decisive significance" (5)	"Important" (4) and "of decisive significance" (5)	Standard deviation
1. Reliable provision, greater purchasing stability	4.31	61.5%	95.2%	1.20
2. Higher servicing standards, more reliable and shorter lead times, reliable and known quality	4.25	57.7%	92.3%	1.21
3. Calculable contractual terms, purchasing costs	4.25	59.6%	91.3%	1.24
4. Lower, more stable prices	4.18	60.6%	87.5%	1.31
5. Cost-reduction options	3.98	49.5%	81.6%	1.35

In summary therefore it may be ascertained that greater emphasis is being placed by businesses on traditional operational motivational factors related to assuring their functioning in their long-term supplier and customer contacts. However, based on the results for the examined businesses, it may be said that whereas motivational factors that assist and extend cooperation options were previously just beginning to emerge, they are now beginning to gain ground.

4. Inclusion of business partners into supply chain processes

Another important consideration in the classification of partnerships is an examination of the areas in which businesses cooperate with their partners. Coordination between

purchasing contracts which were still included under less characteristic causes in 2004 [8]. By comparison with the previous survey - in addition to an increase in average values for motivational factors - the standard deviation also increased on the customer and supplier side, statistically proving that managers are presently more uncertain in their assessment of motivational factors than they were in 2004.

partners may be implemented in planning decisions and in material flows. Figure 2 illustrates the importance of individual coordination areas on the customer side.

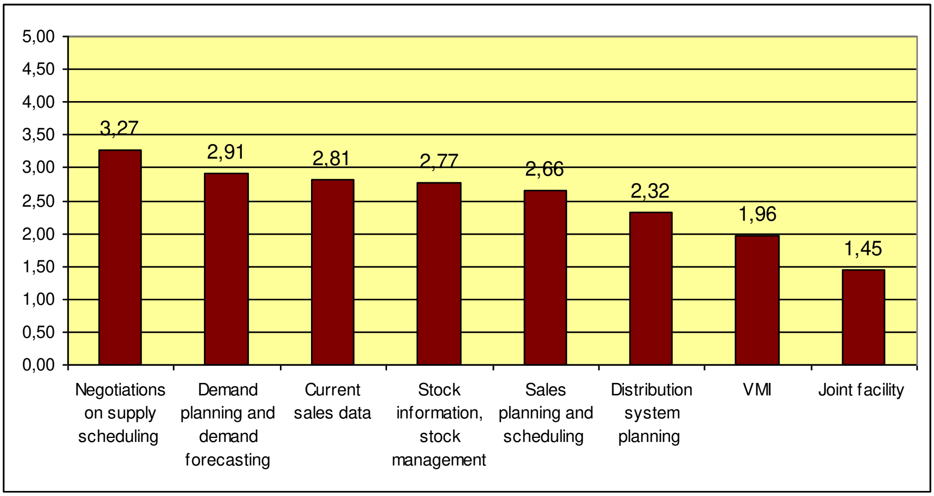

Figure 2. Inclusion of customers in supply chain processes, 2009
(Source: personal compilation)

The diagram shows that businesses include customers to the greatest extent in the area of negotiations on scheduling supplies. Other areas are less characteristic in respect of cooperation with customers (average values under 3.00); although the sharing of information related to these areas would also be an essential condition for partnerships. This conforms to the expectations of companies' customers since expectations that promote the formation of effective mutual partnerships with customers are squeezed into the background. By comparing the results obtained with the results of the 2004 survey [5] it can be said that there has been no change in the order with regard to the most important coordination areas but average values have increased, i.e. the extent of customer inclusion has now increased. Comparing the current customer-side results with the supplier side it is immediately noticeable that average values are higher here, i.e. businesses are cooperating with suppliers to a greater extent in order to coordinate their processes[2]. However, it is also possible to list joint planning of the distribution

[2] Here too, negotiations on scheduling supplies is in first place, as was the case in 2004 [5] but, moreover, companies are also improving cooperation with their suppliers in connection with purchasing, sales, warehousing and production processes. As on the customer side, this conforms to the business expectations of their suppliers, since business managers have highlighted expectations in relation to suppliers' professional skills, reliability and costs as the most important criteria. Criteria that facilitate development of a higher level of partnership are revealed as less important expectations, as also shown by the fact that the least characteristic area of coordination on both the supplier and customer side is establishing and operating joint facilities, with regard to their greater demand for starting capital, possible longer periods for return on investments and greater associated risk.

system and the use of suppliers' inventory management here which is noticeable in view of the fact that companies characteristically share sales and inventory data with their partners. To some extent this reflects the fact that businesses are putting less thought into their supply chains than into just ensuring their own operation the cost efficiency of which would be improved by using vendor managed inventory (VMI) [6]. Figure 3 demonstrates the importance of areas of cooperation with suppliers.

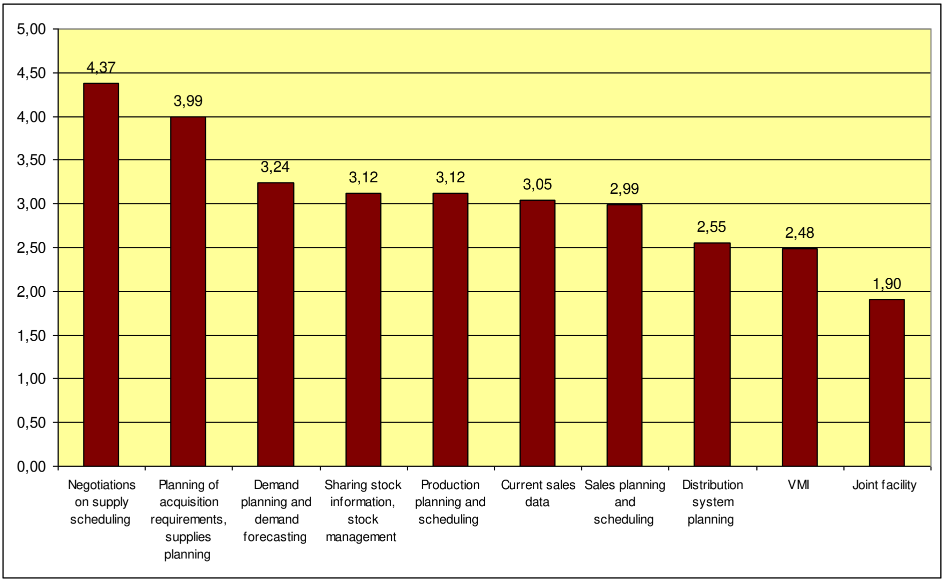

Figure 3. Inclusion of suppliers in supply chain processes, 2009 (Source: personal compilation)

Comparing the results for coordination areas with suppliers, as examined in our study, with the results of the 2004 survey a similar conclusion can be drawn as on the customer side: the present higher average values show a greater extent of supply partners' inclusion.

5. Motivations for long-term business relations and the connection with corporate performance

We have also examined whether any difference can be discovered between performances of businesses with varying motivations in respect of long-term market relationships. In this case the question is whether or not those businesses, the motivations of which include placing greater emphasis on opportunities for cooperation options with partners, reveal improved results. In order to explore this correlation we conducted a cluster analysis forming the basis for motivational factors by means of which the examined business sample may be broken down into groups that substantially differ from one another in terms of motivational factors. As a result of the employed K-centred cluster analysis, we have separated businesses into three groups, as follows:

1. Cluster (n=17): Operation-oriented businesses
2. Cluster (n=40): Cooperation-oriented businesses
3. Cluster (n=42): Neutral businesses.

These motivational clusters have the following characteristics:

5.1. Operation-oriented businesses

One characteristic of these businesses is that they link the main driving force of their long-term market relationships with the assurance of corporate function. Accordingly, factors related to stability and reliability are granted the most important role in their partnerships, i.e. exploiting the opportunity for reliable information, reliable and familiar quality, stability of supply, and time and cost savings, the opportunity for availability of lower and more stable prices, and more favourable supply and storage opportunities. Moreover, they are motivated by exploiting the implied benefits of maintaining contacts with customers, and the opportunity to employ joint developments with them or in other relationships. These businesses are not motivated by developing a common strategy with their suppliers and customers, joint problem solving, improved coordination of their processes, joint developments with suppliers, and opportunities to employ such developments in other relationships. In this regard they include customers in most areas and to the greatest extent in respect of sales processes. On the supplier side they are at the forefront in the area of inventory management since the sharing of inventory data, and the application of suppliers' inventory management are most characteristic, as this enables them to reduce the quantity of inventories produced in their supply chains, and to promote the avoidance of considerable inventory shortages or surpluses, thereby allowing for more stable and cost-efficient operation [7].

5.2. Cooperation-oriented businesses

In the case of these businesses above-average values were generated with regard to every motivational factor however cooperation with their partners provides the greatest incentive to develop long-term relationships. They have an attachment to their suppliers and flexibility within the available contractual budget: this constitutes an important driving force. These businesses are motivated by creating a common strategy with their customers and suppliers and by joint elimination of problems as well as sharing the best industrial sector solutions and the use of joint developments in other relationships. They also try to coordinate processes linked to their suppliers and to exploit implied informational and other benefits of closer contacts. They are less motivated by exploiting the operational benefits resulting from partnerships. By virtue of their orientation they include their suppliers in processes in most areas and to the greatest extent but emphasis must be placed on the motivation for customer-side cooperation and inclusion, which - in their case - indicate above-average values of coordination.

5.3. Neutral businesses

Businesses in this grouping are characterised by "under-motivation" in their long-term market relationships, both on the customer and supplier side, i.e. above-average values for each motivational factor. Based on these values factors that promote exploitation of the implied benefits of maintaining contacts with customers and suppliers and the opportunities for cooperation with them are least motivating for their long-term market relationships. Among such relationships, development of partnerships is least motivated by the acquisition of reliable information, development of a common strategy, sharing the best industrial sector solutions and the opportunity to apply joint developments in other relationships. Examining their under-motivation in detail, it is possible to state that this appears least often in respect of factors that may be linked to corporate functioning. In compliance with the under-motivation of these businesses, their partners are included in supply chain processes to the lowest extent in all areas of coordination.

6. Summary

Based on the research results individual motivational clusters show a deviation in respect of different performance characteristics. Figure 4 illustrates the connection between clusters and performance characteristics.

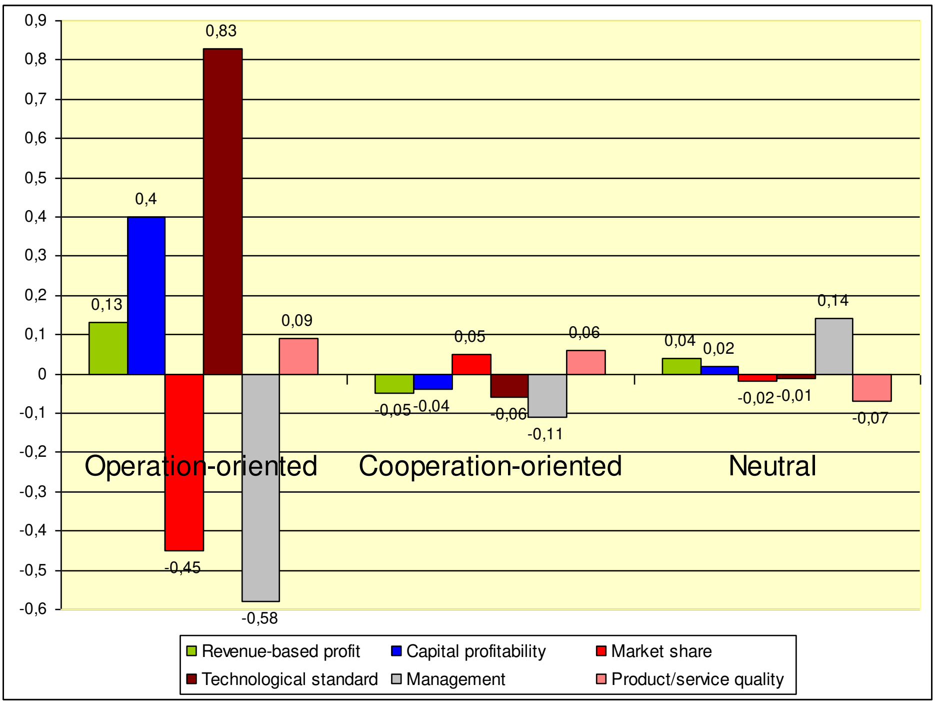

Figure 4. Performance characteristics of individual clusters (Source: personal compilation)

Performance characteristics depict the evaluations of managers in relation to the level of their own industrial sector average. According to the results operation-oriented businesses which provide a better than average performance for 4 of the 6 examined indicators reflect the top performance. In relation to the central element of their motivation, performance is outstanding from the perspective of technological standards but their product quality and financial performance - including their revenue-based profit and capital profitability - are also the best. Nevertheless, their market share is the furthest below average and the evaluation of management's work and level of grounding is easily the worst and neutral businesses provide the best result in performance of the latter factor. In respect of product quality the performance of these neutral businesses is the weakest while demonstrating above-average values for other performance characteristics. In respect of market share cooperation-oriented businesses have the best performance presumably maintaining this level provides them with an incentive in their relationships with partners but the above-average quality of their products may also provide a stimulus to motivations for cooperation with partners just like the weaker than average assessment of their technological standards and revenue-based profit.

The results of the analysis towards motivations for long-term customer and supplier relations and corporate performance therefore refer to the fact that businesses which, alongside the implementation of operational objectives, attribute greater significance to cooperation and have more favourable performance characteristics.

Finally, it may be stated that primarily the "traditional, operational functions" will continue to guide the companies in developing their long-term business relations. While the motivations for long-term business relations have diversified, in addition to operational criteria, the objectives that encourage improved exploitation of market conditions – such as the "corporate attitude towards targeting closer cooperation among partners" - have emerged.

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The Role of Time in the Supply Chain

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Abstract: Time plays an important role for every participant of the supply chain because of the need to ensure internal efficiency, and because of the external pressure of the time-based competition. For the connection of participants, time also plays the leading role because of the global size of production, purchasing and distribution. The size of the supply process is determined by logistics, since transport and different kinds of waiting make up most of the time-demand. Different interests stand behind the reduction of waiting time, depending how expensive the sacrifice of waiting is for each participant. The study examines the buyer's attitude to time on three levels, from the view point of the business participants of the supply chain. Examining firms as buyers reveals their attitudes toward time, the details of practical handling of time, the preference of time - as a logistical quality factor. The results of the empirical research proves that the decision preferences of organizational buyers concentrate on time. Based on the practical handling of the time-factor there is a segment of time-sensitive buyers which shows time-conscious behaviour and needs another kind of service from the suppliers.

Keywords: time sensitivity, value of time, logistics

1. Introduction

One of the clever definitions of time is from Einstein, who said that "time is the invention of God to avoid things happening simultaneously." Nowadays the approach and purpose of time-dimension seems to mean "things happening in the same time", to crowd more things more quickly into our everyday life. Time as a factor of competition has a determining influence on the operation of companies, and the people's way of life. All these are strengthened by several other factors partly as external necessity and partly as internal motivation.

An external factor is time-based competition (Stalk, 1990) which is partly a competition of concurrency: whoever is quicker in entering the market, partly a competition of reducing the response time servicing and supplying customers. A product entering the market as the first of a kind ensures the return of costs in a short time. The service of customers results in quality factors which determine the level of service on the suppliers' side and the level of buyer's satisfaction on the customers' side. The internal motivation is the necessity of efficient operation aiming a low-cost and high-value operation.

The requirements of efficiency cover time as a resource. Time can be measured with actual costs to the participants and in the whole of the supply chain as well [1]. If we consider that products spend only a very little part of their lead-time in production, it is reasonable to look for possibilities for shortening time in logistics. Few organisations are aware of this, in spite of the fact that most of the participants consider time as an important, valuable resource. There are only a few differences of opinion about time, according company-demography factors, but the practical handling of time shows considerable deviations, according to a research completed in 2009. It was done with business participants as buyers, in order to learn how companies consider the role of time in their own lives, what kind of values they ascribe to it and how they manage their interests in their external relations. We examined all these from the point of view of logistics, where service plays the leading role, especially the qualitative side of service. The main hypothesis of the research is that service is more important than low prices, because customers' expectations are increasing for quick, precise and reliable service. First we go through the parts of the supply chain, where time has an important role. Then we review the first results of the primary examination about judging, treating and evaluating of time.

2. The Role of Time in the Supply Chain

Nowadays social and economic phenomena are increasing exponentially. Ever more changes are in progress in an ever shorter time. This fact gives us a feeling of an accelerating world where we live. As time becomes a scarce resource, each unit of it should be used for more and more thing. There is a time-sensitive part of society, and its size is growing. For them the value of time – as an irreplaceable resource - is becoming increasingly important, and as customers they aim to get things within the shortest possible time [20].

2.1. The Role of Time for the Final Consumer

The increasing importance of time is fed by several factors from the side of the final consumer. The separation from the natural rhythm causes an accelerating rhythm of life. The same effect is caused by the higher development of the economy, the diversification of time-utilization [4], the shortening product life cycles, the increasing sort, and the fact that individual free-time is not increasing at the same pace as the range of possibilities to spend it [10]. All these increase the value of time, since several kinds of activities compete for each unit of its limited quantity [2][13]. Similar to the management of money and human resources, it is also necessary to manage time (see figure 1).

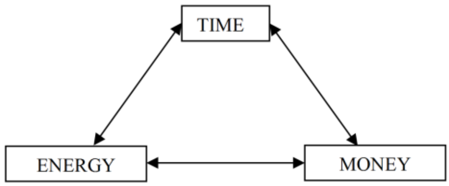

Figure 1. Convertible Resources

The way we achieve our goals depends on how these three – convertible – things are provided, and mostly we optimize for the scantiest. Time in economics is a special resource, which

- is scantily available
- is limited
- cannot be stored and
- cannot be replaced

The attitude to time as a value determines fundamentally the way of life, the customer's behaviour, and the content of the customer's basket. Buyers' decisions are determined not only by monetary factors, but sacrifices in time as well. The different approaches of perception, treatment and valuation of time have generated and are still keeping alive several contradictory theories of time. Many international surveys have been made in different disciplines, which try to describe the individual, group and social attitudes towards time, the discrepancies among them, and their effects in each behaviour situation with differentiated metrics [3][11][18][19][21].

2.2. The Role of Time for Participants of the Supply Chain

Participants, who try to bridge time and space, are challenged by the global-size of the economy. Whole industries have been founded in order to ensure the continuity of production and service in spite of the limits in time and space. The most important among these is logistics, which is responsible for generating the space- and time-value among the four micro-economic value-factors of the product-value according to 7 R's. The increasing role of time can be seen in the trends of consumption, production and in other fields of the economy by using time management methods.

The supply chain is a chain of members from the extraction of raw material up to the final consumption of a product, connecting participants over ever greater distances. The quickly changing demands of customers, the shortening product life-cycles, the fast return and the need for cost-effective operations do not allow long supply chains to operate slowly. Gaps in production and consumption must be reduced or closed. The appropriate operation of the supply chain determines the quality of service, the satisfaction of final consumers. The efficiency of the participants depends on the quality of the whole chain.

As the management of time becomes complete in the economy, there are several reasons – measurable in money –forcing supply chains to a better time-management [3][9]. The need for efficiency aims to create the biggest value within a time-unit. The improvement of the time-based productivity can be explained by the theory of comparative advantages, where the choice of numerator influences how much the result will be, that is, how much valuable activity is done within a given time. The productivity indicator also improves if we produce the same value within a shorter time. The first step is to classify the processes according to their value- and time-input. The decrease of time gaps in supply chains aims to diminish or eliminate non value-added activities (e.g. stock keeping), and to accelerate or parallel value-added activities (e.g. production, transport), as shown in diagram 1.

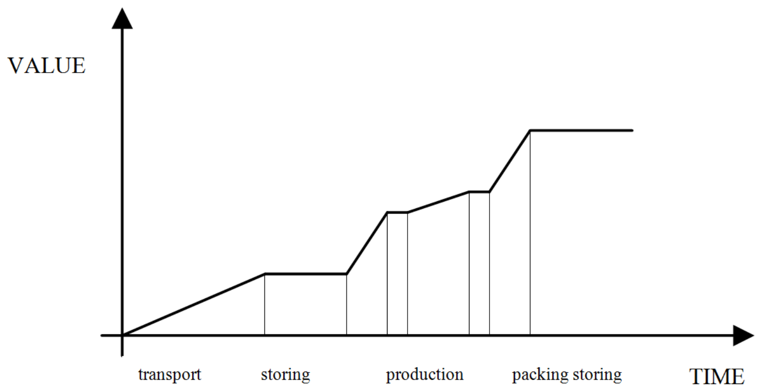

Diagram 1. Value-added and Non Value-added Activities

From the viewpoint of buyers, the acceleration of supply means, to need less stock of material, and the higher transport cost is compensated by the decreasing stocking costs, the possibility of agile operations, and the fact that the internal planning can be concentrated on the outgoing and on the internal processes instead of incoming processes. The importance of flexibility is increasing in the rapidly changing environment. The time efficiency can be ensured with some measures of time compression. Its task is to reach an efficient operation through uninterruptible connections of parts of processes with different time-needs while the time, tools, and labour are maximally exploited. Owning or renting resources generates costs. Time is not the originator, but the bearer of costs, so it can also be a good measurement as well. This is the reason why the 200 year-old sentence of Benjamin Franklin is so often mentioned, saying that "time is money." To manage time or other resources, every field with a specific function created its own method (JIT- just in time, ECR – efficient customer response, QR – quick response, CRM – continuous replenishment, 5S, cross-docking, lean manufacturing, MRP – manufacturing resource planning, DRP – distribution resource planning, etc.)

2.3. Measurement Problems of Supply Chains

Supply chains are selling-and-buying connections of participants depending on each other. In these connections new participants of both traditional and new marketing channels base their optimum-criteria on time. The aim is to reduce the non-profitable phases of shortening life-cycles, since the faster service for customers and the shorter lead times mean a measurable advantage in money, just as the loss of time, through delays means measurable sacrifice costs. The way of organizing connections in time and space depends on logistical strategies. Depending on whether the quality of service or the low-cost-operation ensured a higher profitability, it was possible in the past to choose the type of service. The trade-off of these two aims can be eliminated if we accept time as both a cost AND as a quality factor. Using time-based planning and implementation it is possible to achieve originally opposite aims, which meet the expectations of both suppliers and customers.

Nowadays we see apparently contradictory phenomena of lengthening and shortening of supply chains. The determination of size depends on the measurements used. The length of the supply chains can be measured not only in space but in the numbers of the participants and in time. If counting is done on the basis of time, we get an adequate measurement possibility with the present needs. The time-based counting has far-reaching consequences not only in determining the size, but of comparison and selection, since supply chains are not transitive in time. Traditional conclusions cannot be used to choose the best value method, because the time performance is influenced by several factors beginning with the structure of the value-chain from the method of transport up to the connection of the participants.

We can trace back how important speed, precision, and flexibility are to the problem of the value of time. Several people several times tried to define the value of time in numbers in the most different fields. Becker tried to define the value of individual time [2], more researchers delt with time-savings in transport [5], a whole literature has been created about the operation of time preferences in the field of financial decisions. Ecuador estimated the damages to the national economy caused by inaccuracy the World Bank prepared a study about the consequences of slow transportation in international trade [8][14]. One minute of a production line standing still can be measured in the loss of millions of forints for manufacturing companies using expensive machinery with expensive resources. We think both customers and other participants of the supply chain can be distinguished by their attitude or sensitivity to time.

3. Details of Empirical Research

The empirical research analysed the elusive dimension of time in May –June 2009. It aimed to determine the role and importance of the time-factor. The analysis was performed among nationwide and local business organizations. The research was connected with the speed of delivery. While creating the concept, the emphasis was laid on the issue of supply, as an activity which is the starting point at each participant and has a determining influence on every further activity. The research considered companies as buyers, so we interviewed the managers of the purchasing or logistics departments. We also measured opinions of companies with a 4 degree scale of agreement, in connection with statements about the importance of time in general, the approach to time of other companies, and of their own branch and company. Secondly we inquired about the operation of the supply chain at each company. Questions were focused on needs, satisfaction, practise connected to inbound logistics, and on the attitude to the time-based characteristics. Thirdly we analysed the behaviour of companies through the oxymoron of precision-and-delay. The demographic features were listed at the end of the questionnaire. We asked for data, which we presumed to be connected with behaviour relating to time.

3.1. Methods of Questioning

The presumptions of the research were based on the fact that time-factor varies in importance among companies, and the reasons and consequences of time are diversified. In 2008 we used qualitative research (professional conversations, and in depth interviews) to measure the attitudes toward time of executives of logistical services, and industrial and trading companies as suppliers and customers. Afterwards in May-June 2009 we conducted a national survey using online questionnaires among companies offering industrial, trading and material services. We asked the managers of purchasing/logistics as buyers to answer our questions. Considering the fact that the willingness to answer in questionnaire surveys is shrinking, we used two methods to reach the potential respondents. One of the main channels was using social network connections. The questionnaires were distributed by using business and personal connections, where they were filled in and spread over with a snow-ball method. The other method used web sites acting as network nodes, and printed and electronic newsletters for distribution .

3.2. Composition of the Sample

When creating the sample we focused on companies, where material processes dominate. We looked for bigger companies using logistical market services. The respondents do not represent the registered joint businesses in Hungary, but mainly came from industrial companies, and therefore it is distorted in other demographic parameters as well. Approximately 10,000 enterprises received the invitation to the survey, or got an e-mail message, including 207 Hungarian companies. Each region is represented, and the regional concentration of Central Hungary and Budapest can be detected. According to the objectives of the research, industrial and trading companies are overrepresented, and service companies are underrepresented in the sample in comparison to the branch distribution of the Hungarian joint enterprises. The distribution in size is distorted in favour to the bigger companies. The impact on size and branch appears also in the composition of company forms, companies operating in form of Ltd's and stock companies dominate in the proportion of registered joint businesses.

3.3. The Method of the Analysis

The questionnaire survey was analysed with the 14.0 version of SPSS, which is a mathematical-statistical software used in the field of social sciences. We used simple, descriptive and deeper, analysing methods depending on the measurement level of the variables. The nominal variables were analysed by cross-tables and non-parametric tests in order to find out whether there is a significant relationship among the responding groups with different features in handling time, and whether there is any correlation between the behaviour characteristics. We analysed the scale variables with variance (ANOVA) and discriminant analysis of one or more aspects to find out whether the differences according to the grouping variables are significant. We checked with main-component analysis from the factor-extraction methods how many factors can express the vindication of interests connected to time-parameter in the form of external relationships. We followed the hierarchical method from cluster procedures to decide into what kind of characteristic segments the respondents are divided based on their relation to time considering attitudes and behaviour.

3.4. Results of the Research

Among the main hypothesis of the research, a major role was to show the differences between the attitude to time and the behaviour with time. No significant deviation was proved about the opinions among the respondents. Time was considered as an important factor independently from branch, location, size and form of economy.

The judgement of time is not always reflected in the practical handling of time. There were remarkable discrepancies, on which not only the time-factor, but other considerations, which have a relationship with the world outside, have their influences as well.

The survey proved the hypothesis that among the quality parameters of logistics, the time-based ones are the most important overtaking even the expectations connected to price. The order of quality elements were first the speed, second the punctuality and just third was the price. The survey tried to examine the sensitivity to time by comparisons with theoretical behaviour models. Sensitivity to time as a notion indicates a behaviour which is manifested indirectly in an intensified attention to time, and in planning, measuring, expectations of time directly. Other features of sensitivity to time are the higher price paid for greater rapidity. Sensitivity to time is to measure companies by an elasticity indicator, which is the accepted ratio of price-increment related to a unit of the relative shortening of lead time. The survey analysed the utility of the reduction of lead time (that is the faster service) through price tolerance, anticipating that the value of time can be described by an increasing willingness to pay. According to the theoretical model, time is more expensive for time sensitive companies, so they act flexibly in connection with price while changing the lead time, contrary to those who are not sensitive to time. Time does not have any value for them, so they are not willing to pay for saving it. This can be seen in diagrams 2. and 3.

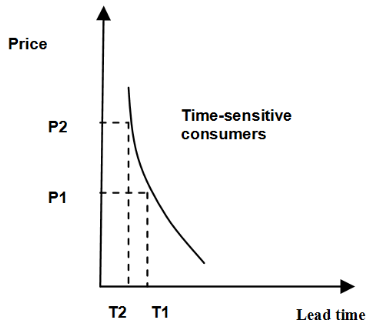

Diagram 2. Time sensitive customer

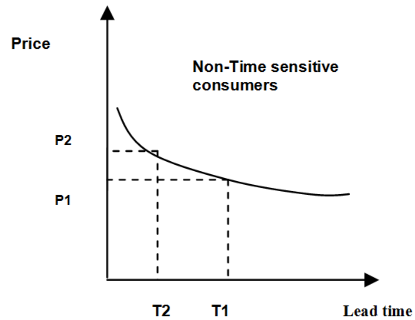

Diagram 3. Non-time sensitive customer

The analysis examined on a 4 graded scale the value of saving and wastage of time in service when the present lead time was halved or doubled at different price-levels. The results partly met the expectations, since doubling the speed of service is attractive to anybody, but only up to a certain increase in price. If the increase is 20 %, the answerers with the opposite opinion win. A price-increase of one and a half and double would not be accepted at all, which inspires several conclusions:

- Purchasing managers are usually interested in getting lower prices
- The trade offs inside the company cannot be directly perceived for those who are responsible for purchases (correlation between cost of stocks and delivery times), so the declared preferences will not be converted into willingness to pay
- The position, of the purchasing manager, how well his work is valued, is closely related to the "success" in price. That's why an extreme price increase cannot be compensated by any other advantage
- The cost expressed in price is far more evident, than the indirect savings and advantages achieved and publicized through time-saving
- If there is an arrangement in the agreed lead time and price, which is sufficient for the customer, there is no real need to deal with the question hypothetically any more
- If there is a chance to reduce the lead time by half, it is a reason for reopening hypothetical investigation

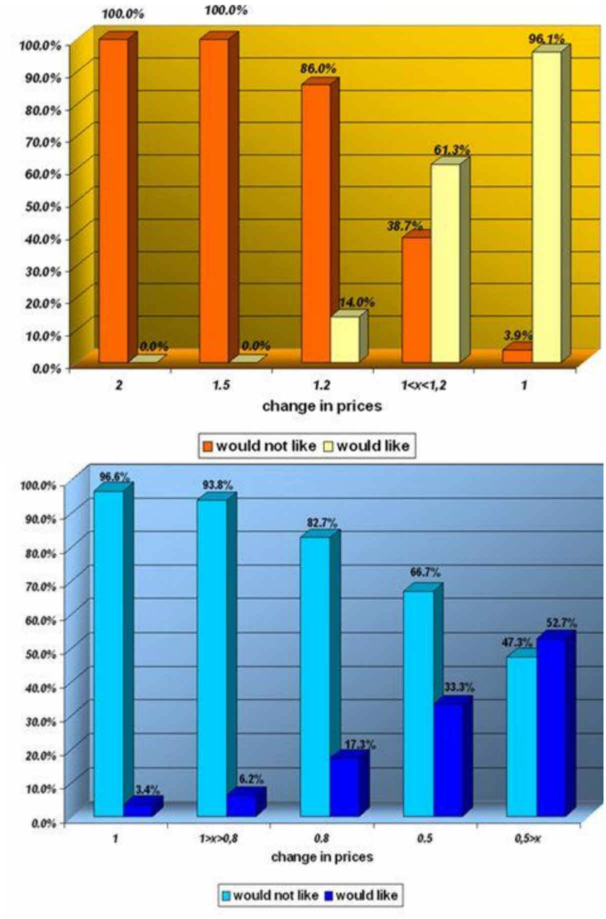

Diagram 4. Willingness to pay in different price level in case of lead time halved

Diagram 4. shows the distributions of answers in the first and in the second case (see below). The counterpart of the question explained previously, examining the relation to the service half as quick as before, reflects the value of time much better. Even if the price is reduced by half, twice as many buyers would reject the doubled lead time as they would like to. The trend turns round only with a strongly reduced price combined with the doubled delivery time. This result can be explained by several reasons:

1. Losing the “possessed”, familiar service time, which was agreed with the supplier, means a great loss, because it has several negative consequences
2. Even a considerable price cut is not attractive enough to accept a doubled lead time
3. Only an almost free transport would be able to redeem the disadvantages of an increased lead time

It seems more expensive to loose the speed we already have than the new increased rapidity. The accustomed lead time has a greater psychological value, than a shorter one available in the future.

These were the results of raw data. The weighted, aggregated results can be seen in diagram 5. where the curves represent the ratios of accepted and refused offers in various prices. The weights of data were:

- 1 strongly would like
- 0.5 would like
- 0.5 would not like
- 1 would not like at all

According to this weighted, aggregated data the doubled lead-time is not acceptable at all in any price-level (all data are located in negative side of utility axis), while the doubled speed (lead-time is halved) is hardly attractive until the price arise is low.

!hiányzó diagram!

Diagram 5. Accepted and non-accepted lead-time offers in various prices

4. Conclusions

The study examined the role and importance of time in the supply chain. It proved the increase of the importance of time for the final customer based on a professional literature, and reviewed the motivations of the higher levels of the supply chain to manage time. Time management is fed from outside by increasing buyers' expectations of speed and flexibility and with time based competition against competitors, and with the need to operate efficiently from inside. All these make time a preferred characteristic in the operation of companies, which influences costs and efficiency directly.

The treatment of time has a great impact on both of the main objectives of logistics, low costs and high quality service. The trade-offs of the two aims usually cause problems both in planning and in implementing. Treating time as a resource and a quality factor has several positive effects, and also resolves the trade-off mentioned above, involved in creating the logistical strategy.

Time based indicators can achieve more important roles in following up the logistical performance as well. The supply chain can be more precisely measured to meet the present demands. It needs due foresight to make a time based choice to get the appropriate supply chain because of the transferability / intransitivity of supply chains.

Since the buyers' preferences are organized around time, it is possible to measure the satisfaction of customers with time indicators. The main question is whether it is worth providing/ time based services and to whom culminates in STP (Segmentation, Targeting, and Positioning) planning. The empirical research shown in this study can give help among others to this. The research was focused on needs in connection with the arrival of incoming materials, spare parts, and products, the present judgement of their performance and on the attitude to quality parameters related to time. The research tried to reveal the main characteristics which can be bound to the sensitivity to time of a company, examined the opinions about time, expectations, behaviour and purchasing experiences related to time. Future research needs to investigate characteristics of separated segments, and the estimation of future behaviour of companies, and of their needs and demands related to time.

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Implementation of Activity-based Costing in Logistics

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Abstract: Logistics costing methods need continuous improvement. In this respect one of the potential development paths is activity-based costing. It is an effective tool for enhancing the accuracy of costing systems. To facilitate the adoption of activity-based costing in logistics a theoretical calculation model had been elaborated before. This paper intends to examine how this conceptual model and the new costing approach can be implemented in logistics practice. A general implementation model has been set up and adapted to the specific attributes demanded by logistics principles. Examples for concrete realisations and some empirical experiences have also been provided. The main conclusion of the study is that activity-based costing implementations in the logistics field have to be adjusted to the information needs that are influenced by several factors. The most important of these factors is the maturity of logistics competences and the complexity of cost structure.

Keywords: logistics management, activity based costing

1. Introduction

Activity-based costing (ABC) is a well known and often used cost calculation and management method in different industries, mainly in the manufacturing industry. After the necessary adaptations this methodology can be used in the field of logistics as well.

The theoretical model of logistics ABC has already been elaborated including also the mathematical formulas and equations. The operation of the theoretical logistics ABC model can be briefly described as follows. The production of logistics services uses different resources. Resources cause costs which can be divided – from the point of view of elementary logistics services (as profit objects) – into direct and indirect parts. The indirect costs shall first be assigned – based on resource cost drivers – to activities which take part in the production of performances. Activity costs can then be further allocated – based on activity cost drivers – to profit objects. Technology systems deliver performance indicators (cost drivers) for each resource and activity (or their pools). After allocating the costs of activities “consumed” by a certain profit object and adding its direct costs the prime cost of a logistics service/product will turn out. If revenue data can be made available at this accounting level the margins of profit objects can be analysed, too [4].

Thus the model and the formulas can help practitioners establish their own cost calculation tool which takes into account the specific business and technology features of the given company or supply chain. Here one may face the operative problems of ABC implementation: several pre-conditions shall be ensured before launching the ABC procedure in practice. It is reasonable to apply a systematic implementation methodology which gives a structured framework for the introduction of the new costing mechanism. To support this management approach a general ABC implementation methodology based on the literature is established in the following chapter. After having built the general implementation framework more specific recommendations are elaborated for the case of logistics related issues. Here such questions have to be answered like:

- what are the profit objects in logistics?
- what types of resources are consumed in logistics or supply chains?
- what are the logistics related activities?
- what resource and activity cost drivers can be used in logistics?

As a preliminary remark it can be stated that no universally applicable tools can be developed to overcome the implementation problems and give exact answers to the questions arisen. Nevertheless, the methodology of ABC realisation adapted to logistics will probably give more concrete guidelines than the results of theoretical modelling. The modelling principles and the implementation methodology, however, shall be used in an integrated way to make success of ABC pilot projects.

2. General implementation methodology

Several authors offer implementation plans for ABC realisations. Most of them have already been tested even in case studies carried out for different business areas. The general methodology elaborated – illustrated in Figure 1 – synthesises also these theoretical and empirical findings that are published and accessible in the international literature [2, 3, 7, 8].

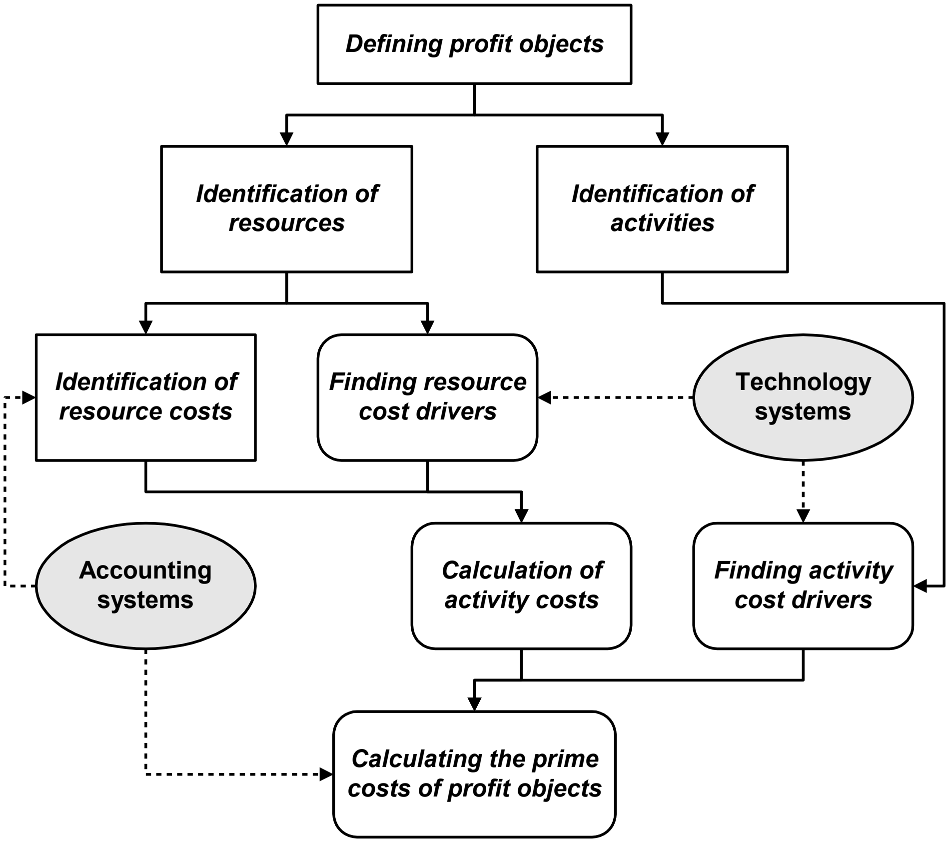

Figure 1. The methodology of ABC implementation

The first task is to define profit objects. These are the smallest entities in the service chain or product hierarchy whose prime costs shall be exactly calculated. The production of profit objects needs resources. So the next step is the identification of resources or resource pools (work forces, machinery, etc.) used for the examined business processes realising profit objects. Knowing the resources the identification of cost items associated with them can be carried out. These are indirect costs from the point of view of elementary products or services and can be obtained from the accounting systems (general ledger). Then cost drivers for resources or resource pools shall also be found (as the resources and their costs can – in general – not be allocated to activities directly).

The identification of activities participating in the examined processes and taking part in the production of products or services can be performed in a parallel way. But the calculation of activity costs requires the availability of resource costs and their drivers. The calculation of costs in the activity level is based on resource consumption measured by resource cost drivers. Another task is to find the activity cost drivers and measuring their values. Resource as well as activity cost drivers are delivered by technology systems (inventory management, transport organisation, maintenance, etc.). At last it is possible to calculate the prime costs of profit objects based on the activities consumed and direct costs – coming from the accounting systems – allocated.

3. Methodology adaptation to logistics features

Here the ABC implementation steps identified before are explained in detail with special regards to the specific characteristics of logistics business and technology processes. The task is to give answers to the questions raised in chapter 1. The proposals reflect the ideas of the author but rely on the – not always logistics specific – experiences of corresponding case studies as well [1, 2, 3, 8].

The definition of profit objects is important as it determines the structure and specification of the ABC model. There are several possible entities which can be chosen as profit objects in logistics:

- products handled in supply chains;
- service elements of supply chains;
- customers or logistics services performed for them, etc.

Additionally, these entities can vary according to the level of sophistication: particular products or product groups consisting of homogenous products; whole supply chains or their certain building blocks; customers or client clusters; complex logistics services or their certain elements. It is advisable to select those logistics related entities for profit objects which are the main contributors to the long term (sustainable) profitability of the examined company. Of course, the activity area of the company also influences the definition of logistics profit objects: logistics service providers probably prefer services or customers while manufacturing or trading companies may chose products as costing objects.

The definition of logistics profit objects determines the resources and activities that are necessary for performing production related tasks. The resources or their pools represent the indirect costs which need special cause-effect based calculations (in contrast to direct costs). The first stage allocation is carried out to logistics activities. Table 1 gives an overview of the resources and their possible drivers applicable in logistics ABC systems. Note that this overview does not cover all relevant items so can be extended on the basis of further empirical studies. The aim here is to give initial ideas for practical implementations.

Table 1. Possible resources and their drivers in logistics ABC

Logistics resources	Logistics resource cost drivers
personnel (indirect cost items)	no. of personnel, working time
vehicle depreciation	distance
facility management and maintenance	area used
central administration	transaction duration
supporting functions (PR, HR, etc.)	transaction duration
information and communication services	no. of transactions, service hours

The second stage allocation of indirect costs is carried out between logistics activities and the selected profit objects. Thus proper activities and cost drivers shall be found to support this allocation procedure. Table 2 illustrates some of the potential logistics activities and their drivers. The situation is the same as in the case of Table 1: the list of activities and drivers is not comprehensive so companies shall adapt it to their own operation models.

Table 2. Possible activities and their drivers in logistics ABC

Logistics activities	Logistics activity cost drivers
planning and control	no. of interactions, transaction duration
disposition	no. of transactions or documents
dispatching	no. of. shipments
ordering	no. of demanded items
material handling	no. of items
inventory	material/product quantities
transport	tonne kilometre, vehicle kilometre
loading	no. of shipments
tracking and tracing	distance, transportation duration

In possession of logistics profit objects, resources, activities and cost drivers the logistics ABC implementation model can be created and realised for the case of any company operating logistics services. The examples described can be used as a basis for the concrete implementation models. Of course, additional considerations have to be made by the users to customise these approaches as far as it is needed by the decision makers taking advantages of the improved logistics cost management system. Nevertheless, the implementation procedure can not be finished yet: further requirements shall be met before the “official” start. The next chapter discusses these practical conditions on the one hand and gives an impression about ABC experiences on the other hand.

4. Practical conditions and experiences of the implementation

The followings illustrate what additional practical considerations shall be taken into account when implementing the logistics ABC. The instructions and experiences are partly derived from case studies of non-logistics activity areas but can be useful for logistics applications as well.

An examination of international differences in ABC has concluded that there are no significant variances in the rates of ABC adoption in different countries. It was explained by the global homogenisation of management accounting practices. Some differences could, however, be identified regarding the implementations in various industries. The main operational and methodological problems could be connected to activity and driver selection issues [7]. That is why special attention shall be given to the methods supporting these procedures with special regard to the industry characteristics (see chapter 3).

Case studies have shown that ABC implementations are mainly completed by teams of professionals. So it is important to pay attention to the factors influencing these teams and so the success of the costing project. These factors can be the following: external environment (degree of competition), team size and heterogeneity, ABC knowledge and training, team dynamics. The team capacity shall be harmonised with ABC structural parameters reflecting model complexity: number of activities and first/second stage cost drivers [1].

Dedicated researches have investigated the association between ABC and financial performance (as one of the –indirect – aims of ABC implementations is to enhance the long term financial sustainability of the company). Confirmatory factor analysis and structural equation modelling were used to evaluate the relationship between ABC and financial performance. The results have justified that there is a positive association between ABC and the better values of financial performance indicators (like return on investment). It has, however, many pre-conditions, among others:

– ABC is implemented in complex and diverse companies;
– ABC is used in business environments where costs are relatively important;
– there are limited numbers of intra-company transactions [6].

These requirements apply to logistics, too, because (bigger) logistics companies operate complex supply chains with diverse services, running costs are of high importance (cost reduction is one of the business goals) and the number of inter-company transactions grows continuously due to global and expanded supply chains.

Several ABC implementations (in various business sectors) have resulted in more accurate costing information of activities and products/services. Another positive consequence of activity-based management is that it gives better insight into the operation cost structure by exploring the relationships between its components. The strength of a detailed cost accounting system lies not only in the analysis of the actual situation but also in the possibility to run simulations on variations of resources or business strategies. At the same time ABC may have some disadvantages: the high model complexity requires high work load and some distortions may still remain in the costing system (as ABC is not a perfect solution either) [2, 8].

Logistics ABC implementations are company specific and so shall be adjusted to the "logistics development level" of the given company. This level determines the functionality and quantitative/qualitative parameters of the cost controlling system. The more sophisticated and comprehensive are the logistics functionalities the more complex logistics costing system shall be operated. The highest logistics development level (where physical processes are outsourced), however, may need a simplified cost management concentrating on some key performance indicators. Here most of the costing functions may also be "outsourced" [5].

5. Conclusions

During the former analysis it has turned out that ABC can be implemented for the case of logistics related business processes and for companies running such processes. The implementation, however, have several prerequisites. One of these conditions is to have a clear implementation strategy consisting of logical steps and milestones. To support this recognition an ABC realisation methodology adapted to logistics has been developed. The methodology has been supplemented by example parameters like applicable profit objects, resources, activities and (first and second stage) cost drivers. The sample tables are (far) not complete and intend to encourage logistics professionals to set up corresponding catalogues of logistics related ABC building blocks.

Pilot projects conducted in logistics and in other branches have proved the significance of improving costing systems along activity-based management principles. The new costing approaches have resulted in more precise and reliable cost information and at the same time have made the cost structures more transparent. These additional management information help decision makers to better establish capacity allocations and make accurate business plans. In logistics business ABC solutions shall be in line with the "logistics development phase" reached by the company. It means that no uniform logistics costing model exists although some general guidelines – like the ones in this study – can be proposed.

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Managerial Problem Solving in Logistics How to Bridge Practice and Methodology

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Abstract: This article is aimed to give a methodology for dealing with problems in logistics systems at managerial level, and to present an approach capable of addressing logistics trade-offs.

Keywords: logistics, consulting, methodology, optimization, problem solving

1. Introduction

Being a professional in the field as well as a teacher researcher, I must constantly face the fact that practice and theory greatly differ from each other. It is really hard to bridge the gap between these two realms. There are certain well-defined logistics problems, or rather symptoms to be more exact, that I have often run into during my work as a consultant. In these cases, one could not help thinking of the typical situation when we go to see a doctor, and the GP prescribes Aspirin or the same wonder remedy to every patient, treating every case and everyone the same way. Any doctor doing this is a bad one. These kinds of symptoms, similarly to the abovementioned logistics cases, often turn out to be really just symptoms and the real causes lie somewhere else because in supply networks and in logistics everything is connected to everything else.

From a knowledge management point of view, a wide variety of organizational practices have been proposed to support the creation, storage and transfer of knowledge, yet it is often unclear how these practices and methodologies relate to one another in their contribution to supply chain performance.

In the following I would like to present a 6+1 step method to manage situations where seemingly there are some underlying logistics problems.

2. The method

To give a clear view of the proposed method, I list the 6+1 steps before their actual discussion. These are:

1. Helicopter view!
2. Focusing!
3. Methods for the recipes!
4. Technology planning!
5. Focusing on business opportunities (cost-benefit)!
6. Measurement!

+ 1 Kaizen (i.e. continuous development)

2.1. Helicopter view

Take the helicopter view. The first step is not to focus. One way of overcoming problems, in `management-speak', is to `take the helicopter view' [1]. This is a metaphor for rising above the detail of the situation so that you can see it as a whole, and in its wider context, the whole supply chain. It means taking the overview; seeing the essentials rather than the details.

Let's see a concrete example. Several companies reacted to the present economic crisis with stock reductions. According to recent surveys, this action was the number one crisis management goal in the supply chain in fact [2]. A classic way to reduce stock levels is to demand more frequent deliveries of smaller quantities from our suppliers. Unfortunately though, it brings about a painful symptom causing our goods transport costs to grow significantly. No wonder, for the supplier who has made deliveries once a week, now has to make deliveries twice a week but in smaller quantities. The unit costs and also total costs of the supply system will increase, the system gets worse so to speak. It means that if we focus on the supply system only, without looking at the entire logistics process, we will most probably maltreat the problem. For the root of the problem was in the stock management (too).

2.2. Focusing

If we have managed to clearly identify the problem with its causes and results then we must focus our resources. This means that we must precisely define, determining our system limits too, what we want to solve and focus our resources on the actual task. Focusing attention on the problem while transforming knowledge into business values, is not a new way to understand the interconnections within a system and the links between knowledge management practices and organizational goals [3]. It may require nothing else but to conduct an ABC analysis (Pareto- analysis). This tool can tell us which are the particular SKU's that are limited in quantities but make up the bulk of our turnover, or which haulers are the most common targets of customer complaints etc. To achieve serious results, we had better not try to redeem the whole world but concentrate on fixing a relatively smaller, well-defined part of the supply chain.

2.3. Methods for the recipes

We must apply methods for our recipes. Using methods means that we approach the problem systematically. It is not enough to get down to problem solving, we must follow a clearly defined and worked-out method, calculation, formula, process, scheme or system. We should involve the professionals because without the appropriate methods we cannot cook good food. It is like merely having an excellent goulash soup recipe is not enough to reproduce or even get close to grandma's delicious meals. In the field of supply chain management, we can choose from a large number of deterministic analytic models, stochastic models, simulation models and models covering economic aspects too [4].. In many cases, though, we are afraid of using them because our professional knowledge or expertise is not enough.

2.4. Technology planning

Technology can be planned. Do not forget, logistics is a technology-intensive activity. Just think of transport infrastructures, or the tools of materials handling. But besides the actual trucks, fork lift trucks, packaging lines or scales, we can also think of the underlying know-how, IT systems and processes since they also qualify as technologies. Technology is the amalgamation of physical aspects (machinery and tools) and techniques (processes, know-how) [5]. It largely defines how well a certain task can be executed. A basic principle of business is to do the right thing in the right way [6]. Because just doing the right thing (to be effective) is not enough, we must also do it in the right way (to be efficient). In other words, it greatly matters what we can achieve by spending say 100 cost units. For this reason, we must plan our technology, no matter if we talk about the process description of receiving goods (standard operating procedure) or defining the technical specifications of a materials handling machine with continuous operation.

2.5. Focusing on business opportunities (cost-benefit)

We must focus on the business opportunities. Today's management practice tends to accept highly publicized, hype solutions [7]. It is especially true for fields of pioneering technology, such as IT, but there are many overused and fashionable management techniques too, including outsorcing. One reason for this trend is because most of the companies try to follow the main stream. However, it is a dangerous practice easily resulting in wrong decisions. Managements must not forget about the useful tool of cost-benefit analysis. Besides being cost-focused, a company should study not only the introduction costs of a technique, but its costs of operation or TCO (Total Cost of Ownership). It is much tougher to quantify the actual results or what the solution means in terms of benefits and savings. If these latter aspects cannot be clearly determined, we should ask the suppliers/offerers to provide us with such analyses and/or involve the company's finance department. We must be able to express the monetary worth of a solution.

2.6. Measurement

"If one does not know to which port one is sailing, no wind is favorable". In short, we must measure the things. That is we must define the "instruments" and indicators that help managers to decide if an organization or project is going to the right direction at the right speed. Targets must be quantified. In terms of performance measurement, we must touch on two useful management approaches developed in the past decade. The first is the so-called Balanced Scorecard (BSC) method by Norton-Kaplan from 1992, which explores the various performance aspects in a detailed and comprehensive way. In their study, Kaplan and Norton also underlined the fact that we cannot assess a company's performance based on purely financial indicators [8]. Aggregate financial indicators are hard to understand by people in operative positions and they do not help much in determining how to change the operation/culture of an organization in order to improve its performance. The BSC approach aims to motivate companies to measure such factors as quality or customer satisfaction. The other widely used technique is monitoring KPI's (Key Performance Indicators). These are quantifiable measurements of the improvement in performing activities that are critical to the success of the business [9]. Typically they are process-oriented, differing from process to process, activity to activity and company to company. It follows that only a well-constructed performance measurement system can give us appropriate and effective performance parameters.

2.7. Kaizen (i.e. continuous development)

This is a Japanese word for continuous improvement. It means that from time to time we should return to things already dealt with to check them, to see if they are still working well and to revise them if necessary. Or, paraphrasing the Hungarian proverb, "seek a knot even on the rush", try to find fault with everything.

By adhering to the above steps, we can minimize the mistakes and help to improve our company's logistics processes and resolve painful real life problems due to following a systematic and thorough procedure.

Of necessity, there are some elements in the described procedure where we might need help. We can get such help internally, from within our company, from a colleague with great expertise and extensive knowledge of the given field. There are other cases though, when we should ask for external aid, turning to consultants and planners. In either case, the logistics officer must be the "captain", the conductor who composes and leads the execution of the required tasks. He/she must be the one who, by calling for internal/external help and managing the cooperating colleagues, will finally "reach the port".

3. Simple trade-off

In case of a lot of problems, we must deal with one specific aspect in particular concerning the methods under step 3 and 4 above. This issue is called optimizing with capacity constraints. A specific and profound example of it is the ski lift, which can be considered a special logistics system. Anyone who goes skiing is possibly frustrated at standing in queues, waiting for a ride on the ski lift. For this article we will call this situation the "ski lift problem". This often long waiting time greatly mar the quality of skiing and the quality of the service. How can we improve this situation?

A solution to the above problem will show that it is possible to improve the quality of service without increasing the actual capacity of the system. It sounds good but what does it mean exactly? And how can we achieve this? Let us take the following example: we got a ski lift with 2-person chairs that take people to the top of the hill in 20 minutes. What if we put 4-person chairs on the cable, doubling the number of seats, but in the same time we reduce the speed of the lift to half so that the engine will work at the same capacity? The result is that twice as many people are being transported at any given time but because of the slower lift speed the ride to the top will take twice as long, that is 40 minutes.

Why is it any better for the skiers?

Let us suppose that, for this example, a full round takes one hour and it includes 15 minutes' skiing downhill, 25 minutes' waiting for the lift and 20 minutes' ride uphill on the chairlift. With our modified ski lift we reduce the waiting time to one fifth because the "people waiting" are put on the lift now so, from now on, they will spend most of their former time of queuing sitting in the chairs. It is much more interesting for them to watch the scenery with snow-covered tree-tops than to trample on each other's skies in the line. So a downhill ride will still take us 15 minutes but we only have to wait 5 minutes for the lift that takes us to the hilltop in 40 minutes. And we achieved this without increasing the performance or capacity of the lift, we still transport the same number of people within the same time frame! What happened is that part of the system's waiting time (we can call it "lead time" too) were moved from one subsystem to another subsystem. But, since it results in a much more interesting and enjoyable experience for the skiers, the quality of service is increased [10].

The above simple problem shows us that we can drastically change, without significant costs, a system's benefits and performance (i.e. its operating parameters) by shifting and reshuffling the emphasis on its subsystems.

Our ski lift is a logistics system, or a materials handling machine with continuous operation how logistics would call it, where skiers are the "material".

As an extension of the ski lift problem, we will look at some analogies, some similar trade-off situations and solution possibilities in the field of logistics.

Production processes and (semi-finished) goods waiting in the warehouse might be similar cases. A good example is when bananas spend their waiting period usefully ripening in the depot. The process is planned, banana harvest is scheduled early because the ripening of the fruits while transporting and warehousing is calculated into the whole process. A similar case is the post train when the mail is being sorted during the otherwise non-productive transportation process. (Unfortunately, not in Hungary any more, since a few years ago the Hungarian Postal Service switched to road transport entirely.) Or in car manufacturing some pre-assembly processes are carried out in the warehouse during the waiting time. For instance parts of the engine exhaust manifolds are assembled in this way in many factories.

In short, we can often find lead-time related improvement possibilities that can increase system efficiency through minor adjustments, without major efforts or costs. To achieve this, we should follow the following principles:

#1 Be bold, make changes to subsystems that no one has dared to touch before. Do not forget, we are looking for the optimal operation of the entire system and not of the subsystems.

#2 The keyword is "look for trade-off". We should study that which process elements can be expanded or moved "at the costs of" other process elements.

#3 Destroy to build! Take the process to pieces, disassemble it to its components, down to the smallest lego blocks.

#4 Play lego. Try to play freely (see principle #1). Put the pieces together again in a different new way. This is the most important thing! We really are capable of building operational systems from the existing lego blocks. And this is the core of the ski lift example too. We must build a better thing from the existing parts, without new building blocks. That is what playing lego is about.

#5 Evaluate: Run a PDCA (Plan-Do-Check-Act) cycle, that is check the results, make the feedback and, if necessary, change or fine-tune things.

But be careful, there many are bad examples and partial solutions too. One such case is when the truck spend the same time in front of the warehouse but to reduce its waiting time they "drag out the" loading process, pretending that they are working on the case. It means that they are loading several trucks in parallel but the loading of each truck takes a bit longer. It is a bad solution because we must split our attention and resources, increasing the chance of making mistakes and making the system more prone to disturbance.

4. Management limits

Although the method described above can be useful in itself, often it does not lead to a concrete practical step or action for the company. It is because bridging the gap between the goals and the existing situation are hindered by the following problems:

- Distance: managing operative problems and daily market issues erodes the importance of thinking about of the future;
- It is hard to quantify the financial benefits of a solution due to the many boundary conditions and estimations and thus the monetary yield is often underestimated.
- The constantly changing management have no interest in long-term planning through several cycles, they usually focus on the short-term financial targets only [11]. (Unfortunately, this is true for policy makers too).
- Past successes, achieved market positions and strong products often make the companies blind to the change in framework conditions, making it hard for them to revise a formerly successful strategy. (A good example of this is the

agonizing of the once world-famous instant photo camera brand Polaroid due to the appearance of digital photography.) [12].

- The goals, the needs for managing the future usually come up only after the trouble, which, on the other hand, cannot be managed by long-term tools.

Only those companies can remain standing that are flexible enough to adjust to the changing conditions. This requires that they must know what to expect and what to watch carefully so that they will be able to react on the occurring changes as fast as possible. If we can answer to the changes within a certain time, it is called reaction. If we can change together with the environment, it is called preaction. But it is proaction, when we can influence our environment being one step ahead of the changes, that can give our company a real competitive advantage over the others. The method described in this article can help to achieve this.

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Efficient Control of Logistic Processes Using Multi-criteria Performance Measurement

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Abstract: Supply chain management (SCM) is a dynamic-developing and rapidly changing phenomena supported by companies and researchers throughout the world. Supply Chains are getting more and more complex, longer and complicated, making them hard to measure and control. Extended Supply Chains have large amount of capital invested and high level of inventory that makes control, measurement and optimization an important issue for the world economy. This particular article encompasses the necessity of possessing knowledge of supply chain complexity and length.

Keywords: modelling, Supply Chain Performance, Supply Chain length, complexity

1. Introduction

The term ‘Supply Chain Management’ (SCM) was first introduced by consultants in the early 1980s. The concept was mainly used to discuss the benefits of integrating a firm’s internal business functions: purchasing, manufacturing, sales, and distribution [1, 2]. The original view of supply chains had an intra-organisational focus and concentrated primarily on the firm’s internal supply chain and how different functions could be integrated in order to smooth the material flow within the company. This view of the supply chain is closely related to what [2] labels the firm’s ‘value chain’. From this intra-organisational focus the scope of the supply chain was later extended beyond the boundary of the (manufacturing) firm to include ‘upstream production chains’ and ‘downstream distribution channels’. This complementary perspective gave inter rather than intra-organisational focus to SCM.

To be able to control a supply chain a performance measurement tool is inevitable. To be able to choose the right tool for the right Supply Chain we need to characterise the supply chain according to various characteristics [11]. Complexity and length are key characteristics of Supply Chains that is why a very deep research was needed in these fields.

2. Need for operational feedback and identification

On Fig. 1 the strategic vision of supply chains can be seen. According to this figure, for the time being, mainly strategic view is dominant in planning, thus a good strategy will always result in customer satisfaction. This principle is questionable because of the lack of feedback from strategic level to operational level. Problems and barriers on operational level can hold back strategic level goal fulfilment: a decision on strategic level can be excellent but maybe it cannot be accomplished on operational level. That is why an operational feedback was added to the following figure. This feedback is to check the operational feasibility of strategic decisions.

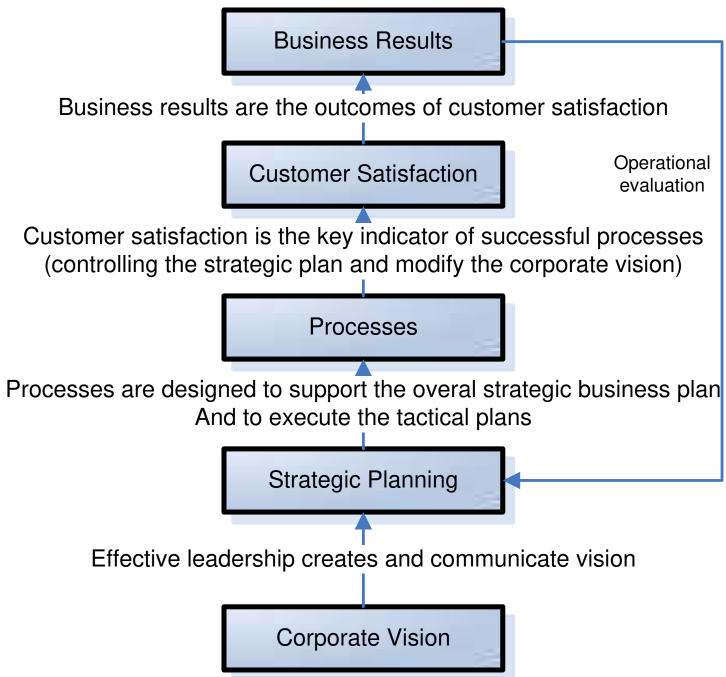

Figure 1. Strategic vision of Supply Chains

To be able to evaluate a strategic decision on operational level the identification of the particular supply chain is inevitable. The proper recognition of two main supply chain characteristics, complexity and length, is an important step in this process.

3. Supply Chain complexity

Complexity is a key managerial issue that supply chain managers should address. Although its meaning has been discussed by a large number of authors, a broad range of definitions still exists. Much of this definitional work has been incorporated into the organisational theory literature, with a focus on studying, predicting and controlling chaotic systems.

Within operations management, the concept of complexity has been linked to operational processes and manufacturing strategy [3]. In our case complexity has other links witch – by using the same concept – can be used to describe supply chain complexity.

According to literature, supply chain complexity depends on several drivers:

- Number of supplier relationships that must be managed. In fact, adding suppliers necessarily increases the complexity, due to the greater number of information flows, physical flows and relationships that must be managed.
- Degree of differentiation among these suppliers, in terms of size, technology, etc.
- Delivery lead time and reliability of suppliers.
- The extent of global sourcing, since global linkages potentially expose companies to a wide range of complicating factors (e.g. import/export laws, cultural differences).
- Level of inter-relationship among the suppliers, since the greater their level of interaction, the greater the operational “load” borne by the main company in managing its supply base. For example, a supply base with two independent suppliers is less complex than a supply base with two inter-related or linked suppliers [3].

Later I will use this and other drivers to define supply chain length which has large effect on performance measurement problems and possible solutions.

4. Length of Supply Chains

As found in various logistics-related books and papers [3,4] the length of a supply chain is the number of tiers, or intermediaries, that materials flow through between source and destination. We might imagine a supply chain with raw material suppliers, main operators, wholesalers and retailers. Some supply chains are shorter than this when, for example, producers sell directly to final customers through a Website.

Usually, though, supply chains are much longer with many intermediaries, perhaps including several stages of manufacturing, and several stages in the distribution of finished products. This can be particularly noticeable when exporters use a series of logistics centres, transport operators, agents, freight forwarders, brokers to move materials through different parts of their journey.

Obviously, the length of supply chains in the world economy is growing. Main drivers of this process are the production complexity, growing importance of economies of scale in production – and in determining economic batch size, and the frequent use of cheap labor force – mainly thousands of kilometers away from the home of the company.

It is of no doubt that the operation and working capital flow of transnational companies is having great effect on world economy. These companies produce approx. 10 percent of the world GDP and 30 percent of the world export. The main part of world production is produced by a small amount of companies [5].

Determining Supply Chain Length

Summarizing the statements of the reference works cited above and considering the aforementioned facts it can be stated that so far mainly the material flows have been taken into consideration, and very little attention have been paid to the information flows that are the framework of commercial and legal acts and give the basis of planning and managing operation is time. A more sophisticated method is to count beside the material flow: the information flow. In this article an extended definition of supply chain length is presented, using graph theory methodology.

Many important optimization problems can best be analyzed by means of a graphical or network representation. A graph, or network, is defined by two set of symbols: nodes and arcs. We define a set (call it V) of points, or vertices. The vertices of a graph or network are also called nodes. We also define a set of arcs A. An arc consist of an ordered pair of vertices and represent a possible direction of motion that may occur between vertices. If a network contains an arc (j,k) , motion is possible from node j to node k.

A sequence of arcs such that every arc has exactly one vertex in common with the previous arc is called a chain.

A path is a chain in which the terminal node of each arc is identical to the initial node of the next arc.

In our case:

- V is the vertex set, the participants of the supply chain
- A is the edge set, the material and information flow

Two graphs are considered equal when $V_1 = V_2$ and $A_1 = A_2$.

Order of the graph n= the number of vertices in a graph, denoted $|V(G)|$.

Size of the graph m= the number of edges in a graph, denoted $|A(G)|$.

The minimum number of edges is *n-1 (*see Fig. 1.*),* but in our case more edges are also possible because the information flow between two vertices is also regarded as an edge.

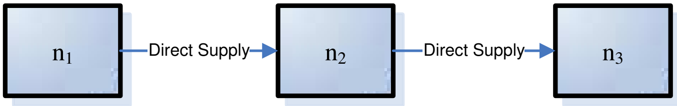

Figure 1: Basic 3 order supply chain graph

The length of a supply chain in most literatures is characterized with the number of vertices (and thus with the number of edges) [1,5]. Our proposal is to also use – besides the aforementioned number of vertices – the number of edges weighted by the complexity of the edges. The reasoning is the following: the main parameters of the supply chain are amongst others the lead-time, the cost of transshipment, the reliability of supply in time and in quality. These parameters are significantly dependent on the actual geographical distances between nodes, the selected transport mode, the necessary legal and commercial actions to be taken in order to transship the cargo from a vertex to an other. In this sense the features of edges are at least as important as the nodes where the production processes are taken place. Almost 50% of the total lead-time is devoted to commercial and planning, transport and idle (waiting) time. That is why the control of supply chains must take the edges into consideration as well. In addition there are two types of edges:

– material and information flow parallel from the same origin to the same destination, but not necessarily in the same time,

– information flow without material flow (see Fig.2)

Remark: material flow without information flow is not possible, since in any case some pieces of information are being transferred jointly with the material, recorded either on the packaging and/or on the shipment note.

The term network is a synonym for a weighted graph. In this case a network of raw material suppliers, main operators, wholesalers and retailers build up our supply chain so we have to add weight to the edges. This weight is the complexity of edges – that is:

– Length of the edges: the sum of the physical – geographical distance multiplied with the transport mode parameter and the “resistance” representing the necessary unloading and loading process during the shift between transport modes and the transit warehousing if any.

– Informatics complexity: order placing, respond time, information handling, transmitting and checking data, interpretation and processing ordering and dispatching information.

– Commercial and legal complexity: interpreting and following different regional legislation, obtaining official certificates (e.g. phytosanitary certificate, certificates of origin) , arranging custom clearance.

The complexity of informatics in supply chains cannot be disregarded. However pieces of information can be transmitted electronically with the speed of light, information handling and respond times accuse delays. Complex informatics edges in supply chains can cause the so called "bullwhip effect" [6] which is an often observed phenomenon in forecast-driven distribution channels (see Fig. 2.).

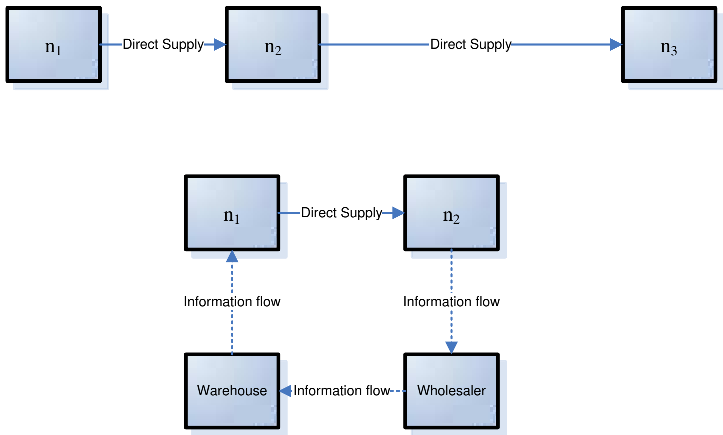

Figure 2. Complex supply chains

As it can be seen in Fig. 2 the material flow can be a simple edge between the two manufacturing actors but the information (order, stock check, etc.) connects commercial actors to the supply chain without material flow.

The various types of network strategies are shown in Fig. 3. Using the same routine as in Fig. 2, the material flow can be a Point-to Point strategy (1) and the information flow can be a Corridor-type (3) or Hub-and-Spoke (5) strategy.

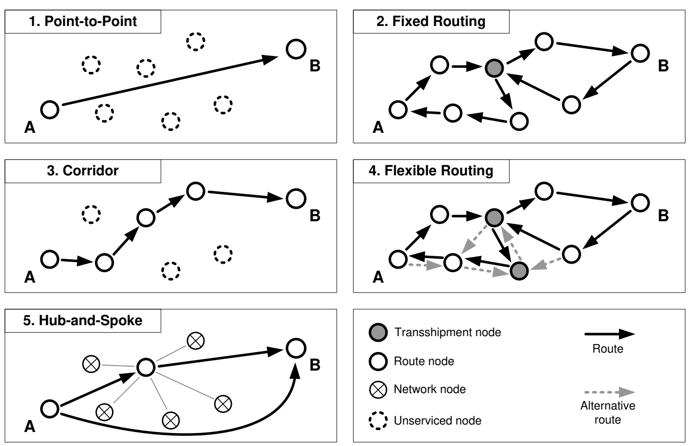

Figure 3:Network strategies

Also the simple summation of number of vertices must be reconsidered. Obviously the different actors represent different "resistance" in the network. On the basis of the activities the following groups can be distinguished:

- Production vertex: where manufacturing processes are taken place
- Transit vertex: hubs and freight forwarding warehouses
- Commercial vertex: where stocks are kept for commercial purposes, mainly in push systems

For the evaluation of logistic networks and supply chains the above listed groups have different weight, since they have significantly different affect on lead-time, distribution cost, reliability etc.

On the basis of the above reasoning the proposed formula of supply chain length (LSC) is:

$$LSC = c_1 \sum_{i \in P} w_s \cdot V_i + c_2 \sum_{(i,j) \in P} f(D_{i,j}) \cdot A_{i,j} \tag{1}$$

where:

- c_1 constant represents the technical and managerial level of vertices
- c_2 constant represents the technical and managerial level of edges
- w_s is the weight corresponding the nature of node (production, transit or commercial)
- P is the path from the origin to the destination
- V_i are the vertices (nodes) in the path
- $A_{i,j}$ are the arcs (edges) in the path
- $D_{i,j}$ distance in logistic terms
- $f(D_{i,j})$ the weight determined by the distance in logistic terms

5. Conclusions

By determining supply chain length so far mainly the material flows have been taken into consideration, and very little attention have been paid to the information flows that are the framework of commercial and legal acts and give the basis of planning and managing operation is time. A more sophisticated method is to count beside the material flow: the information flow. In this article an extended definition of supply chain length is presented, using graph theory methodology. Our proposal is to also use – besides the number of vertices – the number of edges weighted by the complexity of the edges.

With the formula proposed the length of supply chains can be determined and used for choosing the right performance measurement tool.

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Security Solutions of Supply Chain Management

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Abstract: International trade is an essential driver for economic prosperity. The global trading system is vulnerable to terrorist attacks that could severely damage the entire global economy. Articles on supply chain teach us the basics of visibility, variability, velocity, and value (the 4 Vs conception). At the same time there is no word about vulnerability! The supply chain is clearly vulnerable; therefore Supply Chain Security (SCS) doubtlessly comes to the fore as an issue of high priority. In today's global market, a terrorist incident or attack involving a critical segment of the supply chain infrastructure will impact you anywhere your business is located. If a company chooses to invest in new security protocols and its competitor does not, the company may have to raise its rates, which could in its turn drive business towards the competitor's. Let us take the question of increased security and apply it to the hotel industry. Four of five hotels in one city, for example, have great security procedures, but the fifth hotel has none. It is fair to assume that this hotel's guests are more at risk for robbery, assault, or even a terrorist attack. Should the unsecured hotel fall victim to a terrorist attack, all hotels in the area will lose substantial revenue and business – not just the hotel that didn't invest in security procedures. The same principle can be applied to companies operating within every aspect of the global logistics industry. A successful attack on this vital conveyor of the global economy will impact business around the world. While the interconnected nature of the global market is great for business, it is exactly what makes securing the supply chain so challenging. SCS refers to efforts of enhancing the security of the supply chain: the transport and logistics system for the world's cargo. It combines traditional practices of supply chain management with the security requirements of the system, which are driven by threats such as terrorism, piracy, and theft. The appropriate platform for this initiative is readily apparent.

Keywords: Supply Chain Management; Supply Chain Security Management; Strategic business planning;Total Quality Management.

1. Introduction

Supply chain managers are increasingly becoming aware of the new operating environment after the terrorist attacks on the World Trade Center and the Pentagon on September 11, 2001. These events exposed the pre-existent and latent risk of disruption to supply networks from terrorist attacks. The risk was there all along but these attacks made it real and foremost in our minds. Furthermore, these events began to expose the more significant interdependence that exists between all firms in the supply network. The interdependence also includes reliance on the governmental agencies involved with inbound material flows and transportation infrastructure. Given these interdependencies, if one firm fails in the supply network, the entire network performance is put at risk. Understandably, this constitutes a new operating environment where firms need to think in terms of their supply network and not just their individual performance.

Novelty of the research of Supply Chain Security Management is to analyze, compare, and adapt various types of research, analysis and case studies surrounding the broad field of supply chain security management programs, standards, measures, trade-offs, and costs. Generally the research is targeted to the following two audiences:

1. It is intended to assist companies in international trade and logistics to better plan and prepare for the implementation of new supply chain security standards; and
2. It is intended to help governmental administrations, mainly customs and transportation agencies, to better understand the realities and constraints of international supply chains, while developing new security standards.

The best way to secure a company against disasters and attacks is to break down those preconceptions and make security everyone's obligation. The costs of implementing necessary security measures are insignificant compared to the potential expenditures due to damage to the worldwide supply chain infrastructure and the global economy. As to government organizations that control and administer the international movement of goods, Customs administrations are in a unique position to provide increased security to the global supply chain and to contribute to socio-economic development through revenue collection and trade facilitation. There is a need for an endorsed strategy to secure the movement of global trade in a way that does not impede but, on the contrary, facilitates the movement of that trade. Securing the international trade supply chain is only one step in the overall process of strengthening and preparing Customs administrations for the challenges of the 21st Century.

2. How do you improve security without jeopardizing supply chain effectiveness?

Government and business leaders now are searching for ways to prevent terrorist attacks on or through our freight distribution systems. At the same time, questions have been raised within the supply chain profession as to whether existing best practices remain sound. There is no doubt that significant changes need to be made — and that these changes will have a significant cost. The goal of this study is to help those leaders succeed in this dual objective, reducing security risks while, at the same time, contributing to supply chain productivity and effectiveness. One of the most effective strategies may be to apply the lessons of successful quality improvement programs. We can learn from the quality movement and begin to think about supply chain security more in terms of prevention, process control, and design improvements that will restore supply chain confidence while increasing productivity and reducing costs. The quality movement started with the recognition that defects can be very costly to a company. The following principles that shaped the quality movement can help frame our responses to the supply chain security challenge.

The new operating environment calls for designing security and resilience into the supply network. Security and resilience are unique characteristics that require distinct plans in order to develop and create these characteristics within the firm. Fortunately, there are several actions that firms can take which will contribute to both improved security and resilience, although this is not always the case. The key takeaway is that it is critical to design for both security and resilience. New organizational capabilities are also called for in this environment. Specifically, firms will need to pioneer new relationships with governmental agencies that now share responsibility for making the supply network secure and resilient. Additionally, firms will need to develop deeper relationships with suppliers and customers throughout their supply networks to co-create a more secure and resilient network. Internally, the largest organizational challenge may be in establishing at the individual level a solid understanding of the interdependence of the systems, and the educational and training systems needed for robust network designs and planned responses to disruptions.

For operation excellence in SCS performance management goals must be aligned and software should be deployed to serve the entire enterprise. SCS performance management consists of doing three things: aligning plans with goals, optimizing future activities to reach goals, and understanding business results and their impact on the supply chain and, through it, the organization. Stated somewhat differently, SCS performance management answers three key questions about business: What should we be doing? How are we doing? And what can we do to make it better? SCS performance management is the practice of managing the effectiveness and value of your supply chain by aligning trading partners, service providers, employees, processes and systems to a common set of goals and objectives. When this practice is applied at the three key levels – strategic, tactical and operational, of an organization, it provides not only a framework but a toolset with which to address and resolve the uncertainties and risks of the supply chain, and thus to improve business outcomes. That may sound challenging at first, but addressed systematically it is easier to understand and do than it may initially seem. A focus on supply chain protection and security requires a shift in the firm's perspective:

- Shifting from an internal focus on corporate security to a cross functional perspective involving supply chain, security, and quality assurance. Within supply chain, the cross functional team needs to include representatives from procurement, production, warehousing, and transportation;

- Shifting from preventing theft (focus on keeping food in buildings and trucks) to keeping terrorists and their agents out of supply chain facilities;
- Shift from focusing primarily inside the company to being concerned about the end-to-end supply chain. The firm must now worry about what happens to the product outside its control;
- Shift from focus on the firm's relationship with its supplier and customer only to including the supplier's suppliers and customer's customers. This also considers the trend for firms to outsource manufacturing, storage, and transportation responsibility to focus their primary efforts and other functions such as new product development and marketing;
- Shift from country or regional operations to global operations.

That all means – a shift from contingency planning to determining how to deal with crises.

Proposing that, logistics can benefit from borrowing theories from other areas of study and presenting examples of theories from other disciplines that have already been applied to logistics issues offer potential applications from a variety of non-logistics disciplines, including accounting, anthropology and sociology, computing, economics, marketing, philosophy, political science, and psychology. This research is attempt to analyze examples from various disciplines in detail and identifies possible applications of the theory, subsequently it is planned to formulate conclusions on the benefits of "transferring" non-logistics theories to logistics research and, as a result, to contribute to practice and theory development. Besides Total Quality Management (TQM), Organization theory (OT) has the potential to offer provocative and helpful wisdom to the field of supply chain management, yet OT's potential has remained largely underdeveloped in the supply chain arena. As a result, enormous opportunities exist to integrate insights from organization theory, marketing, outsourcing and supply chain management in order to build understanding of why some supply chains excel while others do not. The research provides an overview of the contributions toward developing such a synthesis offered by each of the articles contained in this special issue. Collectively, the articles take a significant step toward closing the gap between 'what we know' and 'what we need to know' about supply chain security management.

Traditionally, supply chain management has been viewed predominantly as a process for moving materials and goods. From this view, supply chain management has been viewed as a support function that helps organizations implement their strategies.

Best value supply chains take an important additional step. Their focus is on strategic supply chain management—the use of a supply chain not merely as a means to get products to where they need to be, but also as a means to enhance key outcomes that drive firm performance. In other words, strategic supply chain management elevates supply chain management from a function that supports strategy to a key element of strategy. An emphasis on strategic supply chain management does not imply a need to use cutting-edge and expensive equipment, nor to emphasize rich teamwork at all stages in the chain. Instead, the emphasis is on matching the chain's approach to each problem to the nature of the problem that needs to be solved. Beyond a general focus on strategic supply chain management, best value supply chains are further distinguished from other chains by how they approach issues of agility, adaptability, and alignment Best value supply chains use strategic supply chain management in an effort to excel in terms of speed, quality, cost, and flexibility.

Despite the value of this concept to modern firms, little is known about how prominent theories can help shed light on what distinguishes these chains from others and makes them exceptionally successful. As an example could be mentioned Demand chain management (DCM). It is a conceptually new business model aimed at creating value in today's marketplace, and combining the strengths of marketing and supply chain competencies. Demand chain design is based on a thorough market understanding and has to be managed in such a way as to effectively meet differing customer needs. Based on a literature review as well as the findings from a co-development workshop with marketing and supply chain professionals, a conceptual foundation for demand chain management is proposed. Demand chain management involves (1) integrating the demand and supply processes; (2) managing the digital integration (3) configuring the value system and (4) managing the cross-functional working relationships between marketing and supply functions.

3. The role of marketing and SCM

Propositions for the role of marketing within demand chain management and implications for further research in marketing are derived. Conceptual and empirical research on the concept of market orientation has long suggested that interfunctional coordination is key in achieving the main goal of marketing, the creation of superior customer value. As a consequence, a stream of research on the relationship between marketing and R&D, marketing and finance, marketing and engineering and the integration of marketing with several other functions in the formation of business strategy can be traced. The overarching rationale of this research is that customer value is being created through the integration of areas that are not traditionally associated with marketing.

One of these models, which have rapidly become a strategic priority in many companies, is supply chain management (SCM). SCM has grown in importance since the early 1990s, although the approach was introduced in early 1980. SCM can be defined as "the management of upstream and downstream relationships with suppliers and customers in order to create enhanced value in the final market place at less cost to the supply chain as a whole". The synergies between SCM and marketing have been widely acknowledged, leading some to conclude that better coordination could define competitive superiority in new ways. The most recently introduced approach of demand chain management (DCM) seems to capture the proposed synergies between SCM and marketing by starting with the specific customer needs and designing the chain to satisfy these needs, instead of starting with the supplier/manufacturer and working forwards.

Such integration between customer - facing and supply functions seems mandatory in today's marketplace, where customers benefit from having real-time access to their accounts, making real-time changes in their customized product configuration and communicating their individual service requirements. Collaboration between supply functions and marketing needs to ensure that supply functions are involved in the marketing planning at an earlier stage, are involved in customer priority decisions and, most importantly, need to be able to reject marketing decisions if they are not financially viable to the business. On the other hand, marketing must become more cost driven and less inclined to agree to sales that are not optimal for the business.

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Greening Supply Chain Management

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Abstract: The last few decades have seen an increase in environmental consciousness. More and more people are aware of the world's environmental problems such as global warming, toxic substance usage and the decrease of non-replenishable resources. Governments have released campaigns to promote this problem to people. Several logistic organizations responded to this by applying green principles to their company, such as using environmental friendly raw materials, reducing the usage of fossil based power and using recycled papers for packaging. Green supply chain management (GSCM) has been emerging in the last few years. This idea covers every stage in the manufacture from the first to the last stage of the life cycle, i.e. from product design to recycling. Transportation cannot be replaced as it is a part of the production chain. Societies are horizontally and vertically differential. The manpower, the stock, the semifinished and finished products must be transported, thus the importance of the transport sector is unquestionable. The purpose of this paper is to describe the importance of greening the supply chain.

Keywords: greening the supply chain, environmental impact

1. Introduction - Transport logistics related environmental pollution

In the last two or three hundred years there was an explosion in the development of industrial and technical sector, which gave people a multiplied set of tools to encroach nature. The motorization has developed so dynamically that the air, soil, water pollutions are considerable to the amounts of air, soil and water of Earth. The sustainable development is a development, where the pace of technical development, the satiation of increasing supply and the raw materials and resources of Earth are poised so that the rate of living and opportunities of the next generations need not to be worse. Transportation cannot be replaced because it is the part of the supply chain. Societies are horizontally and vertically differential. The manpower, the stock, the semi finished and finished products must be transported. The importance of the transportation sector is indicated by the sector production which is 10% of the GDP of the European Union and more than 10 million people are working in this sector. One of the most emphasized goals of the transport policy of the European Union is sustainable mobility.

For this reason transportation systems must be developed and standardized, the effectiveness of transportation service must be increased, while the environmental pollution must be decreased or prevented.

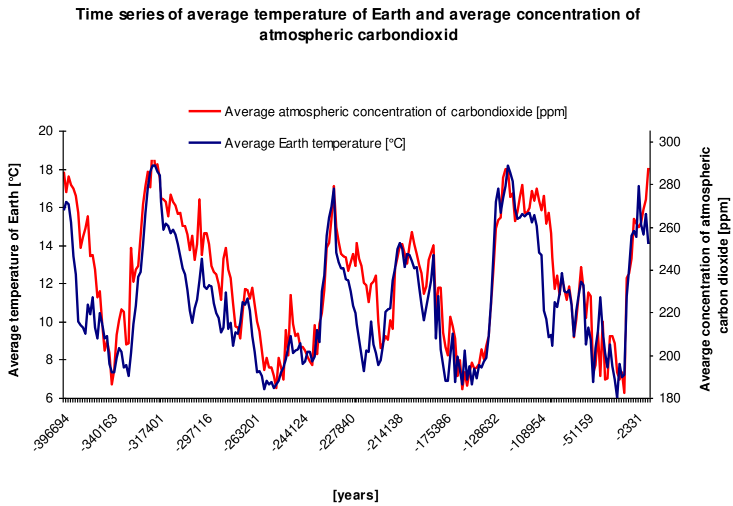

Figure 1. Normalised time series of CO2 and temperature before human impact [16]

There is a strong correlation between atmospheric CO2 concentration and the average temperature of the Earth. (r=0,8657, Figure 1.) Nowadays with the human impact which is considerable to the size of the atmosphere, the relation can be changed. More than the quarter of the total emission of CO2 caused by the humanity is produced by road transport (Figure 2.).

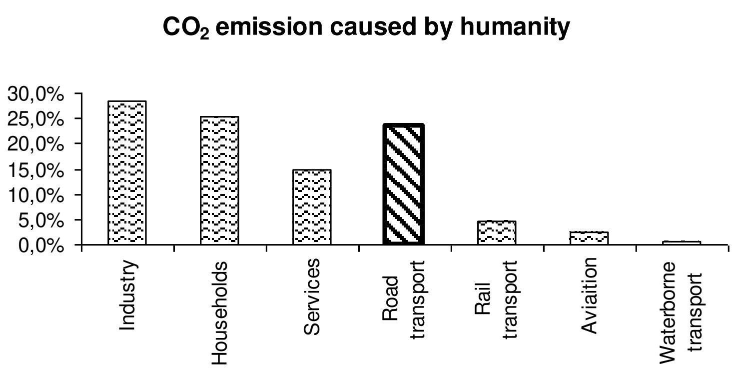

Figure 2. Transportation on the road contributes to climate change [16]

There is a common, social will to protect the Earth and the environment and at the same time the connection is strong between the environment and the supply chains as these affect the environment by emitting pollutants and greenhouse gases, but the environment also influences supply chains through the climate change. From this point of view supply chains have to play a major role in fulfilling the challenge presented by the environment, the society and the economy.

2. Supply chain management

Supply Chain Management includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer. Supply chain management has emerged as the term defining the integration of all these activities into a seamless process. Supply Chain is the interrelated collection of processes and associated resources that starts with the acquirement of raw material and extends to the delivery of end items to the customer. It includes suppliers, manufacturers, logistics service providers, warehouses, distributors, wholesalers and all other entities that lead up to delivery to the final customer. In more advanced operations it may extend to the customer of the immediate customer. A supply chain is the system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer (Figure 3.) [1].

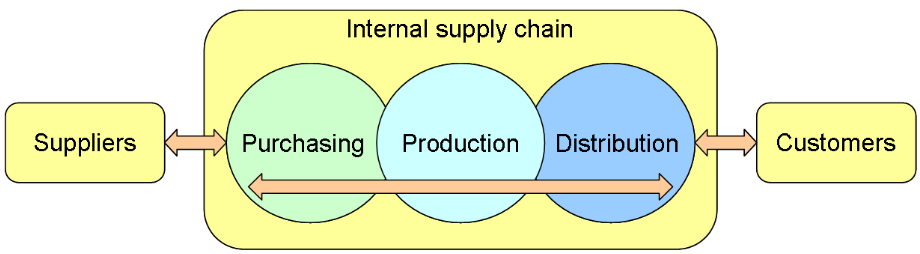

Figure 3. An illustration of a company's supply chain; the arrows stand for supplier-relationship management, internal SCM and customer-relationship management [2]

In the 1980s, the term Supply Chain Management (SCM) was developed to express the need to integrate the key business processes, from end user through original suppliers, original suppliers being those that provide products, services and information that add value for customers and other stakeholders. The basic idea behind the SCM is that companies and corporations involve themselves in a supply chain by exchanging information regarding market fluctuations and production capabilities. If all relevant information is accessible to any relevant company, every company in the supply chain has the possibility to and can seek to help optimizing the entire supply chain rather than suboptimize based on a local interest. This will lead to better planned overall production and distribution which can cut costs and give a more attractive final product leading to better sales and better overall results for the companies involved. Incorporating SCM successfully leads to a new kind of competition on the global market where competition is no longer of the company versus company form but rather takes on a supply chain versus supply chain form. The primary objective of supply chain management is to fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory and labor. In theory, a supply chain seeks to match demand with supply and do so with the minimal inventory. Various aspects of optimizing the supply chain include liaising with suppliers to eliminate bottlenecks; sourcing strategically to strike a balance between lowest material cost and transportation, implementing JIT (Just In Time) techniques to optimize manufacturing flow; maintaining the right mix and location of factories and warehouses to serve customer markets, and using location/allocation, vehicle routing analysis, dynamic programming and, of course, traditional logistics optimization to maximize the efficiency of the distribution side.

3. Importance of GSCM

As in any emerging research area, the early literature focuses on the necessity and importance of GSCM, defines the meaning and scope of various terms and suggests approaches to explore the area further. Fundamentals of greening as a competitive initiative are explained in [3], [4]. Their basic reasoning is that investments in greening can be resource saving, waste eliminating and productivity improving. Three approaches in GSCM, namely reactive, proactive and value-seeking, are suggested [5], [6]. In the reactive approach, companies commit minimal resources to environmental management, start labelling products that are recyclable and use ‘end of pipeline’ initiatives to lower the environmental impact of production. In the proactive approach, they start to pre-empt new environmental laws by realizing a modest resource commitment to initiate the recycling of products and designing green products. In the value-seeking approach, companies integrate environmental activities such as green purchasing and ISO implementation as strategic initiatives into their business strategy. The perspective then changes from greening as a burden to greening as a potential source of competitive advantage [6]. Owen [7] and Sarkis [8] discuss environmentally conscious manufacturing. Friedman [9], Guide and Wassenhove [10] and Gupta [11] discuss the changing role of the environmental manager. Interactions among various stakeholders on integrated GSCM and advantages that may accrue to them have been described by Gungor and Gupta [12]. At the end of the 1990s, integrating these issues into the mainstream was identified as the future research agenda [13]. In a study linking GSCM elements and performance measurement, Beamon [14] advocates for the establishment and implementation of new performance measurement systems. He suggests that the traditional performance measurement structure of the supply chain must be extended to include mechanisms for product recovery (RL).

In today's business world, the competition among companies is very high. To impress customers the company needs to distinguish itself from others. Being environmentally friendly is one way to make a difference. Besides, when competitors have already adopted GSCM, this puts an extra pressure on the given company. Therefore it is adviseable to implement GSCM independently of whether the competitors have already adopted it or not.

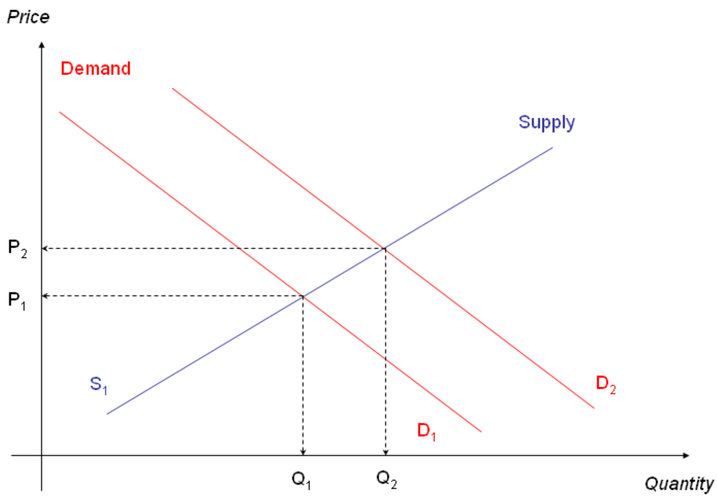

Figure 4. Change of the demand curve [17]

Not only competitors, but customers also play a role in the company's decision to adopt the GSCM. In many cases it was the customers who required special treatment or special products. Consequently the company needed to make changes to satisfy them and keep them as customers [15]. Practical uses of supply and demand analysis are often centred on the different variables that change equilibrium price and quantity, represented as shifts in the respective curves (Figure 4). Comparative statics of such a shift traces the effects from the initial equilibrium to the new equilibrium. In our case the company that uses GSCM can have a gain on market compared to other companies.

That means that we had a wanted right-ward shift in demand that increases both equilibrium price and quantity. When consumers increase the quantity demanded at a given price, it is referred to as an increase in demand. At each price point, a greater quantity is demanded, which can be depicted as a move from the initial curve D1 to the new curve D2. In the diagram, this raises the equilibrium price from P1 to the higher P2. Mathematically the demand function can be described as:

$$x_t = a \cdot p_t + \alpha \text{, as demand function} \quad (1)$$

In the example above, there has been an increase in demand which has caused an increase in (equilibrium) price. At each point, a greater amount is demanded (when there is a shift from D1 to D2). Mathematically the supply function can be described as

$$y_t = \beta + b \cdot p_{t-1} \text{, as supply function} \tag{2}$$

It is well known that market equilibrium is when demand xt and supply yt are equal. For every time period t there is an equilibrium that can be described with

$$\begin{aligned} a \cdot p_t + \alpha &= b \cdot p_{t-1} + \beta \\ a \cdot p_t &= b \cdot p_{t-1} + (\beta - \alpha) \end{aligned} \tag{3}$$

Where:

$x_t = a \cdot p_t + \alpha$, as demand function

$y_t = b \cdot p_{t-1} + \beta$, as supply function

pt: price in time t

We reach the market equilibrium when p_t=p_{t-1}. Therefore, we get

$$\hat{p} = \frac{\beta - \alpha}{a - b} \tag{4}$$

and the actual price differs from the market equilibrium price by

$$\tilde{p} = p_t - \hat{p} = p_t - \frac{\beta - \alpha}{a - b} \tag{5}$$

Now the market equilibrium can be described as:

$$\begin{aligned} a \cdot \tilde{p}_t &= b \cdot \tilde{p}_{t-1} \\ \tilde{p}_t &= \frac{b}{a} \cdot \tilde{p}_{t-1} \end{aligned} \tag{6}$$

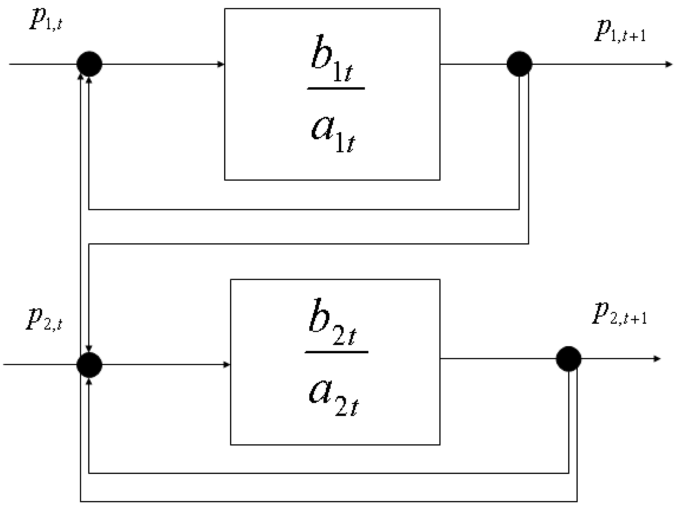

Figure 5. Cybernetic model of market equilibrium with two concurring companies [17]

Logistics are estimated to account for 10-15% of the final cost of finished products and businesses are increasingly seeking to cut costs by reducing fuel consumption and time spent in queues. That is why the greening of logistics has not only an environmental dimension for companies, but is also a question of efficiency. The worldwide demand for Green Solutions increases the demand for GSCM. It will increase the price of products from P1 to P2 for those firms which invest in it.

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Fuzzy Modeling for Service Strategy and Operational Control of Loading Systems

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Abstract: Requirements, such as adaptive behavior, learning ability and self regulative features, that have to be met by modern logistic systems, need the construction of such control systems that are able to control the basic processes and also to develop and improve the material and information system by automating the control processes. For controlling the logistical systems focusing on loading systems the papers propose the application of LPV structure by which non-linear systems can be controlled on the basis of linear control theories. The proposal points out that the priorities of different states are of great importance when generating the logical rules of operation. For resolving the difficulties of constructing mathematical algorithms fuzzy sets are suggested, so in the control model a Takagi-Sugeno solution is proposed, that can describe multi-input multi-output, non-linear, dynamic systems like logistical systems.

Keywords: Takagi-Sugeno controller, loading system, fuzzy modeling, adaptive behavior

1. Introduction

For designing control systems of complex logistical processes the service strategy and operational algorithm of given system must be known. Service strategy is the set of procedures, rules that determine the direction, feature and measure of state transformation the system and its sub-systems for all possible situations and conditions. Since constructing operational algorithms for large scale logistic systems is of great difficulties we focus our research to the loading system which is one of the subsystems of logistic system.

There are many different design point of views for service strategies and operational algorithms of general stochastic demand and adaptive material handling systems , and the way of descriptions can be differ as well. The deployment of processes to operational elements, the interpretation of states and their transition are partly subjective. They depend on the features of actual system and the approaches of designers as well. Determination, description and representation of service strategy mean determination of states, specification and interpretation of transitions and definition of rules regarding the assignment of states and transitions. [13]

Many methods have been proposed to deal with multi-input, multi output systems, like logistics system by the literature. This paper describes a fuzzy modelling approach. For controlling the logistical systems focusing on loading systems we propose the application of LPV structure by which non-linear systems can be controlled on the basis of linear control theories. The proposal points out that the priorities of different states are of great importance when generating the logical rules of operation. For resolving the difficulties of constructing mathematical algorithms fuzzy sets are suggested, so in the control model a Takagi-Sugeno solution is recommended.

2. Strategy for loading systems

2.1. Elementary strategy for loading systems with adaptive behavior

In the case of stochastic loading systems linking two stochastic processes (such as inbound transportation - outbound transportation, transportation – internal material handling) is causeless to suppose the independency of onset and service, especially the system contains intermittent-duty, mobil, materiel handling machines. On that grounds developed models (eg. queuing models) are suitable for only approximate disquisitions. At the most part of loading systems the demand process has an effect on the service process, controls it, accelerates or slows down the executive process. (Fig. 1.)

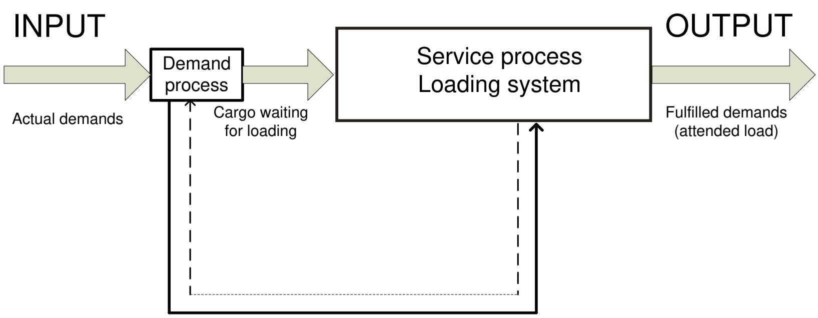

Figure 1. Scheme of relationship for demand and service processes

Those loading systems, in which the input influences the systems operational processes, are called loading systems with adaptive behavior.

The adaptivity can be shown in changing of

- service intensity (spontaneous adaptivity);
- number of elements being in the system (homotroph adaptivity);
- function of elements creating the system (heterotroph adaptivity);

or in any kind of combination of previous criterions [12].

The demand process can affect the service process through the arrival (eg. coming wagons, trucks, load-units) or changing the volume of queuing (eg. queuing wagons, trucks, load units). In practice the relationship between queuing and service occurs almost exclusively, arrival has an effect on service, if the system is refusal, which means: there are no room for waiting units.

Let be $x(t)$ the representative (differing only a bit from the expectation of value) realization of $\xi(t)$ stochastic demand process, $y(t)$ the representative realization of $\eta(t)$ stochastic service process, and C the capacity of loading system (maximum number of load units served by the loading system during a period of time).

In the systems behavior the next serving states can be distinguishable in function of time (Fig. 2.):

1. state: $x(t) > C$ and $y(t) < C$
2. state: $x(t) > C$ and $y(t) = C$
3. state: $x(t) \leq C$ and $y(t) = C$
4. state: $x(t) \leq C$ and $y(t) < C$.

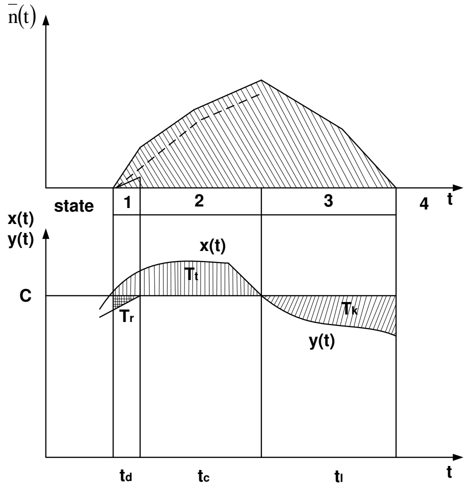

Figure 2. Scheme for demonstrating the temporal conformation of demand and service processes [12]

2.2. For the above mentioned states the strategic rules are the followings:

2.2.1. Strategy of the 1. state:

The system should endeavor to work on the capacity level as soon as possible if the demand process exceeds the capacity level. The system could complete the rules of service strategy with a delay of t_d duration because of the system's inflexibility. (Fig. 2.)

The darkest area in Fig. 2. demonstrates the demand numbers waiting because of the system's inflexibility. Function y(t), the realisation of service process as a stochastic process, is performed pushed left with the average service time. Characteristics of process realisations are denoted with continuous line.

2.2.2. Strategy of the 2. state:

The system should work on capacity level. The vertically striped area represents the demand numbers waiting because of overcharging.

2.2.3. Strategy of the 3. state:

The system should work on capacity level after the overcharged phase until satisfaction of waiting demands because of overcharging.

$$T_k \cong T_r + T_t \tag{1}$$

The upper part of Fig. 2. introduces the average numbers of waiting demands for states 1., 2. and 3., the creating and dissambly of waiting queues.

2.2.4. Strategy of the 4. state:

The system should endeavor to work flexibly under the capacity level after satisfaction of demands because of overcharging.

2.3. Description of service strategy for loading systems

The loading system and its sub-system go through state transition during the operation, since the external factors (type of vehicles and goods) and internal elements (such as material handling machinery, facilities) affects each others and induces a series of state transitions.

In our case the state is qualitative feature of a given process, an actual status, cross-section of complex loading process in time (e.g. the status of transport vehicle can be being loaded or waiting, status of handling machinery can be operable or out of order etc.). The transition parameters are qualitative features and logical variables of complex loading processes (e.g. priorities of loading, demand for loading capacity, maintenance time of machinery etc.)

In the framework of strategy the interactions between individual elements are not distinguished so machinery and facilities are not individualized only homogenous sets of machines and goods are considered. Thus service strategy can be generally determined and less vulnerable for changes than the operational algorithm. The description of operational algorithm of given actual system is more detailed than the above mentioned strategy. In the operational algorithm we distinguish and analyze the individual machinery and facilities, goods, vehicles, and states, state transitions by describing them quantitatively. The two objects, the service strategy and the operational algorithm have close connection to each other, so in the terminology we can use them in interrelation, that is service strategy is an overall, draft operational algorithm and the operational algorithm is a detailed service strategy.

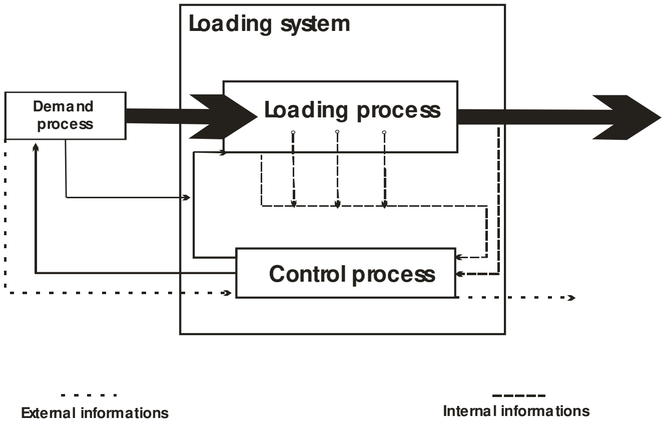

Figure 3. Extended structure model of general stochastic demand and adaptive material handling systems [13]

Fig. 4. demonstrates the schematized model of technical and technological process by complex loading systems. There are *n* type of goods loaded, unloaded and temporary stored in the analyzed system. The states of processes running in the system are shown as circles and rectangles, the transitions are directional arrows. External priority means the loading sequence based on the precedence information of goods on transportation vehicle arriving from outside the system [13].

2.3.1. Input

LI – Symbol for **loaded** transportation vehicle arriving occasionally. Parameters that have to be considered: arrival time, type of transported goods, quantity of arriving goods, demand of loading and dates of external priority. This information follows the transportation vehicle through the subsystem.

EI – Symbol for **empty** transportation vehicle. Parameters are the same as in the previous case.

2.3.2. Loading processes

WU – Symbol for transportation vehicle **waiting for unloading** ordered by preset priorities or by arriving sequence.

WL - Symbol for transportation vehicle **waiting for loading** ordered by preset priorities or by arriving sequence.

TS – Symbol for **temporary storing** or warehouse. The warehouse is divided into **n** parts for each type of goods to be stored. Parameters that have to be considered: coordinates, capacity and load of storing parts and possibility of conversion (exchange) between storing units.

SIU – Symbol for **interrupted state** of unloading because of failure of loading machine ordered to transportation vehicle (there is not free loading machine capacity) or appearing of loading demand in excess of critical priority (not enough loading machine capacity)

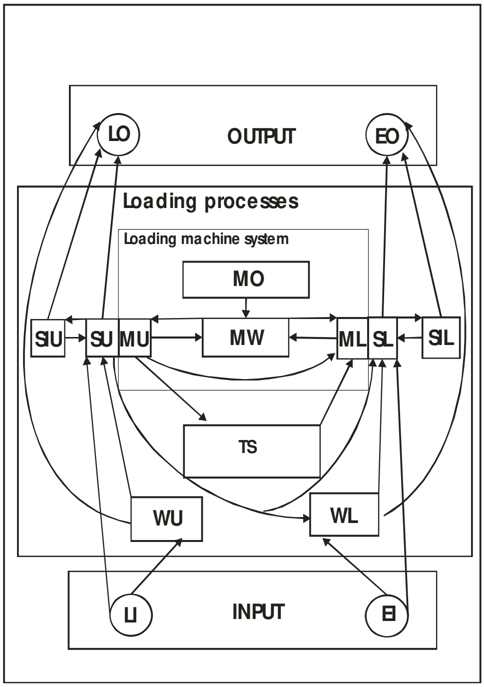

Figure 4. Subsystem realizing the basic process of a loading system

SU - Symbol for **state of unloading.** Transportation vehicle and loading machine are ordered together by type of transportation vehicle and transported goods. Parameters of loading are loading time and destination.

MU - Symbol for **unloading machine.**

MW - Symbol for **working loading machine** waiting for loading. Parameters that have to be considered: value of work capacity demanding on type of goods and transportation vehicle, kinetic characteristics.

ML - Symbol for **loading machine.**

SL - Symbol for **state of loading.**

SIL - Symbol for **interrupted state of loading**.

MO - Symbol for loading **machine out of work.**

2.3.3. Output

LO - Symbol for transportation vehicle leaving **loaded.** Parameters that have to be considered: leaving time, quantity of transported goods, type of transportation vehicle.

EO - Symbol for transportation vehicle leaving **empty.** Parameters that have to be considered: leaving time, type of transportation vehicle.

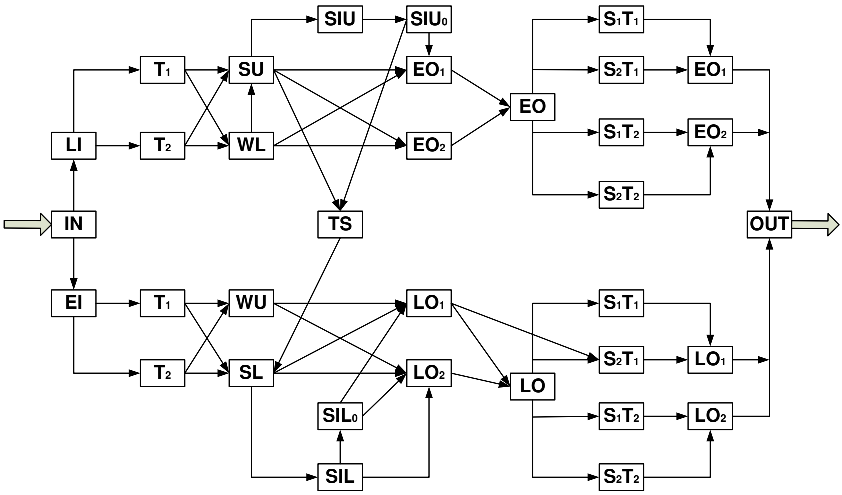

Figure 5. Graph of a loading system

3. Examples for multi input - multi output (MIMO) logistic system

3.1. The Port of Hamburg

The Port of Hamburg as one of the most important cargo handling sites in worldwide shipping is a suitable example for multi input multi output large scale logistic system. Logistical services must ensure that at any point along the transport chain the necessary goods are available in the right quantities, in the right place and at the right time. The port has capacities for forwarding the goods by feeder, ship, truck, rail and barge and also arrange the warehousing, the commissioning on behalf of foreign exporters. The same applies to exports from inland regions, i.e. for collecting, for interim storage and finally shipment to overseas destinations.

The in- and outflow of goods over longer distances is mainly affected with the environmentally friendly transport medium rail. Round 160 international and national container trains run per day from and to the port. It is not only containers but also project shipments, tubes, fruit, liquid cargoes (in tank wagons), ores, coal, grain, sugar and much more that are shipped by rail. Apart from the combined traffic terminals at the container terminals Hamburg can boast a handling station for combined freight traffic.

Although around 96 percent of Hamburg 's total general cargo turnover is now containerised the remaining quantities of "conventional cargo" are still of great significance to the port. This term includes crates and bags, wheeled cargo, heavy goods and bulk goods such as steel pipes etc. The port has specialist terminals for the conventional handling of vehicles, fruits/vegetables, paper/cardboard, cellulose, scrap, fertilizers, sugar, coffee and cocoa in sacks.

In many shipping regions Ro-Ro traffic plays an important role. Apart from pure car transport vessels very often con-ro ships are also used. These transport containers on deck while inside the ship itself cargoes are stowed that can be driven on board on their own wheels. These can be all types of vehicles and goods packed on trailers. The Hamburg port facilities are equipped with quay indentations or ro-ro ramps for the loading of these special ships.

As it has been turned out from this review, controlling such a difficult logistic system requires many kind of inputs in large quantities, for example type of transportation vehicle, of transported goods and of loading machine have to be ordered to the transportation vehicle, arriving time, priority. Situation is more complicated because of presence of combined traffic and each transport sector (rail, road, air and water).

3.2. Cross-docking depot at Wal-Mart Stores Inc, Home Depot, Tesco and Metro AG.

An other simple example for MIMO systems are the cross-docking depots. Cross-docking means unloading goods from a railcar, ship, or trailer, and quickly reloading the same goods in a similar or alternative source of transportation with little or no storage in between. It eliminates the need for warehousing and typically takes place at a transportation hub where goods are unloaded, sorted, and reloaded. Cross-docking may be done to change type of conveyance, to sort material intended for different destinations, or to combine material from different origins into transport vehicles (or containers) with the same, or similar destination. Direct trans-shipment of products to stores on an on-demand basis, (instead of delivery from stock) gets products to customers faster, and eliminates warehouse stock costs, material handling and personnel time.

The floor area of the depo is divided into a break up area and a build up area, where sorting and consolidation of consignment takes place, respectively. Customer order types can vary as well as the techniques for fulfilling them. The two main techniques for fulfilling orders are either through manual order picking operatives or automated order dispensers or on some occasions by both. A Cross-docking distribution centre system can exhibit some unpredictability in its behaviour which can influence its overall performance. For example, manual order picking operators can have different skill levels and familiarity with picking certain types of orders, while automated order picking machines failure are sometimes random occurrences. These arbitrary events amongst others can influence the overall volume of orders fulfilled through the Cross-docking distribution centre.

The center has two types of doors, receiving doors and shipping doors. The assignment of destinations to shipping doors, clustering of destinations to form groups, and determination of the number of groups are major operation problems directly related with the performance of the center.

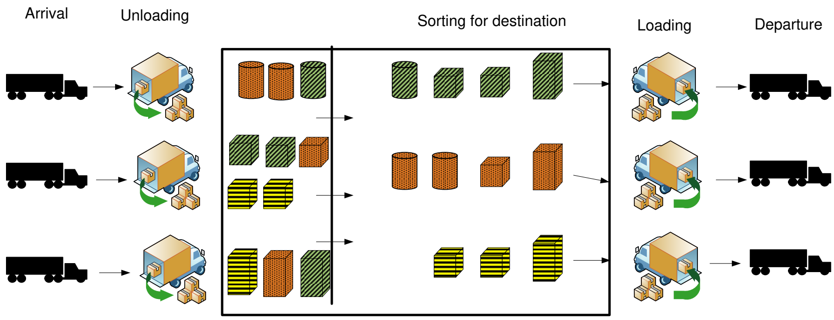

Figure 6. Scheme for cross-docking depots

4. Fuzzy modelling

The fuzzy sets based approach is suitable for describing (very) complex systems which cannot be modelled analytically. By fuzzy sets, operations and rules, inference systems may be created which imitate in some sense the ways of everyday human thinking. Such systems are referred to in the literature as fuzzy systems [9]. Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made, or patterns discerned. Two types of fuzzy inference systems can be implemented: Mamdani-type and Sugeno-type (Takagi.Sugeno). These two types of inference systems vary somewhat in the way outputs are determined.

„Because it is a more compact and computationally efficient representation than a Mamdani system, the Sugeno system lends itself to the use of adaptive techniques for constructing fuzzy models. These adaptive techniques can be used to customize the membership functions so that the fuzzy system best models the data." [16]

Comparison of Sugeno and Mamdani method

Advantages of the Sugeno Method:

- computationally efficient
- works well with linear techniques
- works well with optimization and adaptive techniques
- guarantees continuity of the output surface
- well suited to mathematical analysis

Advantages of the Mamdani Method:

- intuitive
- has widespread acceptance
- well suited to human input.

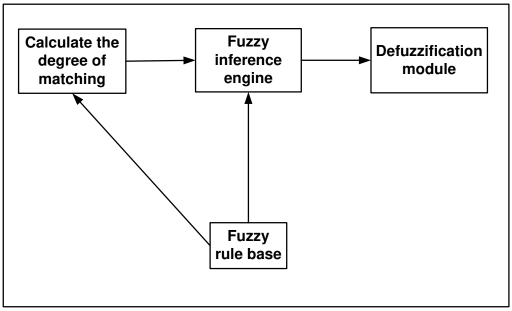

Figure 7. Structure of a typical fuzzy system [9]

4.1. Takagi-Sugeno(TS) fuzzy model

Takagi-Sugeno fuzzy models are suitable models for large class of nonlinear systems. In this section we give a brief review on the fundamental form of TS fuzzy models. A TS model consists a number of local linear models assigned to fuzzy regions, which are designed to approximate the dynamic features at the corresponding operating fuzzy points in vector space P. Fig. 5. shows the structure of a TS fuzzy model. The model varies according to vector $p \in \Re^N$, which may contain some values of the state vector x as well. The TS fuzzy inference engine is responsible for combining the local linear models according to vector p in order to find a proper model, which is assumed to be the momentary linear descriptor of the system capable of generating output vector y from state vector x and input vector u. A discrete time model varying on the parameter p:

$$\begin{aligned} x(k+1) &= \Phi(p)x(k) + \Gamma(p)u(k) \\ y(k) &= C(p)x(k) + D(p)u(k) \end{aligned} \tag{2}$$

Suppose that its system matrix

$$S(p) = \begin{pmatrix} \Phi(p)\Gamma(p) \\ C(p)D(p) \end{pmatrix} \tag{3}$$

is a parametrically varying object, which can be written as a convex combination of the system matrices $S_1,...,S_N$. It means that for any $p \in \Re$ there exist coefficients $\mu_j(p) \in \Re$, $0 \le \mu_j(p) \le 1$ and $\sum_j \mu_j(p) = 1$, such that

$$S(p) = \sum_{j=1}^{V} \mu_j(p) S_j \tag{4}$$

where system matrices S_j are constans. Consequently, the original system is approximated by a convex combination of a number of local linear models assigned to regions defined by basis functions $\mu_j(p)$. In case of TS model approximations coefficients $\mu_j(p)$ are computed as the firing probability of the fuzzy rules, which based on the product operator t-norm.

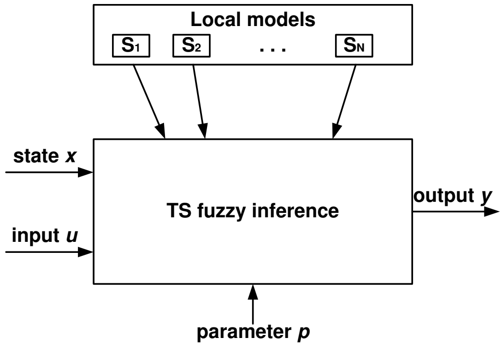

Figure 7. Scheme of the Takagi-Sugeno fuzzy inference model

4.1.1. Uncompleted TS Fuzzy Model

Assume $n-$varieble model consequent-based fuzzy rules as follows:

IF p_1 is $A_{1,i}$ AND . . . AND p_N is $A_{N.i}$ THEN model S_i

Here $A_{j,i} : \mu_{A_{j,i}}(p_j)$ is the $i-$th antecedent fuzzy set on the $j-$th input universe. The output of a rule is:

$$\hat{S}_i = S_i \prod_{j=1}^{N} \mu_{A_{j,i}}(p_j) \tag{5}$$

The approximated model is:

$$\hat{S}(p) = \frac{\sum_{i=1}^{V} \hat{S}_i}{\sum_{i=1}^{V} \prod_{j=1}^{N} \mu_{A_{j,i}}(p_j)} = \frac{\sum_{i=1}^{V} \prod_{j=1}^{N} \mu_{A_{j,i}}(p_j) S_i}{\sum_{i=1}^{V} \prod_{j=1}^{N} \mu_{A_{j,i}}(p_j)} \tag{6}$$

Usually the antecedent sets are given in Ruspini-partition, so for every $j : \sum_i \mu_{A_{j,i}}(p_j) = 1$. This implies that the denominator is equal to 1, so this can be taken out of consideration.

4.1.2. Completed TS Fuzzy Model

The completed fuzzy rules are formed by all combination of the antecedent sets. So a typical rule is:

IF p_1 is A_{1,i_1} AND . . . AND p_N is $A_{N.i_N}$ THEN model $S_{i_1 i_2 \ldots i_N}$

The range of indeces $i_n = 1 \ldots V_n$ where V_n denotes the number of antecedent sets in the $n-$th universe. The output of a rule is:

$$\hat{S}_{i_1, i_2, \ldots, i_N} = S_{i_1 i_2 \ldots i_N} \prod_{j=1}^{N} \mu_{A_{j,i_j}}(p_j) \tag{7}$$

The final conclusion is the weighted sum of the outputs:

$$\hat{S}(p) = \frac{\sum_{i_1=1}^{V_1} \cdots \sum_{i_N=1}^{V_N} \hat{S}_{i_1, i_2, \ldots, i_N}}{\sum_{i_1=1}^{V_1} \cdots \sum_{i_N=1}^{V_N} \prod_{j=1}^{N} \mu_{A_{j,i_j}}(p_j)} = \frac{\sum_{i_1=1}^{V_1} \cdots \sum_{i_N=1}^{V_N} \prod_{j=1}^{N} \mu_{A_{j,i_j}}(p_j) S_{i_1, i_2, \ldots, i_N}}{\sum_{i_1=1}^{V_1} \cdots \sum_{i_N=1}^{V_N} \prod_{j=1}^{N} \mu_{A_{j,i_j}}(p_j)} \tag{8}$$

If the antecedents sets are in Ruspini partition then

$$\sum_{i_1=1}^{V_1} \cdots \sum_{i_N=1}^{V_N} \prod_{j=1}^{N} \mu_{A_{j,i_j}}(p_j) = 1 \tag{9}$$

so the approximated model is

$$\hat{S}(p) = \sum_{i_1=1}^{V_1} \cdots \sum_{i_N=1}^{V_N} \prod_{j=1}^{N} \mu_{A_{j,i_j}}(p_j) S_{i_1, i_2, \ldots, i_N} \tag{10}$$

4.2. The Mamdani Method

The Mamdani method is the most commonly used one in practical applications [10]. The inference engine may be viewed as a special kind of generalised function generator as it maps the set of all possible input fuzzy sets into the set of all possible fuzzy outputs. The output is converted to a so-called “crisp” value by the defuzzification module. At the beginning of the inference the degree of matching between the observation and the rules is determined. Each component of the observation vector is compared to the same component of the antecedent of each rule. Let A^* be the *n*-dimensional observation vector. The degree of matching (firing) in the j^{th} dimension in the i^{th} rule can computed as:

$$w_{j,i} = \max\{\min\{A_j^*(x_j), A_{j,i}(x_j)\}\} \tag{11}$$

where $A_{j,i}$ is the membership function of the i^{th} rule in the j^{th} dimension. If the observation is a crisp vector then the above calculation is simpler: in case of state vector x^*, the degree of matching in the j^{th} dimension is:

$$w_{j,i} = A_{j,i}\left(x_j^*\right) \tag{12}$$

After the degree of matching was calculated in each dimension, the resultant for the whole antecedent is determined. The degree of applicability of a rule is affected by the degree of matching of its each dimension. Thus, the firing degree of the i^{th} rule can be computed by taking the minimum value of the degrees of matching of the rule's antecedents:

$$w_i = \min_{j=1}^{n} w_{j,i} \tag{13}$$

w_i shows that how important the role of rule R_i will be in the calculation of the conclusion for observation A^*. After the degree of firing was determined for each rule, each conclusion is separately calculated. This can be made by cutting the consequent fuzzy set of the rule at height w_i:

$$B_i^* = \min\left(w_i, B_i(y)\right). \tag{14}$$

The conclusion for the whole rule base can be computed by taking the union of the previously calculated sub-conclusions:

$$B^*(y) = \max_{i=1}^{r} B_i^*(y). \tag{15}$$

After the inference a $B^*(y)$ conclusion fuzzy set was obtained. However, in most cases, the expected conclusion is not a fuzzy set, but crisp value. Hence, the crisp value needs to be determined, wich describes the conclusion fuzzy set int he best way. This called defuzzification.[9]

4.3. Mixed method

For further research we decided to build a mixed (hybrid) method for resolving some problematics of control on loading systems. Because of different outputs of fuzzy methods this mixed method will use the Mamdani Method for resolving the inventory planning and control, as well as the Takagi-Sugeno Method for resolving the control of service strategy of loading systems. The next section entertains a proposal for introduction of service strategy using TS fuzzy modeling, which needs to be extended in the future. We also plan to match the next model with the Mamdani Method providing a complex solution for loading systems.

It is also worth considering, how can it be possible to get a fast solution to serve the loading and transportation tasks. When requiring inputs in such a great numbers as in our case, it is difficult to serve both quality characteristics of a control system: fastness and finding the optimal solution. It may be decided for the fast solution by description of operational algorithm, because a fast control system providing satisfying solution can be more effective then a slow one searching for the optimal solution.

5. Fuzzy modelling of a loading system based on TS method

5.1. Priorities and fuzzy sets

In serving systems, such as a loading system, one of the most important question is determining the order of importance between different demands. There are may be some exact, well-measurable features for ordering, but there are always uncertain, non well-defined features, for instance ”important”, ”perishable”, etc. Because of this uncertain information it is a difficult task to establish ordering between priority levels assigned to different kind of goods and transportation vehicles. In general, the priority level arises from different terms, for example:

$$P(t) = P_v + P_g + a(t)\frac{c_{req}}{c_{req} - c(t)} + b(t)\frac{n - n_{min}}{n_{max} - n} + c(t)t_w \tag{16}$$

where c_{req} is the required quantity of goods, $c(t)$ is the loaded quantity , n is the number of loading machines working with the vehicle, n_{min} is the minimal number of required loading machines, n_{max} is the maximal number of loading machines that could work with the vehicle, t_w is the waiting time, $a(t)$, $b(t)$ and $c(t)$ are proportionality terms, P_v and P_g are the priorities assigned to the transportation vehicles and to the goods, so the last two terms are usually not well-defined. As we seen, to every kind of goods and transportation vehicles can be ordered a priority value, which may be an uncertain measure. But these priority levels have exact meaning only if we compare them with the priority levels of goods and transportation facilities already being in the system, and with the priorities of the running processes in the system. For instance, perishable goods coming by a lorry handled in a different way if there is a loading in progress in the system and interrupting of the process or rearranging of the loading machines indicates too high cost, and in another way if there is enough available free loading capacity. So, priority values coming with the goods and the transportation vehicles are modified by the actual states of the system [7].

The duties in the system can be ordered using these modified priorities. Just a few example for modifier states: if a there is a load waiting for a long time , its priority level is increasing; if there is loading in progress, the priority level of the load is increasing; if a loading machine had worked a lot, priority level of its employment is decreasing. Priorities coming with goods and transportation vehicles, and priorities from the states of the system are usually uncertain, not crisp properties, so it seems reasonable to handle as fuzzy sets.

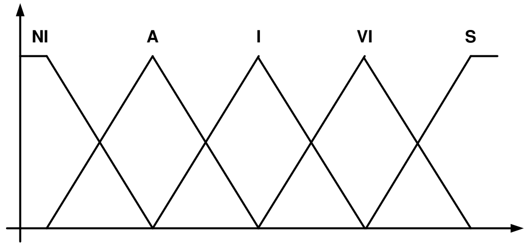

Figure 6. An example for fuzzy priority levels

In Fig. 4., there are some possible fuzzy sets for different priority levels, such as not important (NI), average (A), important (I), very important (VI) and super important (S).

5.2. Model description

As we mentioned in section 5, the model is essentially determined by the states of the system (state vector x) and the quantities, qualities and priorities of the incoming goods and transportation facilities (input vector u). The elements of the state vector x could be the following [7]:

- Number of incoming loaded and empty transportation vehicles (LI,EI)
- Number of available loading machines (separeted with respect to loading and unloading, kind of goods and type of transportation facilities) (MU,ML)
- Number of loading and unloading processes in progress (SL, SU)
- Number of waiting transportation vehicles in the system and their priority values (WL,WU, Pv)
- Quantity of waiting goods in the system and their priority values (Wg, Pg)
- Quantity of available goods for loading (C)
- Available storage capacity (TS)

Various states of the system (it means different values in the parameter vector p) indicate various local models. These type of models could vary in long term and short term, for example in short term different shifts in a day indicate different models or in long term different models valid for the seasons. Few example for rules describing the system operations:

$$\text{IF}\left(\text{ML} = 0 \wedge \left(\text{P}_g \wedge \text{P}_v < \text{P}_{crit}\right)\right) \vee \left(\text{W}_g = 0 \wedge \text{SU} = 0\right) \text{ THEN EI} \rightarrow \text{WL}$$

$$\text{IF}\left(\text{MU} = 0 \wedge \left(\text{P}_g \wedge \text{P}_v < \text{P}_{crit}\right)\right) \vee \text{W}_g > \text{TS} \text{ THEN LI} \rightarrow \text{WU}$$

$$\text{IF}\left(\text{W}_g < \text{TS}\right) \wedge \left(\text{MU} \neq 0\right) \text{ THEN LI} \rightarrow \text{SU}$$

$$\text{IF } \text{MU} \neq 0 \vee \text{P}(\text{SU}) > \text{P}_{crit} \text{ THEN SIU} \rightarrow \text{SU}$$

$$\text{IF } \text{ML} \neq 0 \vee \text{P}(\text{SL}) > \text{P}_{crit} \text{ THEN SIL} \rightarrow \text{SL}$$

$$\text{IF } \mathrm{WL} \neq 0 \wedge \mathrm{SL} \neq 0 \wedge \mathrm{P}(\mathrm{SL}) > \mathrm{P}_{\mathrm{crit}} \text{ THEN MU} \rightarrow \mathrm{ML}$$

The complex entirety of these type of rules describe the behaviour of the whole system. To each micro-system (for example a day) of the global system assigned to the same model with different parameter values. In such a way, if a long term behaviour of the system (season) is approximated with an LPV model S, then the short term behaviour of this system is approximated with the same model changing the parameter values.

6. Conclusion

At the most part of loading systems the demand process has an effect on the service process, controls it, accelerates or slows down the executive process. The loading system and its sub-system go through state transition during the operation, since the external factors (type of vehicles and goods) and internal elements (such as material handling machinery, facilities) affects each others and induces a series of state transitions. Description of operational algorithm needs proper handling of priorities and composition of rules in relative small numbers to achieve the optimal function in the case of multi input multi output logistic system.

This study provides a fuzzy modelling approach for resolving the difficulties of constructing mathematical algorithms for loading system. The fuzzy sets based method is suitable for describing (very) complex systems which cannot be modelled analytically. In the control model a Takagi-Sugeno solution is proposed.

For further research our conception is to build a mixed (hybrid) method which contains the Mamdani Method for resolving the inventory planning and control, as well as the Takagi-Sugeno Method for resolving the control of service strategy of loading systems.

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Change Management for the Greening of Supply Chains

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Abstract: Green Supply Chain Management (GSCM) can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance or energy utilization efficiency. The primary areas of emphasis have been quality, operations strategy, supply-chain management, product and process technologies, which are collectively beginning to contribute to a more systematic knowledge base. It is reasonable to expect that these research areas will continue to hold the greatest promise for advance in the short term. However, more integrative contributions are needed in the longer term, including intra- and inter-firm diffusion of best practices, green technology transfer and environmental performance measurement. One of the biggest challenges facing the field of GSCM is extending the historical 'common wisdom' about managing operations. Much research, management education and many practical applications have focused on buffering the operations function from external influences, including the natural environment, in order to improve efficiencies, reduce cost and increase quality. When the natural environment is considered, it is typically recognized or modelled as an external constraint, requiring operations to work within prescribed limits. Our aim in this paper is to investigate how to use the tools of change management for the greening of supply chains.

Keywords: greening supply chains, change management

1. Introduction

There is a growing need for integrating environmentally sound choices into supply-chain management research and practice. Perusal of the literature shows that a broad frame of reference for green supply-chain management (GSCM) is not adequately developed. Regulatory bodies that formulate regulations to meet societal and ecological concerns to facilitate growth of business and economy also suffer from its absence. In early environmental management frameworks, operating managers were involved only at arm's length. Separate organizational units had responsibility for ensuring environmental excellence in product development, process design, operations, logistics, marketing, regulatory compliance and waste management. Today, this has changed. As in the quality revolution of the 1980s and the supply-chain revolution of the 1990s, it has become clear that the best practices call for integration of environmental management with ongoing operations. Green supply-chain management (GSCM) is gaining increasing interest among researchers and practitioners of operations and supply chain management. The growing importance of GSCM is driven mainly by the escalating deterioration of the environment, e.g. diminishing raw material resources, overflowing waste sites and increasing levels of pollution. However, it is not just about being environment friendly; it is about good business sense and higher profits. In fact, it is a business value driver and not a cost centre [1]. In addition, the regulatory requirements and consumer pressures are driving GSCM. Hence, the scope of GSCM ranges from reactive monitoring of the general environment management programmes to more proactive practices implemented through various Re-s (Reduce, Re-use, Rework, Refurbish, Reclaim, Recycle, Remanufacture, Reverse logistics, etc.). Sufficient literature exists about various aspects and facets of GSCM. Comprehensive reviews on green design [2], repairable inventory [3], [4], production planning and control for remanufacturing [3], [5]; [6]; [7] issues in green manufacturing and product recovery [8]; [9], reverse logistics (RL) [10]; [11] and logistics network design [12], [13], [14] have been published. In addition, Bloemhof-Ruwaard et al. [15] deal with interactions between operational research and environmental management, and Roy and Whelan [16] discuss recycling through value-chain collaboration. Much of the work is empirical and does not focus adequately on modelling and network design related issues and practices.

2. Green supply chain management

Green supply-chain management has its roots in both environment management and supply chain management literature. Adding the 'green' component to supply-chain management involves addressing the influence and relationships between supply-chain management and the natural environment. Similar to the concept of supply-chain management, the boundary of GSCM is dependent on the goal of the investigator. The definition and scope of GSCM in the literature has ranged from green purchasing to integrated green supply chains flowing from supplier to manufacturer to customer, and even RL [17]. For the purpose of this paper, GSCM is defined as 'integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life'. We specifically focus on RL and mathematical modelling aspects in order to facilitate further study and research. Green design has been used extensively in the literature to denote designing products with certain environmental considerations. It is the systematic consideration of design issues associated with environmental safety and health over the full product life cycle during new production and process development [18]. Its scope encompasses many disciplines, including environmental risk management, product safety, occupational health and safety, pollution prevention, resource conservation and waste management. Green operations relate to all aspects related to product manufacture/remanufacture, usage, handling, logistics and waste management once the design has been finalized. Green manufacturing aims to reduce the ecological burden by using appropriate material and technologies, while remanufacturing refers to an industrial process in which worn-out products are restored to like-new condition [19]. Rogers and Tibben-Lembke [20] define RL as 'the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal', while Maruglio [21] defines waste minimization as 'the reduction ... of hazardous waste which is generated (during production and operations) or subsequently treated, stored or disposed ...' (Figure 1.).

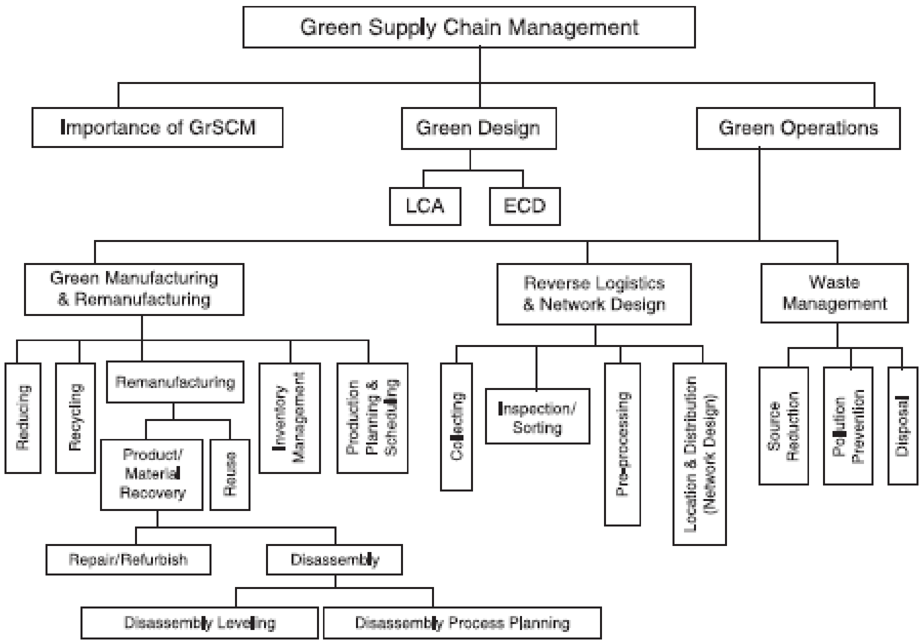

Figure 1. Classification based on problem context in supply chain design [25]

3. Tools of change management for the greening of supply chains

In the product lifecycle concept the cycle starts at the designing of the product. According to Srivastara [22], green design emphasizes both environmentally conscious design and life cycle assessment/analysis. In designing a product, the designing team can change the raw materials or substances used during the manufacturing to be less toxic, more environmental friendly. Change management is the process during which the changes of a system (SC to GSC) are implemented in a controlled manner by following a pre-defined framework/model with, to some extent, reasonable modifications. The Change Management process in Systems Engineering is the process of requesting, determining attainability, planning, implementing and evaluation of changes to a system. It has two main goals: supporting the processing of changes – which is mainly discussed here – and enabling traceability of changes, which should be possible through proper execution of the process described here [23].

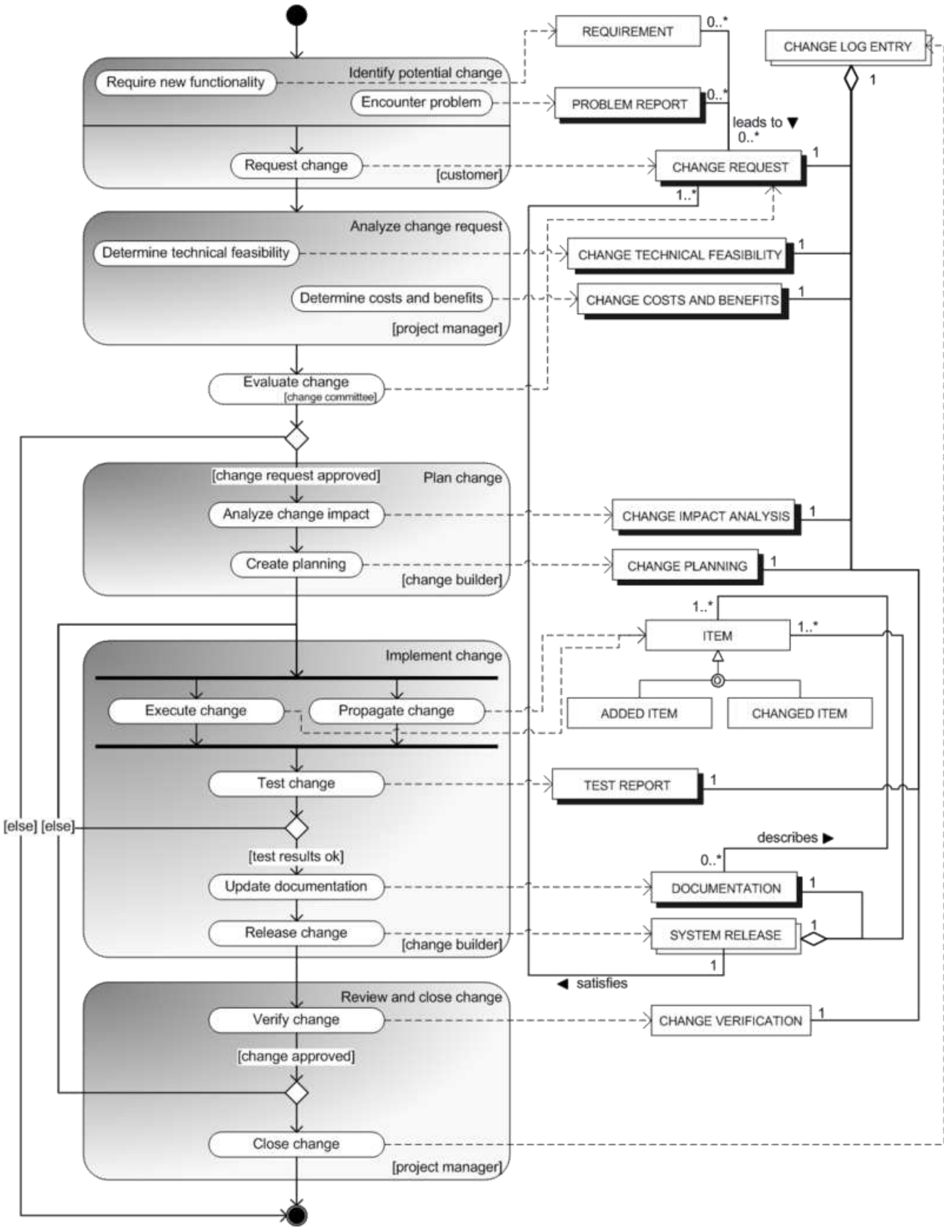

Figure 2. Process-data model for the process of change management [26]

Structural transformation has four characteristics: scale (the change affects all or most of the organization), magnitude (it involves significant alterations of the status quo), duration (it lasts for months, if not years), and strategic importance. Those who lead the transformation often say they are concerned about how the work force will react, how they can get their team to work together, and how they will be able to lead their people. They also worry about retaining their company's unique values and sense of identity and about creating a culture of commitment and performance. Leadership teams that fail to plan for the human side of change often find themselves wondering why their best-laid plans have gone awry. No single methodology fits every company, but there is a set of practices, tools, and techniques that can be adapted to a variety of situations. What follows is a "Top 10" list of guiding principles for change management adopted to GSCM. Using these as a systematic, comprehensive framework, executives can understand what to expect, how to manage their own personal change, and how to engage the entire organization in the process.

3.1. Address the "human side" systematically.

Any significant transformation creates "people issues." New leaders will be asked to step up, jobs will be changed, new skills and capabilities must be developed, and employees will be uncertain and resistant. Dealing with these issues on a reactive, case-by-case basis puts speed, morale, and results at risk. A formal approach for managing change — beginning with the leadership team and then engaging key stakeholders and leaders — should be developed early, and adapted often as change moves through the organization. This demands as much data collection and analysis, planning, and implementation discipline as does a redesign of strategy, systems, or processes. The change-management approach should be fully integrated into program design and decision making, both informing and enabling strategic direction. It should be based on a realistic assessment of the organization's history, readiness, and capacity to change.

3.2. Start at the top.

Because change is inherently unsettling for people at all levels of an organization, when it is on the horizon, all eyes will turn to the leadership team for strength, support, and direction. The leaders themselves must embrace the new approaches first, both to challenge and to motivate the rest of the institution. They must speak with one voice and model the desired behaviors. The executive team also needs to understand that, although its public face may be one of unity, it, too, is composed of individuals who are going through stressful times and need to be supported. Executive teams that work well together are best positioned for success. They are aligned and committed to the direction of change, understand the culture and behaviors the changes intend to introduce, and can model those changes themselves. At one large transportation company, the senior team rolled out an initiative to improve the efficiency and performance of its corporate and field staff before addressing change issues at the officer level. The initiative realized initial cost savings but stalled as employees began to question the leadership team's vision and commitment. Only after the leadership team went through the process of aligning and committing to the change initiative was the work force able to deliver downstream results.

3.3. Involve every layer.

As transformation programs progress from defining strategy and setting targets to design and implementation, they affect different levels of the organization. Change efforts must include plans for identifying leaders throughout the company and pushing responsibility for design and implementation down, so that change "cascades" through the organization. At each layer of the organization, the leaders who are identified and trained must be aligned to the company's vision, equipped to execute their specific mission, and motivated to make change happen. A major multiline insurer with consistently flat earnings decided to change performance and behavior in preparation for going public. The company followed this "cascading leadership" methodology, training and supporting teams at each stage. First, 10 officers set the strategy, vision, and targets. Next, more than 60 senior executives and managers designed the core of the change initiative. Then 500 leaders from the field drove implementation. The structure remained in place throughout the change program, which doubled the company's earnings far ahead of schedule. This approach is also a superb way for a company to identify its next generation of leadership.

3.4. Make the formal case.

Individuals are inherently rational and will question to what extent change is needed, whether the company is headed in the right direction, and whether they want to commit personally to making change happen. They will look to the leadership for answers. The articulation of a formal case for change and the creation of a written vision statement are invaluable opportunities to create or compel leadership-team alignment. Three steps should be followed in developing the case: First, confront reality and articulate a convincing need for change. Second, demonstrate faith that the company has a viable future and the leadership to get there. Finally, provide a road map to guide behavior and decision making. Leaders must then customize this message for various internal audiences, describing the pending change in terms that matter to the individuals. A consumer packaged-goods company experiencing years of steadily declining earnings determined that it needed to significantly restructure its operations — instituting, among other things, a 30 percent work force reduction — to remain competitive. In a series of offsite meetings, the executive team built a brutally honest business case that downsizing was the only way to keep the business viable, and drew on the company's proud heritage to craft a compelling vision to lead the company forward. By confronting reality and helping employees understand the necessity for change, leaders were able to motivate the organization to follow the new direction in the midst of the largest downsizing in the company's history. Instead of being shell-shocked and demoralized, those who stayed felt a renewed resolve to help the enterprise advance.

3.5. Create ownership.

Leaders of large change programs must overperform during the transformation and be the zealots who create a critical mass among the work force in favor of change. This requires more than mere buy-in or passive agreement that the direction of change is acceptable. It demands ownership by leaders willing to accept responsibility for making change happen in all of the areas they influence or control. Ownership is often best created by involving people in identifying problems and crafting solutions. It is reinforced by incentives and rewards. These can be tangible (for example, financial compensation) or psychological (for example, camaraderie and a sense of shared destiny). At a large health-care organization that was moving to a shared-services model for administrative support, the first department to create detailed designs for the new organization was human resources. Its personnel worked with advisors in cross-functional teams for more than six months. But as the designs were being finalized, top departmental executives began to resist the move to implementation. While agreeing that the work was top-notch, the executives realized they hadn't invested enough individual time in the design process to feel the ownership required to begin implementation. On the basis of their feedback, the process was modified to include a "deep dive." The departmental executives worked with the design teams to learn more, and get further exposure to changes that would occur. This was the turning point; the transition then happened quickly. It also created a forum for top executives to work as a team, creating a sense of alignment and unity that the group hadn't felt before.

3.6. Communicate the message.

Too often, change leaders make the mistake of believing that others understand the issues, feel the need to change, and see the new direction as clearly as they do. The best change programs reinforce core messages through regular, timely advice that is both inspirational and practicable. Communications flow in from the bottom and out from the top, and are targeted to provide employees the right information at the right time and to solicit their input and feedback. Often this will require overcommunication through multiple, redundant channels.

3.7. Assess the cultural landscape.

Successful change programs pick up speed and intensity as they cascade down, making it critically important that leaders understand and account for culture and behaviors at each level of the organization. Companies often make the mistake of assessing culture either too late or not at all. Thorough cultural diagnostics can assess organizational readiness to change, bring major problems to the surface, identify conflicts, and define factors that can recognize and influence sources of leadership and resistance. These diagnostics identify the core values, beliefs, behaviors, and perceptions that must be taken into account for successful change to occur. They serve as the common baseline for designing essential change elements, such as the new corporate vision, and building the infrastructure and programs needed to drive change.

3.8. Address culture explicitly.

Once the culture is understood, it should be addressed as thoroughly as any other area in a change program. Leaders should be explicit about the culture and underlying behaviors that will best support the new way of doing business, and find opportunities to model and reward those behaviors. This requires developing a baseline, defining an explicit end-state or desired culture, and devising detailed plans to make the transition. Company culture is an amalgam of shared history, explicit values and beliefs, and common attitudes and behaviors. Change programs can involve creating a culture (in new companies or those built through multiple acquisitions), combining cultures (in mergers or acquisitions of large companies), or reinforcing cultures (in, say, long-established consumer goods or manufacturing companies). Understanding that all companies have a cultural center — the focus of thought, activity, influence, or personal identification — is often an effective way to jump-start culture change. A consumer goods company with a suite of premium brands determined that business realities demanded a greater focus on profitability and bottom-line accountability. In addition to redesigning metrics and incentives, it developed a plan to systematically change the company's culture, beginning with marketing, the company's historical center. It brought the marketing staff into the process early to create enthusiasts for the new philosophy who adapted marketing campaigns, spending plans, and incentive programs to be more accountable. Seeing these culture leaders grab onto the new program, the rest of the company quickly fell in line.

3.9. Prepare for the unexpected.

No change program goes completely according to plan. People react in unexpected ways; areas of anticipated resistance fall away; and the external environment shifts. Effectively managing change requires continual reassessment of its impact and the organization's willingness and ability to adopt the next wave of transformation. Fed by real data from the field and supported by information and solid decision-making processes, change leaders can then make the adjustments necessary to maintain momentum and drive results.

3.10. Speak to the individual.

Change is both an institutional journey and a very personal one. People spend many hours each week at work; many think of their colleagues as a second family. Individuals (or teams of individuals) need to know how their work will change, what is expected of them during and after the change program, how they will be measured, and what success or failure will mean for them and those around them. Team leaders should be as honest and explicit as possible. People will react to what they see and hear around them, and need to be involved in the change process. Highly visible rewards, such as promotion, recognition, and bonuses, should be provided as dramatic reinforcement for embracing change. Sanction or removal of people standing in the way of change will reinforce the institution's commitment. Most leaders contemplating change know that people matter. It is all too tempting, however, to dwell on the plans and processes, which don't talk back and do not respond emotionally, rather than face up to the more difficult and more critical human issues. But mastering the "soft" side of change management need not be a mystery [24].

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Method for Calculating Warehousing Costs Based on Simulation Results

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Abstract: The warehousing costs are a significant part of the supply chains costs. This article shows the connections between the warehousing costs and the client number of a 3PL. The parameters are based on paragon simulation. The simulation results are inserted into transportation cost function, which improves the whole model.

Keywords: SMC, 3PL, model, warehouse

1. Introduction

This paper demonstrates how to use vehicle routing software's in warehouse simulation, and how we can use the simulation results to calculate warehouse costs.

The main point of warehouse simulation is to create the computerized representation of the warehouse, by introducing some assumptions, estimations and simplifications. After the model is created, scenarios should be built up - by altering different parameters of the model- to simulate real life processes in the warehouse; e.g.: increase of vehicle or forklift number. By evaluating the results we gain that information which would be expensive or impossible in case of the examination of the real system.

The common vehicle routing software's are rarely used for warehouse material handling simulation, although all algorithms needed for modeling processes are built in many of them. All the road transportation elements used in vehicle routing applications can be converted to a warehouse system element in theory, the algorithms are the same.

2. Warehouse simulation with vehicle routing software

The aim is to simulate the total distance and productive time taken by forklifts in a warehouse. With the help of these data we can calculate the total warehouse costs.

The method of building up the simulation is basically the same as in case of vehicle routing simulation. At first the master data has to be collected (all possible system elements), after that different scenarios can be built up by using these system elements.

The benefits of vehicle routing simulation are the following:

- Reduce transport costs
- Improve customer service
- Maintain efficiency of transport resources during execution
- Increase control of transport - better management reporting
- Reduce delivery lead times
- Support strategic decision making

The benefits of warehouse simulation are the following:

- With the help of simulation we can forecast the resource need of future warehouse processes
- With the help of simulation we can forecast the cost of future warehouse material handling

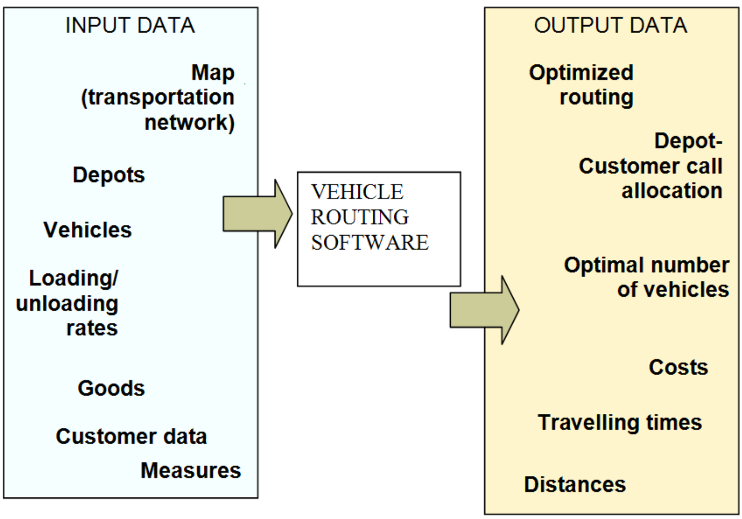

Figure 1. Schematic system model of vehicle routing softwares

Figure 1 demonstrates routes schematic system model of vehicle routing softwares. By creating orthogonal routs on the transportation map, a warehouse corridor network can be built up. On this orthogonal network, nodes for the warehouse rack locations should be placed. Attributes of network segments are average velocity and length.

Warehouse material handling areas can be converted to depots of routing software.

Let us assume that only pallets are stored in racks, forklifts transport them to the consolidation area, where unit pallets are made. Attributes of consolidation area are the time windows, loading and unloading rates. Depending on the direction of material flow, this area will be the loading/unloading point.

Vehicle master data contains the data of forklifts, which are the followings: vehicle capacity, fix and variable costs (based on running performance or elapsed time).

The unit of transported goods is pallet, since the forklifts collect and spread whole pallets to and from the racks – this way vehicle capacity is one pallet.

Customer master data contains the position and loading rates of the rack locations. Locations on upper levels have higher loading/unloading rates, since lifting goods needs extra time. As many "customers" should be declared at the nodes of the route network as many locations are served from that node.

Customer order data are the items of the picking list, it contains the order quantity (1 pallet/rack) and loading/unloading rate (higher levels). For warehouse simulation no time-windows should be determined, but we have to declare whether the order is a supply or demand point.

Loading and unloading times have both fix and variable – time dependent – components.

The measure can be weight, volume – in this case the measure is pallet. Most routing softwares can not handle lengths below 1m; it is suggested to use at least 10 times magnification for warehouse simulation. (In this case variable costs should be decreased, and average velocity should be increased ten times).

Figure 2 shows the graphical visualization of a warehouse simulation model.

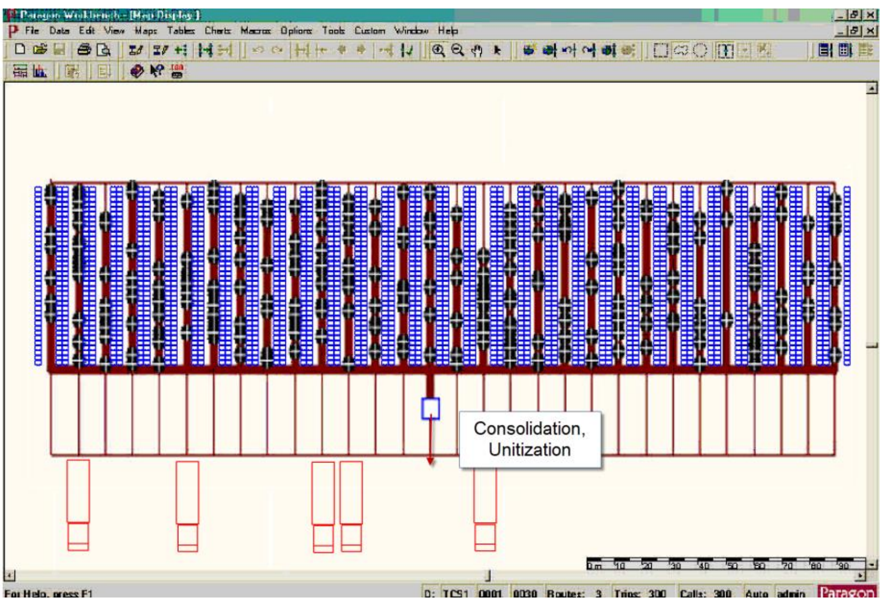

Figure 2. Warehouse simulation model

By running the simulation the routes of forklifts, the total distance covered, the time of single routes, the necessary number of vehicle, capacity data, and other representative data will be generated.

3. Simplifications in the model

To model warehouse processes we have to declare some simplifications. In our case we assume that one corridor belongs to one client. The picking points are evenly distributed.

We assume that the material handling costs increase parallel with the increase of the warehouse length (this way also with the number of clients).

During the simulation we have examined one hour long periods. The cost results for one shift are gained after simulation cost results multiplied by 8 hours.

In this case main point of simulation is to get data about the distance and taken during material handling.

4. Calculation of warehouse costs based on simulation results

The total warehouse costs are built up from three factors:

$$\Sigma K_{WH} = K_{fix}^{WH} + K_{fix}^{FL} + K_{v}^{D} \tag{1}$$

Where:

K_{fix}^{WH}: Fix costs of warehouse (EUR)

K_{fix}^{FL}: Fix costs of forklifts and forklift operators $\left(\frac{\text{EUR}}{\text{Forklifts}}\right)$

K_{v}^{D}: Distance dependent costs (EUR)

K_{fix}^{WH} is not a constant value, it is the function of the length of the warehouse (which depends on the number of clients).

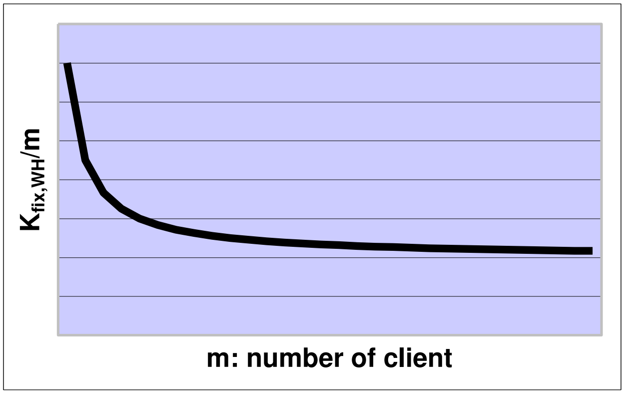

Figure 3. Warehouse fix costs in the function of the number of clients

The costs of forklifts K_{fix}^{FL} depends on the number of the forklifts, it contains the wage of the forklift operator, the amortization and leasing price of the forklifts. It can be expressed as follows:

$$K_{fix}^{FL} = n_{FL} \cdot k_{fix}^{FL} \tag{2}$$

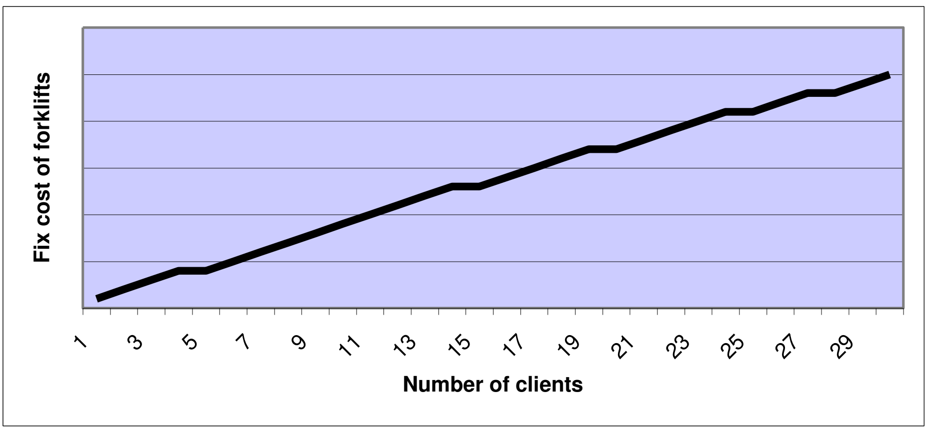

Figure 4. Example of fix cost of forklifts in the function of the client number

By simulation we have gained information about the covered distance during one hour long periods, so the total distance taken in one shift is the gained results multiplied by the number of hours in a shift. – We assumed that the needs are constant during the whole shift.

Number of forklifts:

$$n_{FL} = \left(\frac{t_{pr}}{60} + 0{,}99 \right)_{INT} \tag{3}$$

Where:

t_{PR} : Total productive time of picking process, value is gained from simulation

And the total productive time can be calculated

$$t_{pr} = \frac{D}{\overline{v}} \tag{4}$$

Let us put (4) into (3):

$$n_{FL} = \left(\frac{D}{\overline{v} \cdot 60} + 0{,}99 \right)_{INT} \tag{5}$$

The distance dependent variable cost can be expressed as in the following equation.

$$K_v^D = D \cdot k_D \tag{6}$$

Where:

D: Total distance covered by whole material handling process

k_D : Distance dependent variable cost of forklifts

The covered distance data is gained by warehouse simulation. As we increased the number of clients the distance also increased, shown on Figure 3.

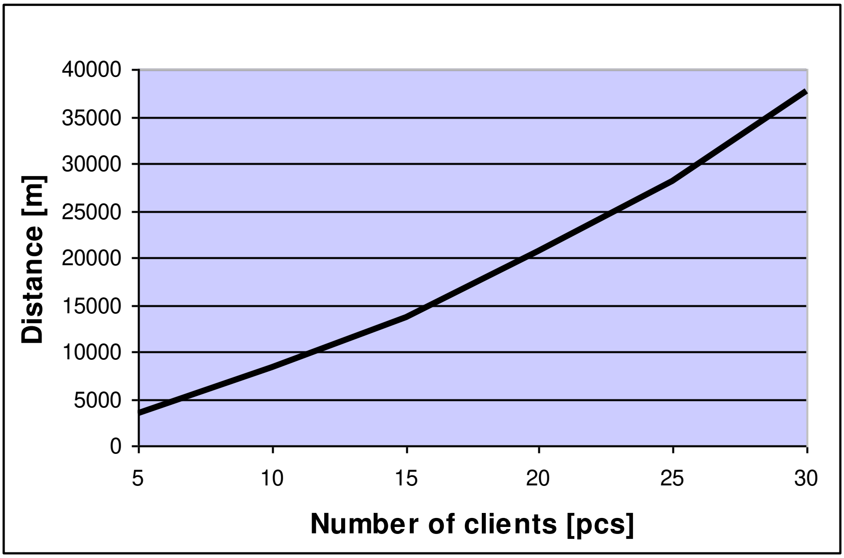

Figure 5. Distance taken during material handling in one hour in function of the number of clients

A correlation between the client number and the distance can be expressed with the help of polynomial iteration method:

$$D(m) = d_0(60 + 10m + m^2) \quad (7)$$

The characteristic shown above is only valid in case of the parameters of the warehouse in our model, where $d_0 = 30m$.

Figure 4 shows the calculated and the simulated distance of warehouse material handling.

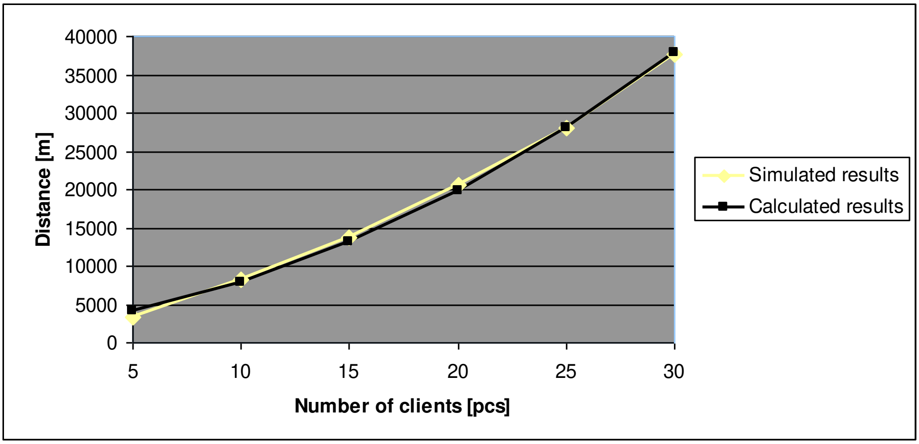

Figure 6. Simulated and calculated distance taken during material handling

The total costs are the sum of delivery costs and depot cost:

$$\Sigma K = \Sigma K_V + \Sigma K_{WH} = \Sigma K_V + K_{fix}^{WH} + K_{fix}^{FL} + K_v^D$$

According to Hirkó the following equation expresses the total delivery costs

$$\Sigma K_V = 0{,}75 \cdot \sqrt{T} \cdot m \cdot k_F^V \cdot \left(\frac{\overline{q}\overline{N}}{g^V} + \sqrt{\overline{N}}\right) + m \cdot \frac{8}{9} \cdot \overline{L_V} \cdot k_F^V \cdot \frac{\overline{q}\overline{N}}{g^V} + K_{fix}^{WH} + n_{FL} \cdot k_{fix}^{FL} + d_0(60 + 10m + m^2) \cdot k_D$$

5. Conclusion

Applications used for vehicle routing simulation are also capable of modeling warehouse processes; by introducing some simplifications and using simulation the total distance and productive time need can be declared. After analyzing the total warehousing costs, three main cost branches can be distinguished: fix warehouse, fix forklift and wage and distance dependent costs. All of these costs have dependence on client number, these correlations were revealed. With the help of former scientific results, we made up a solution to determine client number dependant total costs.

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Managing Infrastructures of Limited Resources

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Abstract: It is hardly impossible to limit traffic by administrative measures. There are, however, chances of using innovative procedures of traffic telematics in order to manage traffic demands and, above all, traffic flows in an optimal way on the basis of available resources. A conclusion concerning the expected resources capacities can be made by predicting the presence of a mobile object at a certain location at a certain time. On the basis of the comparison of available and finally required resources it is possible to give effective anticipatory routing recommendations within a large area.

Keywords: Traffic telematics, LBS, GIS, large-area traffic management, reliability

1. Introduction

The basis for the scenario described below and its possible technical implementation is general knowledge in the field of transport engineering:

- It is not possible to limit traffic by administrative measures.
- Mobility is a fundamental requirement of all actors in the modern economic life and
- The private environment as well.
- It is necessary to develop and use innovative procedures of telematics with the purpose
- of an optimal management of traffic requirements and traffic flows.

The target has to be to improve the use of the available resources in the infrastructure (improvement of infrastructure), to implement an intelligent routing with individual route planning and digital traffic control [1]. The subject of consideration is a large-area traffic network, such as the motorway system. For a regional or urban network there are different effective approaches which are available.

While approaching to the solution of the problem, a considerable quantity of object-related and possibly even personal data are captured and processed. Handling these data safely is therefore particularly important. For this paper the questions of data security have not been considered. They will be subject of different considerations.

2. Approach

On the basis of anticipatory actions it is possible to provide a location-based content, before the relevant location is reached in a traffic activity. If the traffic activities are controlled within a large-area infrastructure such as the German motorways, a lot of information for an optimal traffic management can be gained from the inflowing traffic, the traffic flows in the individual directions and the road users' behavior.

There are potentials of avoiding an overload situation to be expected at a future location by taking anticipatory actions. For this purpose it is necessary to provide a location-based content, before the relevant location will be reached [2]. It is typical that a backed prediction is not possible about which information will be required for a decision in the current case [4]. Hence, the following items have to be considered:

- Predicting the presence of a vehicle at a certain location at a certain time,
- Concentrating individual movements into a traffic flow,
- Predicting an expected traffic density on a certain route at a certain time,
- Comparing available and required resources,
- Identifying the overload situations to be expected and
- Object-related, individual traffic management or measures for controlling the inflow on the basis of a resource-relevant routing.

3. Application to a large-area traffic management

3.1. Scenario

Basis of the approach is the analogy between telecommunications and logistics networks. The basic principles of a traffic control in telecommunications networks can be summarized as follows:

- Recording or measuring the traffic density in the case of usual capacities,
- Determination of destination factors from the inflowing traffic,
- Comparison of the destination factors in the case of usual capacities with the current traffic density,
- Comparison of expected traffic density of individual network elements,
- Routing decision.

For an effective large-area traffic management it is useful to know the source and destination areas of a movement so that effective paths between these areas can be determined before the mobility activity starts. For the solution of the problem it is necessary to segment the total area of the traffic movements. These segments could be structured e.g. on the basis of post code areas. For long-distance mobility activities the accuracy reached in that way should be sufficient. The movement can be shown as a model, as to be seen in Fig. 1.

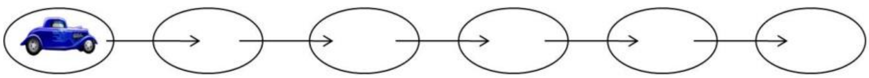


Figure 1. Movement ranges of a vehicle [4]

There are two questions which can be derived from Fig. 1. concerning routine decisions [3]:

- What do I have to expect where?
- How do I have to react when and why?

The movement at a certain speed is integrated in a model. The prognosis of when a certain point of the traffic infrastructure will be reached, is the essential criterion for the routing using an integrated strategy of avoiding overloads in the infrastructure elements, in which the required and the available resources do not match. Marginal requirements for a decision are the movement at a certain speed and the time prognosis of reaching a certain point of the traffic infrastructure. In logistics networks solving the path-time problem is critical, whereas it does not play any role in telecommunications networks.

3.2. Modeling

The requirement for the feasibility has been met, it is connected, however, with the following conditions [4]:

- Movement profile of (all?) vehicles can be shown,
- Movement at predictable average speed,
- Car – to – infrastructure communication,
- Real – time information transmission,
- Reliable routing in good time,
- Background model.

This background model in its essential components is shown in Fig. 2.

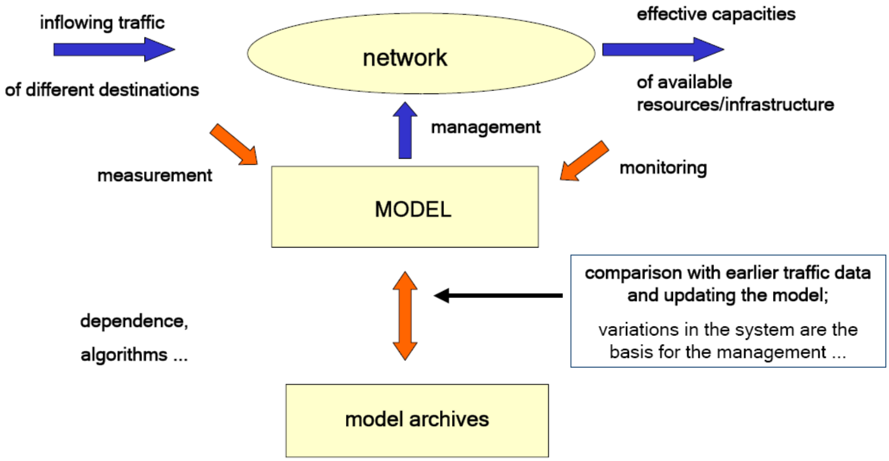


Figure 2. Background model [4]

For a reliable decision there are not only the currently captured data which have to be processed. Essential findings concerning the development of traffic capacities under certain circumstances can also be drawn from historic data. It is, therefore, reasonable to extend the model and consider relevant time series as it can be seen in Fig. 3.

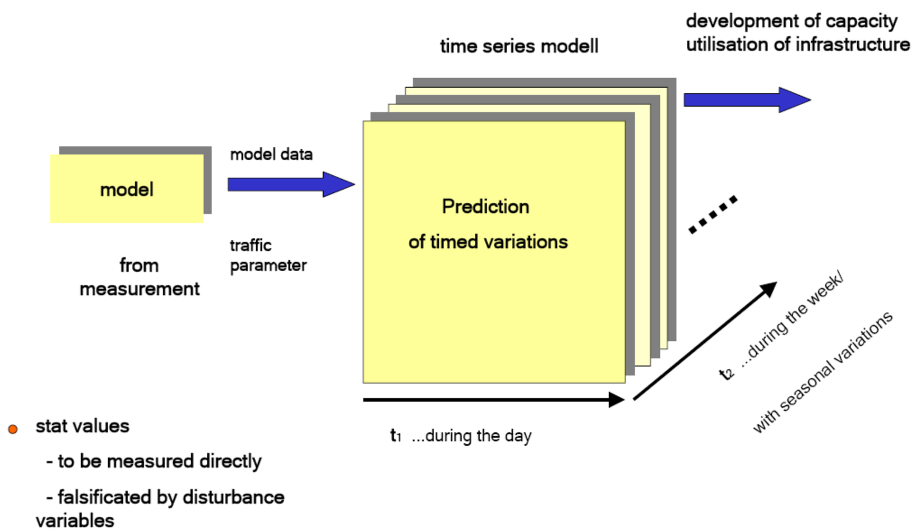


Figure 3. Extended model with time series [4]

3.3. Algorithm

The basic principles of the prognosis procedure for avoiding overload situations in resource-limited traffic infrastructures can be summarized in an algorithm. The algorithm of an application example could be designed as follows:

1. When starting a journey the post code of the destination area is entered via an onboard unit (OBU). This OBU is technically integrated in the mobility process. By this entry the source-destination relation is fixed.
2. Integration of this temporary source-destination relation in the model according to Fig. 2. Measurement or prediction of the source-destination traffic density x_{ij} in a traffic network $G=(W,E)$ which consists of a quantity W of nodes and a quantity E of edges. The individual elements of the graph are continuously indicated with the nodes being referred to as $w_i,\ i \in [1,\hat{w}]$ and the edges as $e_j,\ j \in [1,\hat{e}]$. Hence the symbols $\hat{w}$ and $\hat{e}$ also stand for the number of elements in the quantities of nodes or edges. The individual edges are assigned to the weighting of the edge between w_i und w_j by one or several rational, predominantly positive integers g_{ij}. They indicate characteristics of the edge and represent the quantity of parameters which are required for assessing the traffic load-dependent transport period $T_{Tr_{ij}}$ of motor vehicles on an edge between w_i and w_j.

   These weightings comprise a static and a dynamic part. The static part describes the load on the edge due to the free traffic. In our case it is described by the expectance variable of the transport period $E(T_f)$. The dynamic part considers the real influences of the current traffic situation, such as congestion, accident, high traffic density. In accordance with [5] the process reliability $Z_\Pi(t)$ is defined.

$$Z_\Pi(t) = Z_{Tr}(t) \cdot Z_{Sy_\eta}(t) \cdot Z_{Sy_\nu}(t) \cdot Z_{Sy_\iota}(t) \tag{1}$$

with:

Z_{Tr} Transport reliability,

Z_{Sy_η} Operator reliability,

Z_{Sy_ν} - System reliability of the means of transport and

Z_{Sy_ι} System reliability of the itinerary (Infrastructure reliability)

The transport reliability $Z_{Tr}(t)$ which is defined as the probability that a vehicle goes from i to j within the period t can be characterized by the transport process, whereas the other components of the process reliability are accessible via the failure and recovery processes.

3. Calculation of the destination factors f_{ij} (from destination post code and others) as the quotient of the number of vehicles X_{ij} to the total quantity X. The destination factors can be represented as the following matrix

$$\vec{F} = [f_{ij}] \tag{2}$$

with the condition of standardization

$$\sum_{i=1}^{\hat{e}} \sum_{j=1}^{\hat{e}} f_{ij} = 1 \tag{3}$$

4. The vehicle volumes are subject to temporal and stochastic fluctuations. The temporal variations can be illustrated by day and week curves (model of time series acc. to Fig. 3.). These curves show considerable differences on the individual relations. It is, therefore, difficult to develop an analytic model of the temporal dependences of the individual relations.

   These dependences also have an effect on the destination factors. It is sufficient that the temporal dependences of the destination factors are indicated within the time intervals τ to be fixed

$$\vec{F}(\tau) = [f_{ij}(\tau)] \tag{4}$$

5. Determination of the static weighting factors $g_{stat_{ij}} = E(T_{f_{ij}})$ as the expected value of the transport period of the free traffic under consideration of the following influencing variables:

   - legally fixed maximum speeds,
   - road conditions,
   - traffic conditions,
   - utilization of the payload,
   - specific drive power and
   - drivers' behavior.

   There is

$$g_{stat_{ij}} = E(T_{ij}) = \frac{s_{ij}}{\bar{v}_{f_{ij}}} \tag{5}$$

6. Determination of the shortest paths on all source-destination relations on the basis of an algorithm for calculating minimum paths, e.g. a matrix algorithm following Floyd [6]. Initially these paths are determined without considering the traffic capacity.
7. Determination of the dynamic parts of the weighting factors termed as the process reliability $Z_{\Pi}(t)$. For the individual parts acc. to formula (1) the following items have to be considered:

7.1 Concerning the transport reliability constraints are considered which are caused by excessive traffic volumes. It can be determined in a simplified way by the quotient of the speed dependent on traffic density to the speed of the free traffic. An analytic approach concerning the mean speed $v_m(\rho)$ depending on the traffic density ρ is the approach following Kühne [7]

$$v_m(\rho) = v_f\left[1-\left(\frac{\rho}{\hat{\rho}}\right)^a\right]^b \tag{6}$$

The mean transport speed is a function of

- the empiric road specific parameters a and b,
- the capacity of the road (traffic density) ρ
- the maximum utilization of the road $\hat{\rho}$ and
- the average speed of the free traffic $\bar{v}_f$.

In Fig. 4. there is a model calculation with a = 2.05 , b = 21.11, $\bar{v}_f$ = 100 km/h and $\hat{\rho}$ = 168 cars/km.

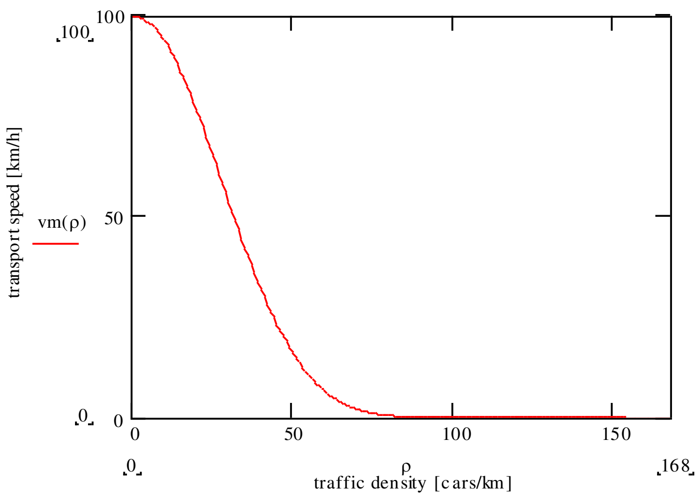


Figure 4. Diagram of speed and traffic density

For the transport reliability the following is applied:

$$Z_{Tr}(t) = \frac{v_m(\rho(x,t))}{v_m(0)} = \frac{v_m(\rho(x,t))}{v_f} = \left[1 - \left(\frac{\rho(x,t)}{\hat{\rho}}\right)^a\right]^b \tag{7}$$

For the purpose of determining the transport reliability the quality of the available data has to be considered. For the transport process on the currently used edge or the edge onto which the vehicle wants to enter immediately (near-future transport process) it is possible and reasonable to consider the current state data of the traffic process (mean density ρ_m, mean speed $v_m(\rho_m)$, maximum possible speed of free traffic v_f,). The farther the vehicle is away from the present location, the more inaccurate the calculations become, since the above parameters can only be estimated or have to be determined by prognosis models. For this far-future transport process a different algorithm for determining the transport reliability will be required.

The (discrete) Hilliges-Weidlich model acc. to [8] is used for modeling the near-future transport process. The continuity equation for this model is

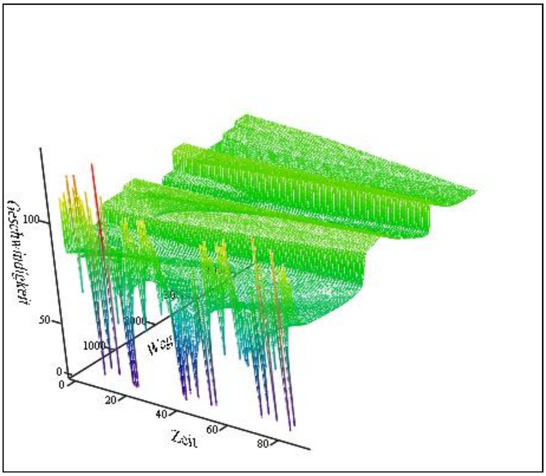
$$\frac{\partial \tilde{\rho}(j,t)}{\partial t} = \frac{\tilde{\rho}(j,t)\,\tilde{v}(j+1,t) - \tilde{\rho}(j-1,t)}{\Delta t} = 0 \tag{8}$$

and the dynamic velocity equation is

$$\frac{\partial \tilde{v}(j,t)}{\partial t} + \tilde{v}(j,t)\frac{\tilde{v}(j+1,t) - \tilde{v}(j-1,t)}{2\Delta x} = \frac{1}{\tau}\left[v_m(\tilde{\rho}(j,t)) - \tilde{v}(j,t)\right] \tag{9}$$

with the traffic density $\tilde{\rho}(j,t) = \rho(j\,\Delta x,t)$, the length of a road cluster $\Delta x = 100m$, the relaxation time $\tau = 5s$ and the relation of velocity and traffic density acc. to formula [6]. Fig. 5. shows the qualitative simulation of the density-dependent velocity $v(\rho)$ for this model on the basis of fictitious data.

Concerning the far-future transport process the traffic density $\tilde{\rho}_{prog}(x,t)$ has to be determined on the basis of the available prognosis data of the destination factors $\vec{F}(t)$ and the actual traffic data ρ_{akt}. Intensive research work will be required for this purpose.



V
Geschwindigkeit nach der Bewegungsgleichung

Figure 5. Traffic flow diagram (qualitative) acc. to the Hilliges-Weidlich model

7.2 The system reliability $Z_{Sy}(t)$ falls into the categories of facilities reliability $Z_{Sy_v}(t)$ - for the transport process also referred to as reliability of transport means-, the operator reliability $Z_{Sy_\eta}(t)$ and the infrastructure reliability $Z_{Sy_{\tau(t)}}$.

The operator reliability describes the driver's work capability, which shall not be detailed here. There is $Z_{Sy\eta}(t) = 1$.

The infrastructure reliability describes the traffic breakdowns or restrictions on an edge caused e.g. by accidents, broken vehicles, unplanned construction sites. The following operational areas are distinguished:

- Nominal operation mode: All traffic lanes are available at a fixed maximum speed.
- Malfunction mode: There are either fewer lanes available and/or the maximum speed is restricted.
- Collapse: There is no lane available.

By using non-stationary reliability models the infrastructure reliability can be determined analytically by approximation. The following simplified example shows the approach. There is a single lane with the following speed ranges:

- Free traffic (in the case of long-term restrictions this can also be the relevant reduced speed) = state Z_0 = nominal operation mode

- Restricted traffic = state Z_1 = malfunction mode
- Stationary traffic ($v = 0$), i.e. congested lane = state Z_2 = collapse.

There is the equivalent diagram of reliability acc. to Fig. 6.:

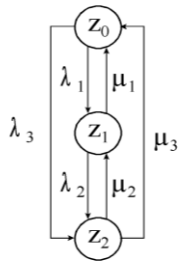


Figure 6. Equivalent diagram of system reliability of a single-lane road

For the purpose of simplification the transition rates λ and μ are assumed to be equal, i.e. there is: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda$ and $\mu_1 = \mu_2 = \mu_3 = \mu$. Concerning the start vector $\vec{P}(t) = (0 \quad 1 \quad 0)^T$, i.e. the state Z_1 is active, the non-stationary state probabilities are determined using the abbreviation $\rho = \dfrac{\lambda}{\mu}$ as follows

$$\begin{pmatrix} Z_0(t) \\ Z_1(t) \\ Z_2(t) \end{pmatrix} = \begin{pmatrix} \frac{1}{2\rho + 1}\left(1 - \exp[-(2\lambda + \mu]t\right) \\ \frac{3\rho}{2 + 5\rho + 2\rho^2} + \frac{1}{2\rho + 1}\exp[-(2\lambda + \mu)\,t] + \frac{\rho}{2 + \rho}\exp[-(2\mu + \lambda)\,t] \\ \frac{\rho}{2 + \rho}\left(1 - \exp[-(2\mu + \lambda)\,t]\right) \end{pmatrix} \tag{11}$$

For the stationary case there is

$$\lim_{t \to \infty} Z_0(t) = \frac{1}{2\rho + 1}$$

$$\lim_{t \to \infty} Z_1(t) = \frac{3}{2 + 5\rho + 2\rho^2}$$

$$\lim_{t \to \infty} Z_2(t) = \frac{\rho}{2 + \rho}$$

The result is the qualitative correlation acc. to Fig. 7.

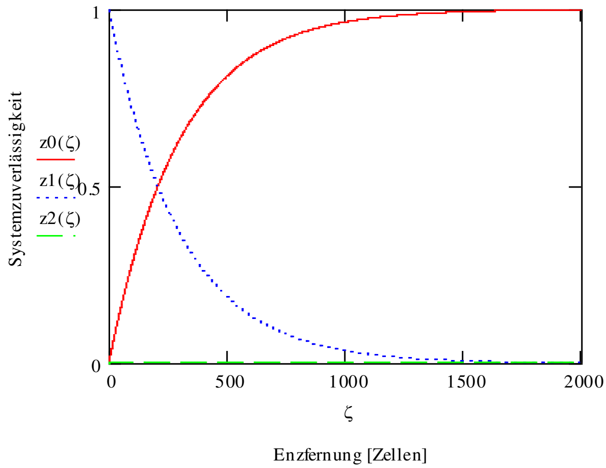


Figure 7. State diagram of a single-lane road

For calculating the dynamic weighting factors the nominal operation mode $Z_{Sy_t(t)} = Z_1(t)$ is used.

Using the facilities reliability $Z_{Sy_v}(t)$, in this case the reliability of the transport means, the availability of the vehicle can be determined. As an analytic model the maintenance theory offers the model of scheduled preventive maintenance (PVI) following a life-related cycle with total maintenance being done in the case of breakdowns, see e.g. [9]. For calculating the dynamic weighting factors we use the availability of the system $Z_{Sy_V}(t) = V_{Sy_v}(t)$.

8. Determination of the weighting factors from the individual relations of the static and dynamic parts as follows

$$g_{ij} = g_{stat_{ij}} \cdot g_{dyn_{ij}} = \frac{\frac{s_{ij}}{v_{f_{ij}}}}{Z_T(t) \cdot Z_{Sy_t}(t) \cdot Z_{Sy_v}(t)} \qquad (12)$$

9. On the basis of route determinations for the free traffic and using the matrix of weighting factors $\vec{G} = [g_{ij}]$ alternative routes can be calculated in accordance with the same routing algorithm.

4. Results

If an edge or a node of a network has been identified as an essential location for the trouble-free traffic management within the total network, this location can be integrated in a management model. For this purpose the inflow is measured, the traffic directions are selected, the capacities at a location are predicted and on the basis of the available capacities the inflows to that location are limited or modified by an alternative traffic guidance. Identifying an overload situation at an integrated location of the infrastructure at a future time means that avoiding strategies can be activated by

- reducing the inflow,
- alternative routing with time restrictions,
- time impacts such as speed regulations in terms of maximum or minimum speeds etc.

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The Traffic Management of Highways by Constant Time to Collision Cruise Control

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Abstract: The paper presents a new method of management and optimization for the highway traffic, based on the Constant Time to Collision Criterion. Each car is provided with a constant time to collision cruise controller, which is maintaining optimized distance gaps between cars, with respect to the speed and to the technical data of the cars. These cruise controllers are planned fuzzy-interpolative PD controllers designed with the help of functional computer models of the cars, following a specific scenario that is containing several complete braking actions performed for different constant times to collision. The highway administration has the possibility to control the traffic flow intensity by imposing the same TTC to all the cars: great TTCs for low traffic, small TTCs for high traffic. The CTTC controlled traffic is distributing evenly the collision risk over all the cars.

Keywords: cruise control, planned controllers, fuzzy-interpolative controller, constant time to collision.

1. Introduction

Logistics is the management of the flow of goods, information and other kind of resources, including energy and people, between the point of origin and the point of consumption, in order to meet the consumers' requirements. Logistics involves the integration of information, transportation, inventory, warehousing, material-handling and packaging. This paper is dealing with a new optimization method for the highway traffic. This method is a result of the solving of a theoretical issue: the definition of a novel optimal distance gap between cars on highways.

The Intelligent Transportation Systems enable cars to "think." Within this field there are many subdivisions like freeway management, electronic payment for tolls, and road and weather management. A set of facilities with different degrees of implication in the driving action is introduced by the Advance Driver Assistance Systems (ADAS) [1, 2], etc. ADAS are systems to help the driver in its driving process. When designed with a safe Human-Machine Interface it should increase car safety and more generally road safety. Examples of such a system are:

- The Adaptive Cruise Control (ACC), very close to the Intelligent Cruise Control (ICC) uses either radar or laser devices to allow the vehicle to slow when approaching another vehicle and accelerates again to the preset speed when traffic allows. ACC technology is widely regarded as a key component of any future generations of smart cars.

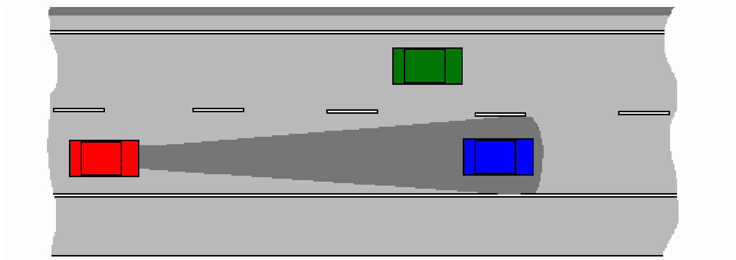

Figure 1. Following ACC cars on highway

- The Collision Warning System is a system of sensors that is placed within a car to warn its driver of any dangers that may lie ahead on the road. Some of the dangers that these sensors can reveal include how close the car is to other cars surrounding it, how much its speed needs to be reduced while going around a curve, and how close the car is to going off the road.
- The Intelligent Speed Adaptation or Intelligent Speed Advice (ISA) are systems that constantly monitor the local speed limit and the vehicle speed and implements an advice or an action when the vehicle is found to be exceeding the speed limit.
- In-vehicle navigation systems with GPS and TMC (Traffic Message Channel) for providing up-to-date traffic information.
- Lane/road departure detection/warning system
- Lane departure warning
- Lane change assistance
- Night vision
- Adaptive light control
- Pedestrian protection system
- Automatic parking
- Traffic sign recognition
- Blind spot detection
- Driver drowsiness detection

– Car to car communication
– Hill descent control, etc.

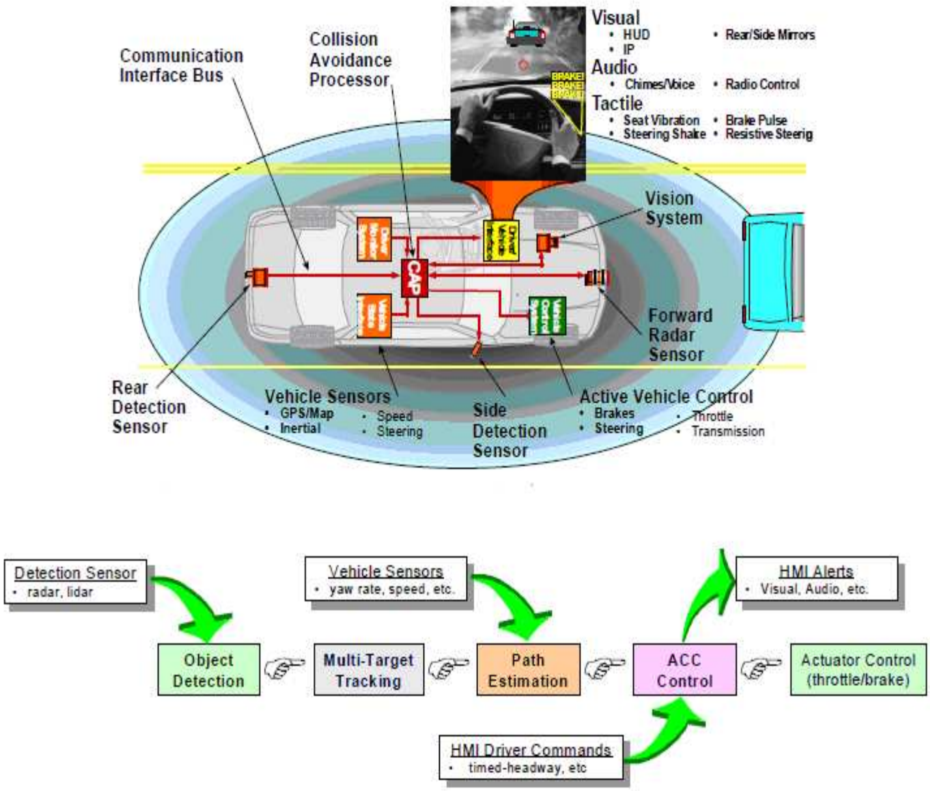

Figure 2. ACC signal processing architecture [5]

Yet, despite the safety benefits: enhanced driving performance and minimization of crash risks, reduced driver stress and fatigue, reduced conflicts and variance in behavior, etc. the effective put in practice of these developments will have to wait. The causes are economic, namely the high costs demanded by the infrastructure and the equipment installed on each car, but also technical. Automate driving is likely to produce at its turn safety risks by the driver distraction and reduced situation awareness, causing in time the reducing of the driving skill. But above all, any automate intervention into the car's operation can cause instinctive and inopportune reactions of the driver. That is why automate driving applications will probably face a transition period. A common sense approach assumes a gradual introduction of the automate features and the abortion of the automate mode at the slightest human intervention. The only ACC achievement that reached a certain popularity in the field of the automate driving, namely in the case of the following cars, is shown in Fig. 3.

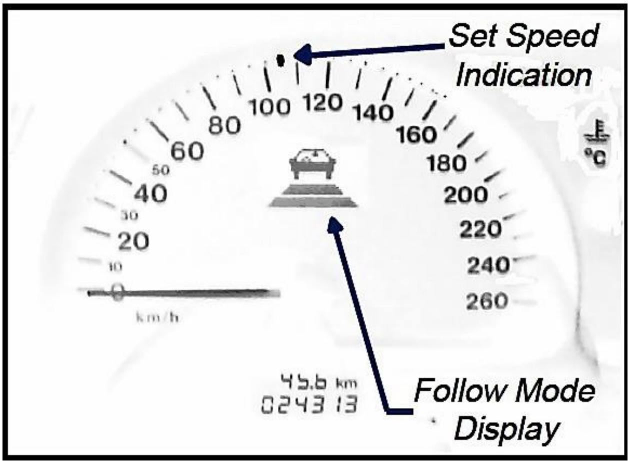

Figure 3. ACC human-machine interface

If several cars are running in the following car mode they may form platoons. Our interest is focused on the highway car platoons, whose importance is expected to grow along with the predictable constant increasing of the traffic flow. One of the essential parameters of this system is the distance gap between the following cars, which must be perfectly adapted to the speeds of the cars v1 and v2 and to the traffic conditions.

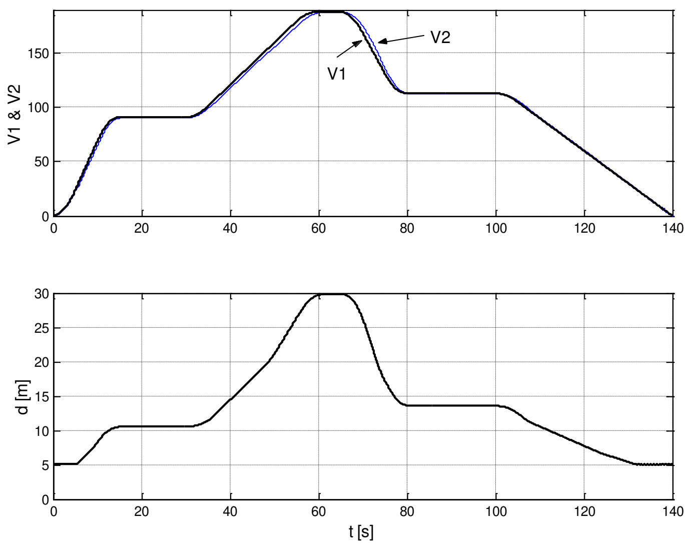

Figure 4. The car following mode

2. Measuring the Highway Traffic

Several indicators were introduced in order to measure the characteristics of the traffic flow [1, 2]:

- the time-to-collision (TTC)
- the time-to-accident (TTA)
- the post-encroachment-time (PET)
- the deceleration-to-safety-time (DTS)
- the number of shockwaves, etc.

TTC is the time before two following cars (Car2 is following Car1) are colliding, assuming unchanged speeds of both vehicles [1, 2]:

$$TTC = \frac{d}{v_2 - v_1} \quad (1)$$

Negative TTCs implies that Car1 drives faster, i.e. there is no danger, while small positive TTCs are leading to unsafe situations. Fig. 5. is illustrating the evolution of the TTC during a car following regime.

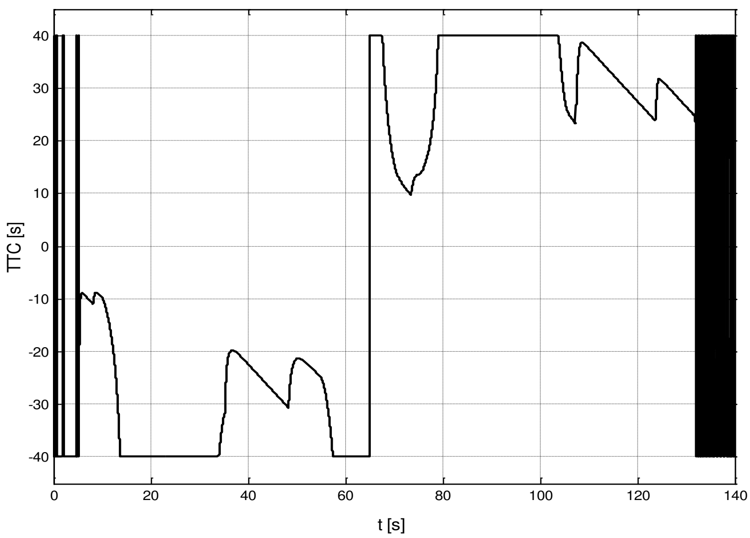

Figure 5. The TTC evolution during the following car mode

However, in Fig. 5. the TTC diagram is bounded at ±40s, because when v2 = v1 TTC becomes infinite! That is why very often another tool is preferred to TTC: the d(v2 – v1) trajectory.

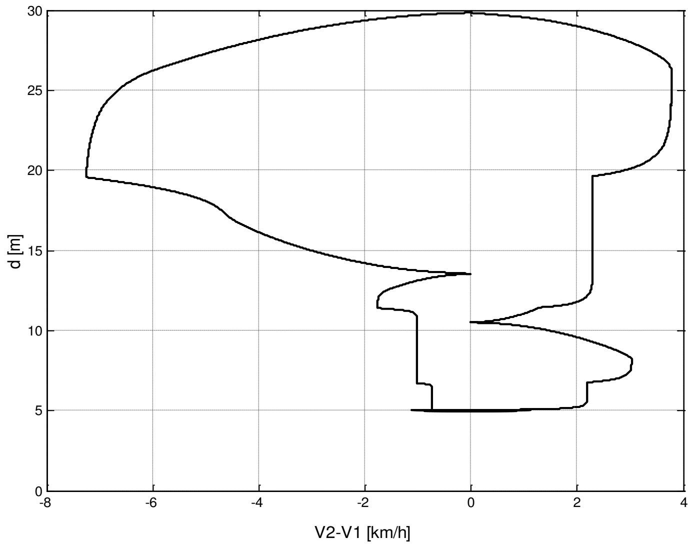

Figure 6. The d(v2 – v1) trajectory

Because d(v1 - v2) is not very suggestive when evaluating the collision risk, the Inverse Time to Collision TTC-1 was introduced [8]. TTC-1 is illustrated in Fig. 7.

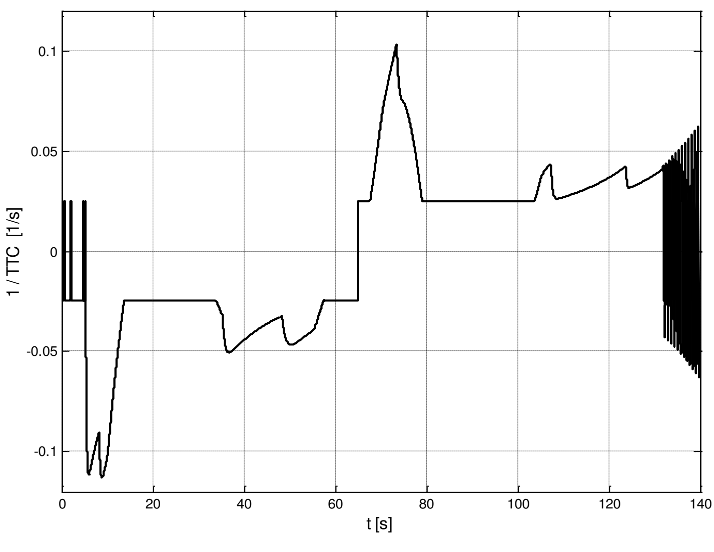

Figure 7. The time evolution of TTC-1

TTC-1 is proportional to the collision risk: the higher is TTC-1 the higher is the risk. Negative TTC-1s have the same significance as negative TTCs. A non-sensitive zone is appearing close to TTC-1 = 0s-1 corresponding to the TTC's saturation.

The TTC-1(v1 - v2) trajectory may be used as an indicator of the collision risk. The significant risk zones are pointed with fuzzy linguistic labels and with appropriate colors that are easily perceived by the driver, as shown in Fig. 8.

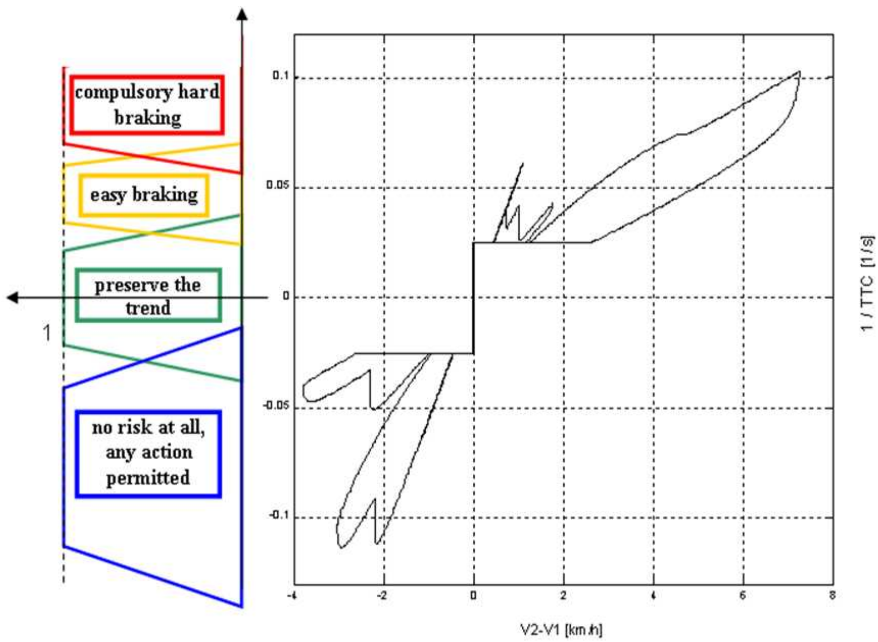

Figure 8. A TTC-1(v2 – v1) trajectory and a corresponding fuzzy partition assisting the driver

3. The Constant Time to Collision Criterion

A central issue in cars' safety is to impose an appropriate distance between cars di. ACC is imposing a particular polynomial di(v2) law [1]:

$$di(v2) = z0 + z1 \cdot v2 + z2 \cdot v22 = 3 + z1 \cdot v2 + 0.01 \cdot v22 \quad (2)$$

Several settings are recommended, for example z1 = 0.8s or z1 = 0.6s. The parameters z1 and z2 are artificially introduced, they have no significance for humans - highway operators or drivers - and they are not linked to the physical features of the system.

The Constant Time to Collision criterion CTTC consists in imposing stabilized TTCs by means of the Car2 cruise controller. Applying CTTC brings two obvious advantages:

- an even sharing of the collision risk for each vehicle involved;
- the possibility to control the traffic flow on extended road sections, if each vehicle will apply the same TTC that is currently recommended by the Traffic Management Center [9]: a long TTC means low traffic flow and higher safety while a short TTC means high traffic flow and higher risk.

The on-line TTC control is not convenient because when the two cars have the same speed the denominator of TTC is turning null: v2-v1=0. That is why CTTC must be implemented off-line, with the help of di(v2) mappings in the sense of the planning systems [4]. The CTTC implementation by di(v2) distance-gap planners is possible because a distance gap planner using TTC will produce CTTC. We studied this method by computer simulations, using a Matlab-Simulink model of the tandem Car1-Car2, introduced in other previous papers [6], [7], [8], [9], etc. Since the design of the planners is made with the help of functional models of the cars, accurate knowledge about the behavior and parameters of each car (traction and braking forces, weight, aerodynamic coefficient, etc.) can be taken into account, which is not possible to the simplified and leveling analytic model (2). This method imposes to the car manufacturers to provide each type of automobile with a computer model.

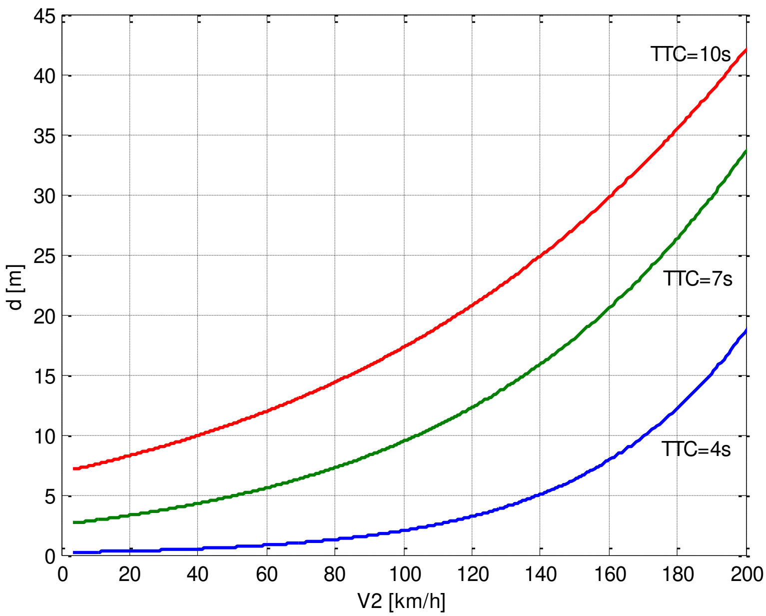

Figure 9. The di(v2) mappings for three different TTC

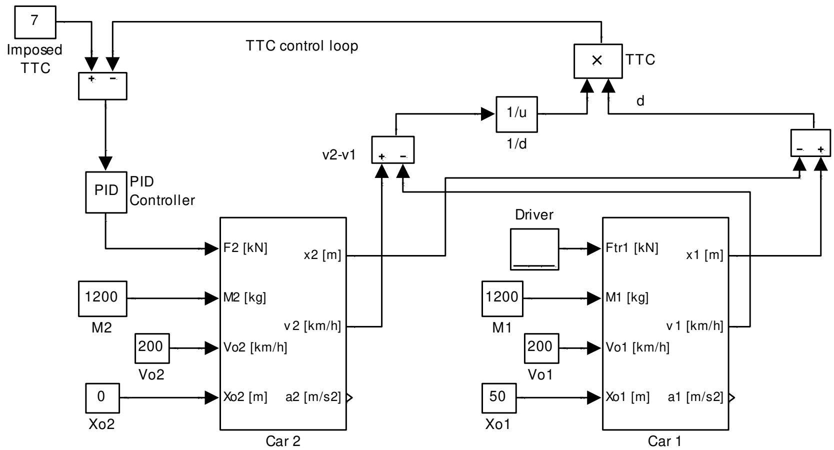

Figure 10. The SIMULINK-MATLAB model of the tandem Car1-Car2

The distance-gap planners are designed with the help of the computer model of Fig. 10. The simulation scenario consists in braking Car1 until the car is immobilized, starting from a high initial speed. A TTC controller is driving the Car2 traction/braking force such way that during the whole simulation TTC is stabilized to a desired constant value. The continuous braking allows us to avoid the v2-v1=0 case because the cars are not reaching at all the steady regime. We will use the recorded d mapping as the desired di(v2) planner for the given TTC. The Fig. 9. planners are set for three TTCs values: 4s, 7s and 10s. These planners can be easily implemented by look-up tables with linear interpolation [6].

4. The Planned Fuzzy-Interpolative Cruise Controller

For the time being we tested by simulations, with very good results, only a minimal version of the CTTC cruise controller, a PD fuzzy-interpolative one, as shown in Fig. 11.

The 2D look-up-table that is implementing the controller is the following:

Row (distance error): [-10 -5 0 5 10]
Column (error derivate): [-10 0 10] (3)

Output: [-1 -1 -1; -1 -0.3 0; -0.2 0 0.2; 0 0.3 1; 1 1 1]

This controller is extremely simple and has multiple tuning options: the look-up-table values as well as the input and output scalar factors. Any usual programmable control device used in the automotive industry can do this implementation.

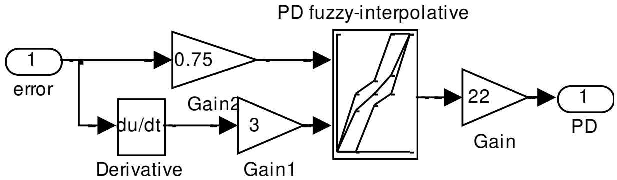

Figure 11. The PD fuzzy-interpolative cruise controller

5. The Constant Time to Collision Platoons

The current trend of the intelligent transportation developments seems to lead us towards the platoon concept. If structured into platoons the highway traffic could be optimized, the same infrastructure could be more efficiently exploited and the traffic safety could be improved. A platoon is a group of cars leaded by the first one, which is choosing the speed and the direction. We can easily imagine the advantages of a traffic structured into large platoons leaded by safety cars driven by professional drivers. Each other member of the platoon has only to follow the previous car as close as possible, with respect to all the traffic safety requirements. The essential problem of a platoon is the choice of the aggregating law that is governing its formation and evolution. The formula (2) can stand as a platoon aggregating law, if each car is respecting it. Another approach was proposed in ref. [1]: the platoon is considered as a virtual train, the connections between the participants acting like elastic springs. Different approaches are possible: non adaptive or adaptive, aiming the velocity, the distance gap and/or the acceleration. Our choice, the CTTC platoon, is an adaptive distance tracking solution.

The CTTC platoons are highway cars formations composed by automobiles provided with CCTC cruise controllers. Fig. 12. is illustrating the Matlab-Simulink model of a five car platoon that was used for the simulations. As one can remark, each car has its own specific technical parameters: weight, power, brakes, etc.

The next figures are illustrating the behavior of this platoon, for a generic simulation scenario, presented in Fig. 13. The scenario is imposing plausible variations of the speed and of the imposed TTC. It is to remark the notable TTC step that appears for t = 470…500s, that has the purpose to test the dynamics of the CTTC cruise controllers. Such fast variations of the imposed TTC are not recommendable during the usual exploitation.

Besides the demonstration of the CTTC principle, the following simulations compare two possible cruise controllers: the (3) PD fuzzy-interpolative controller and a conventional linear PID one. As expected, the nonlinear PD fuzzy-interpolative one (see Fig. 16.) is much more convenient than the PID (see Fig. 15.).

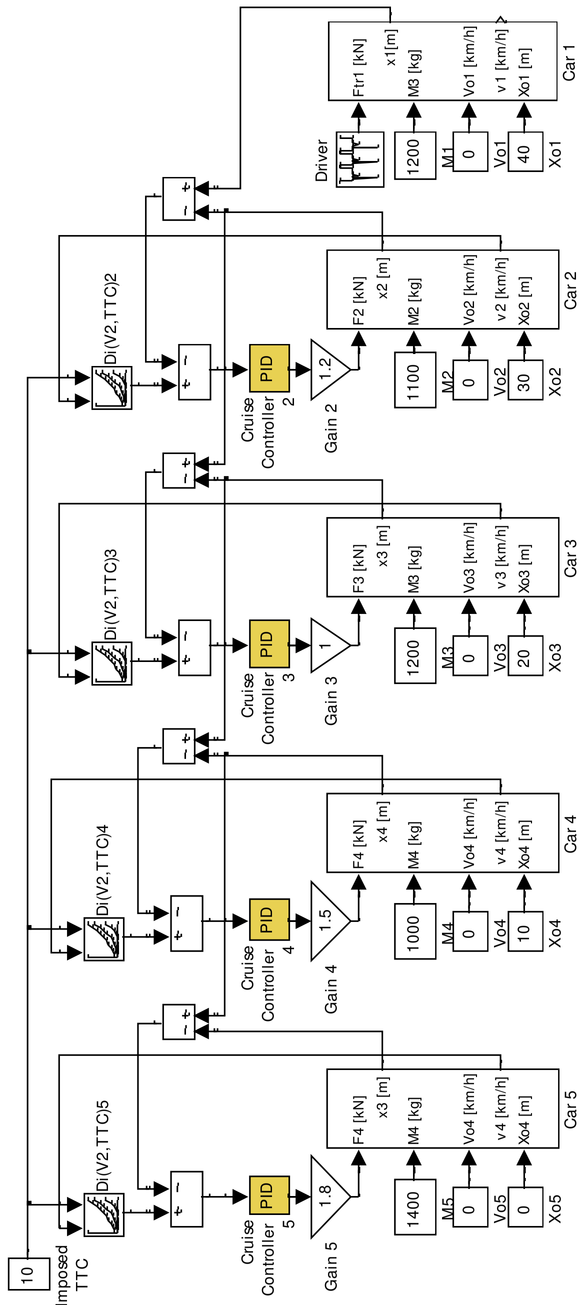

Figure 12. The SIMULINK-MATLAB model of a five car CTTC platoon

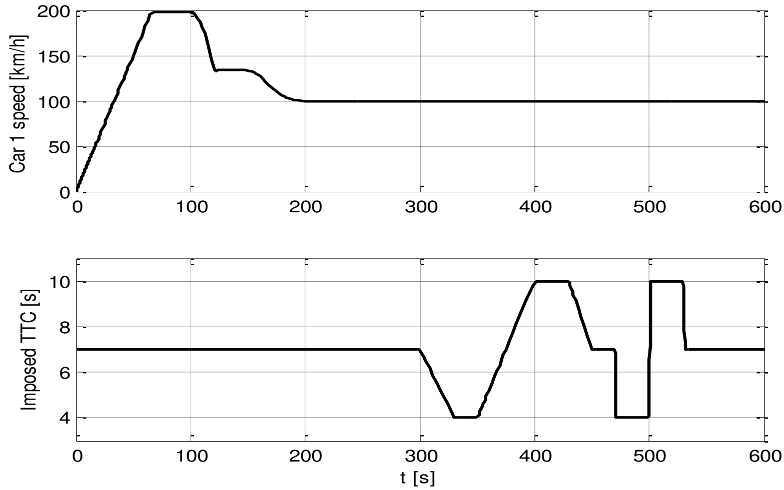

Figure 13. The simulation scenario

The two controllers are acting very similar for slow or normal changing velocities or TTCs. On the other hand the linear PID is producing higher oscillations when the parameters are changing faster (t=470s and t=500s) and especially in the transient regime of the platoon's formation (Fig. 15. and Fig. 16.).

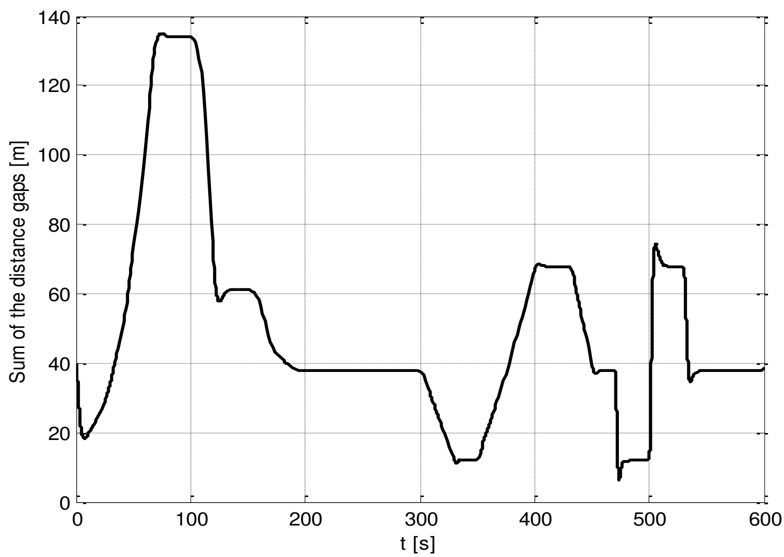

Figure 14. The sum of the distance gaps of the platoon (PD fuzzy-interpolative)

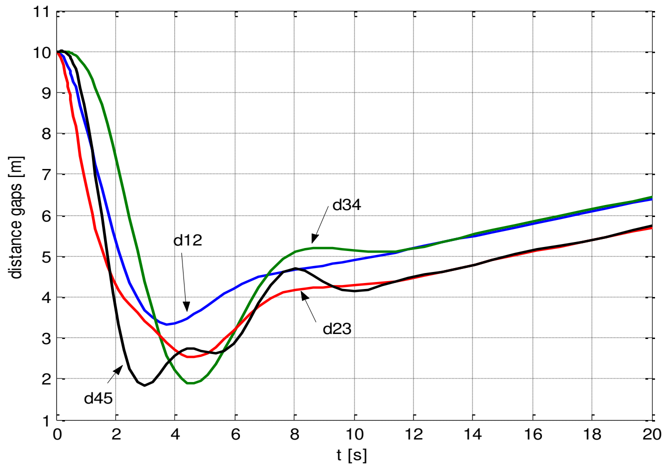

Figure 15. The formation of the platoon (linear PD, for comparison)

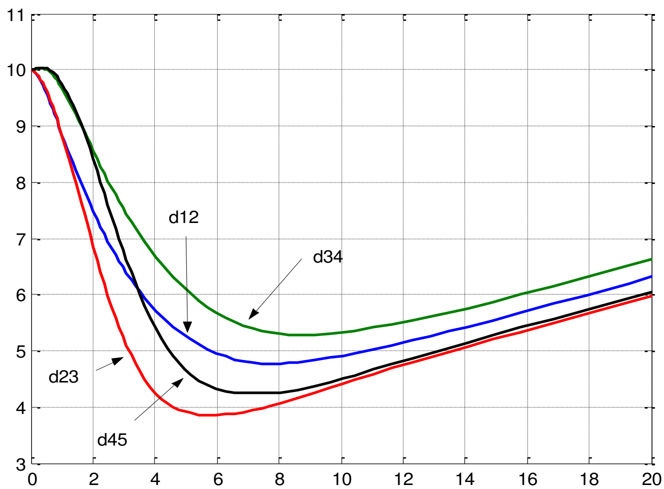

Figure 16. The formation of the platoon (using the PD fuzzy-interpolative controller)

6. Conclusions

The Constant Time to Collision Criterion CTTC is an optimization criterion that, in the case of two following cars, is imposing a particular distance gap, such way that the time to collision between cars is constant for any speed of the following car. If each car is equipped with a CTTC cruise controller and they share the same TTC then CTTC platoons are forming. The whole traffic flow can be controlled if the traffic management center of the highway can impose the same TTC to all the cars. The smaller the imposed TTC is, the smaller the distance gaps between cars will be, and the higher the traffic flow and the collision risk will be. The collision risk is evenly distributed over all the platoon's cars. The highway system becomes distributed, each car trying to reach and to maintain the position that respects the imposed time to collision to the previous car.

The CTTC cruise controllers may be conveniently implemented by PD nonlinear controllers (fuzzy-interpolative for instance). Besides the simplicity and the advantageous interpolative implementation, all the TTC based tools have a common feature: they are extremely well adapted to the changing traffic conditions because they are embedding precise knowledge about the technical data of the automobiles thanks to the functional computer model that stands behind their design.

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Business Process of MÁV Co's Infrastructure Specialised on the Services and Charging System

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Abstract: The paper will present the current situation of Hungarian infrastructure service system and charging policy. The paper introduces handling of train path requests to performance accounting business process of the offering services, service packages of the infrastructure manager, strategy and structure of charging system.

Keywords: railway, infrastructure services, business process, charging system

1. Introduction and background - MAV Co.

The Hungarian State Railways (MAV Co.) – the incumbent national railway company – has experienced a vast transformation with regards to its organisational, administrational tasks and its legal environment. In the last two years, the dynamics of the changes have accelerated (see Table 1).

Table 1. A brief overview of MAV Co.'s history

Year	Event
1992	MAV Co. is established: separation from the state, introduction of corporate accounting
2000	"Internal" separation of accounts of the business segments (freight transport, passenger transport, traction, infrastructure, real estate). Organisational entities are developed (within the corporation) according to the main segments.
2003	The first edition of the Hungarian Network Statement, with access rules and charges.
2004	Establishment of the independent Rail Capacity Allocation Body (RCAB) – as the MAV Co. and the Raaberbahn (GYSEV) are still integrated companies. Start of the first private freight railways (4 companies are operating by the end of the year).
2006	Outsourcing of the freight transport business: establishment of the separate company MAV Cargo Co. Start-up of the Hungarian Railway Authority (HRA) to control and supervise the fair behaviour of the incumbent companies and new market entrants.
2007	Outsourcing of the passenger transport business: establishment of the separate company MAV Start Co.
2008	Outsourcing of the traction and rolling stock maintenance business: establishment of the separate company MAV Trakció Co. and MÁV Gépészet co.

The Infrastructure Business Unit of MÁV Co. operates and maintains MÁV Co's more than 7500 km long railway network, the main characteristics of which were the following between 2004 and 2008.

Table 2. The Characteristics of the MÁV Co's Railway Network (2004-2008)

MÁV Co.	2004	2005	2006	2007	2008
Built length of railway network (km)	7650	7650	7650	7596	7511
Built length of double track railway lines (km)	1146	1146	1146	1173	1173
Rate of double track railway lines (%)	14,98	14,98	14,98	15,44	15,62
Rate of electrified railway lines (%)	33,55	33,55	33,55	33,79	34,17
Run freight train (number/year)	212 827	216 405	237 497	221 976	195 644
Run passenger train (number/year)	1 112 448	1 020 344	1 044 186	1 078 066	1 076 229
Kilometres by freight trains (trainkm)	16 498 2 13	16 894 000	18 963 648	18 836 132	18 276 716
Kilometres by passenger trains (trainkm)	80 237 372	75 396 595	77 238 250	84 527 403	83 447 780
Punctuality of passenger trains (%)	94,78	94,14	92,89	93,39	92,60
IM's staff (people)	19 918	17 878	18 565	17 575	17 272

2. Handling of train path requests to performance accounting, business process of infrastructure manager and service packages

2.1. Handling of train path (and services) requests to performance accounting

Fig. 1. illustrates the whole process (in the case of minimum access package, track access to services facilities and supply of services and additional services) from handling of train path (and services) requests of train operator companies (railway undertakings, RUs) to performance accounting. In the case of ancillary services requests and orders go directly to the Infrastructure Manager from RUs.

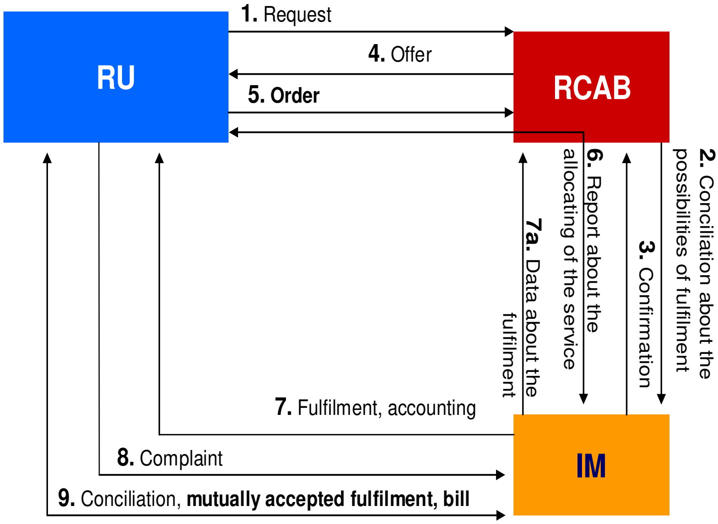

Figure 1. Whole process from handling of train path requests of train operator companies to performance accounting

Activities of RCAB are needed for the harmonisation of 2001/14/EC Directive. RCAB grants the train paths and open access infrastructure services for RUs. IM and RU take access contract (based on Network Statement regulations) on infrastructure services.

2.2. Business process of infrastructure manager

As the first step of the business process – shown in Fig. 2. - it is necessary to ensure the appropriate inland and outland environment, and make research on customer needs. The main elements of this process can be the market research and analysis of competitors, benchmark and analysis about service and charging systems, research on customer needs and developing methods for meeting the customer needs, etc.

The second step is to determine (according to the customer demands and international experiences) the service elements and to develop the service system from the service elements, which contains the processes like introducing new service elements, developing the service system, introducing service packages, determining and developing the quality of the provided services (making station and line categories from different service point of views), making capacity-analysis, determining charging principles.

Before introducing the new service system is necessary to prepare/modify the concerned regulations (Networks Statement, instructions) and to inform and train the members of the IM and RUs as well, about the content of different services.

To get the opportunity to introduce a service system is only possible after developing the frame of the system. After providing the service, the next step is conducting researches for customer needs.

The cycle of business process framed and influenced by the sales and marketing strategy which increases competitiveness and helps to optimize capacity and human resource allocation. The marketing communication about the developed service packages to the market regarding segments is also a part of the marketing strategy.

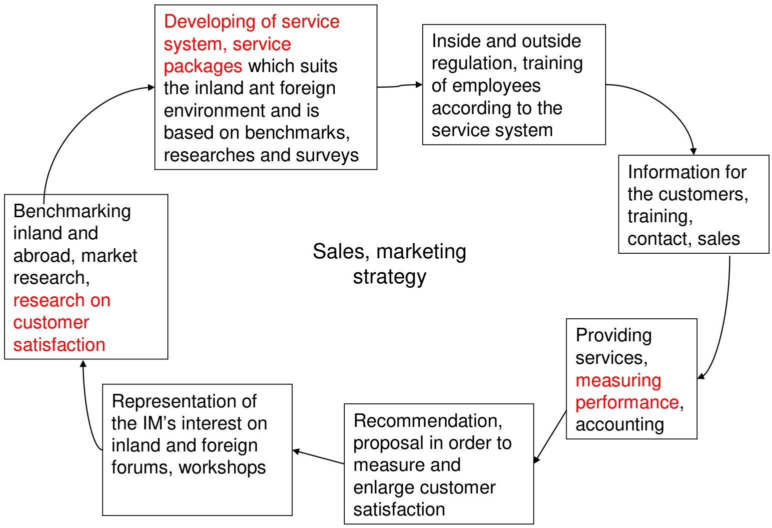

Figure 2. Sales and marketing process of Infrastructure Manager

2.3. Service packages of infrastructure manager

2.3.1. Introduction of the Common „RNE" Structure of the Network Statement, what kind of service groups RNE recommend for IMs to use

The RNE recommendation follows the principles of the Directive 2001/14/EC, so it distinguishes 4 different service categories:

1. The minimum access package, which is obligatory to provide by the IM and RU has to make use of it.
2. Track access to services facilities and supply of services, which is obligatory to provide by the IM but RU can decide whether to make use of it or not.
3. In case of Additional services IM can decide whether to provide and publish the service or not. If the IM publishes the service in NS, IM has to provide for RUs. The RUs can decide whether to use it or not.
4. Ancillary services are not obligatory to provide (deliver) and not obligatory to make use of them, both IM both RU can decide whether to provide and whether to make use of them.

Table 3: Service categories

Service category	For IM to provide the services	For RU to make use
Minimum access package	Obligatory	Obligatory
Track access to services facilities and supply of services	Obligatory	Not compulsory
Additional services	If publishing than obligatory	Not compulsory
Ancillary services	Not compulsory	Not compulsory

The content of the different service categories mentioned above is the following:

The first service group is the **minimum access package**. Here NS has to contain the List and Description of the services obligatory delivered by IM according to Directive 2001/14/EC, Annex II, point 1.

Under **Track access to services facilities and supply of services** NS has to detail the services described in Directive 2001/14/EC, Annex II, point 2 – including track access conditions and usage conditions for each of the services listed, also stating if services are delivered by IM, or by other suppliers, who may be referred to.

If RU is interested in information on location, it can find them in chapter 3 of NS ”Infrastructure”.

For information on charges of the listed services, refer to chapter 6 ”Charges”. This information can not be found in chapter 5.

Under **Additional services** NS has to define products listed in Directive 2001/14/EC, Annex II, point 3 – including usage conditions for each of the services listed, also stating if services are delivered by IM, or by other suppliers, who may be referred to.

If the IM provides other additional services than listed in the previous numbers (5.4.1-5.4.5), these additional services are to be listed here with separate sub numbers. – we will see examples for this case in the paper.

Under **Ancillary services** NS has to contain product definition of services listed in Directive 2001/14/EC, Annex II, point 4 – including usage conditions for each of the services listed, also stating if services are delivered by IM, or by other suppliers, who may be referred to.

2.3.2. The infrastructure service system of Hungarian State Railways

In the introduction, the regulations are listed which have been considered during the Development of the Network Statement. These are:

– Directive 2001/14/EC of the European Parliament and of the Council on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification;

– Hungarian Act CLXXXIII of 2005 on the Railways (Hungarian Railway Act);

The infrastructure services are regulated by the 54th Paragraph (§) and are listed in the 3rd Annex of the Railway Act.

Due to MÁV and GYSEV are integrated companies, in Hungary there is an independent capacity allocation body, the RCAB, who allocates capacity for RUs in order to ensure non-discriminatory. NS is published on the internet by the Hungarian RCAB, named VPE.

3. Determining of access charges

3.1. IM strategy in relation to access charges

The IM of MAV Co has its own balance sheet following the internal separation. It accounts for access charges for users since 2003. This was the time when prices appeared in the Network Statement.

Basic strategic issues with access charges for the IM:

1. The IM wants to achieve full cost recovery without profit. Current access charges are provided according to a full cost allocation method, where all cost components of the IM are coupled to services and "flow" into the prices of these (more details in section 3 below).
2. The law 66/2003 GKM-PM determines that services of the minimum access package (path allocation and train running) are not allowed to cover central management costs. This means, that after the proper allocation of central management costs to all services, the part that should be carried by the services of the minimum access package are not included in the prices, but are subject to the railway–state contract. These costs are approximately 12% of the total costs of the IM.
3. The state is willing to sign the appropriate contract with the IM to cover the part of central management costs that should be allocated to the services of the minimum access package. With this contract the IM would achieve full cost recovery: 12% from the state and 88% from railway users.
4. Direct costs, or those cost elements that are subject to allocation procedures, are "only" those cost items that are booked in the accounts of the IM. Other railway costs (e.g. traction fuel, real estate maintenance used by the traction business unit, etc.) do not appear in the books of the IM and are therefore not part of the basis for cost calculations and charges. The term "full cost recovery" addressed under point 3 above means only the full costs of the IM.
5. There are no external costs or taxes, no environmental overcharges or subsidies included in the prices although these are partly allowed by the Hungarian Railway Act.

6. The cost calculation – the basis for the price determination – is done by the IM, but prices are calculated and negotiated by the RCAB. Prices do not change every year. The available history shows, that price re-engineering has been started every two years, but this has resulted only in a slight change in the price structure, not in a change in price levels of the various market segments.

Although the price structure had several smaller changes in the last years, the nominal values of rail access prices did not change since the first Network Statement. This means two directions of real price changes:

1. As the production price index increased about 5% yearly from 2003-2007, this means approximately a 28% real value discount compared to the 2003 initial price (for all types of trains).
2. The passenger transport business unit introduced integrated cyclic timetable (ITF – Integrierter Taktfahrplan) for some parts of the network. This is why the performance of passenger trains improved in 2006, even though unit prices did not change. Therefore, the passenger transport business unit (later the MAV-START Co.) has nominally an approximately 22% higher expenditure on charges than before.

The pricing principle itself (full cost basis) is rarely discussed, but the level of charges is continuously under heavy negotiations. The decision depends primarily on the Ministry of Finance, and the available state budget for rail infrastructure operation and investments.

3.2. Structure of the current access charges

The current charging system is the slightly developed version of the first one, introduced in 2003. In that year it was only used within the integrated company MAV Co., but later (2004) it appeared also in the Network Statement of the IM. One of the very first questions that had to be answered by the price calculation process is the one of the selected variables. Under this group of problems, the following main questions had to be answered:

1. How detailed should the price system be? Naturally, the easiest would be to divide all costs by the number of trains or the train kilometres, but this “solution” might not be accepted by the market. In Hungary, the price system uses about 5-8 variables that are available independently from each other.
2. Which variables describe the service item accurately? E.g. the shunting service can be more or less independent from the axle kilometre, but may better co-relate with the number of shunted wagons or the real shunting time.
3. Which data is actually measured in real time by the IM (which data is available from own sources)? It is no use to select gross tonne kilometre for train movements as a price basis if the IM only has train kilometres available.

Table 4. Variables and differentiation of the IM's services (based on the Network Statement)

Name of the service	***Variables***	***Differentiation***
Minimum access package		
path allocation	number of paths	type of trains[1)], long term vs. short term orders
train running	train kilometres	type of trains[1)], line category[2)]
Access to service facilities		
use of overhead catenaries	electric train km	type of trains[1)]
passenger train stops	number of stopping	station category[2)]
passenger train departures/destinations	number of departures/destinations	station category[2)]
freight train start/interim/ destination usage	number of cases (usage)	station category[2)]
freight wagon access to loading/unloading tracks (station usage for serving)	number of wagons	station category[2)]
rail vehicle storage	number of wagons	long term vs. short term orders, vehicle technical features
access to weighting facilities	number of wagons	none
additional personnel	person hours	long term vs. short term orders
train registration (outside)	number of cases	none
Additional services		
shunting of freight wagons (marshalling and shunting)	number of wagons	owner of shunting engine
consignment of freight wagons	number of wagons	owner of consigning engine
forwarding of dangerous and outsized goods	number of cases	type of goods / desired allowances
weighting	number of wagons	none
change of axles (normal to wide and vice versa)	number of wagons	type of goods regarding danger code
usage of normal gauge boogies	hours	none
Ancillary services		
education and examination of RU's personnel	number of cases	type of education / examination

[1)] type of trains: long distance passenger trains, local passenger trains, empty passenger trains, freight trains, maintenance trains, single engines.

[2)] lines and stations are classified into 3 categories according to the technical factors (e.g. signalling systems), limitations (number of tracks, axle load) and level of offered services (e.g. opening times, number of shunting locomotives). It can happen that upgrading the line for passenger traffic (e.g. raising the speed from 100 km/h to 140 km/h) causes rising prices for freight trains as well.

The IM now has very limited directly measured, factual data available on passenger transport trains. Naturally, the IM has a proper database about the orders and the planned timetable, and can manage its task according to these data, but the logging system on stations, that could "measure" the differences between the orders and the actual services is missing for passenger transportation (it is already available for freight transportation). The real-time logging of the infrastructure services in the context of the running of passenger- and locomotive trains will be realized in 2010 by the operation of the PASS2 system. This demand on data instigated and motivated the development of the station-logging system that covers all trains, and will provide basic, electronic information about all types of trains by the end of 2008. Services offered by the IM, their variables and the differentiation basis are shown in Table 4.

3.3. Structure of the current cost accounting system

The strict relation of charges to costs requires a well detailed cost database. Without a proper accounting system, the adequate cost and charge calculation will not be possible. Preparation for this new cost accounting system started already in 1995, but the full and live use of the new Accounting Management System (AMS) started only in 2001.

Apart from the technical hierarchy (access to all accounting data via a Web-based application, relatively short answer time of the system, prepared queries according to main controlling and management issues, etc.) the structure of the database is of primary importance.

All accounting data can be split to corporation code, accounting code, activity code, organisational code and track section code.

Since pre-defined and flexible queries can be made according to different instances, the charge calculation is supported by the accounting system.

In their relation to booking entities, costs can be classified into several groups. Each group might have a different allocation procedure. These groups are centrally booked costs, costs booked to open line track sections (captured by track section codes), costs booked to station track sections (captured by track section codes and activity codes).

4. Evolutions, trends and recommendations

The service system is the result of the business process cycle on Fig. 1. with monitoring and following the changes in the international environment, RU demands, IM skills, parameters and legal regulations. It means that the service system is not a stable system, is changes as often the elements which have effect on it are modified. The change of the service system means the all the processes of the cycle on Fig. 1. are under continuously change and development, which results in providing the service elements what the market needs.

The Sales Department of MÁV Hungarian State Railways Company Infrastructure Business Unit (IBU) has conducted Customer Satisfaction Studies since 2005. The personal in-depth interviews concern all the railway undertakings having network access contracts. The research covers the contracting, invoicing, servicing and staff (in headquarters and in the regional centers) area. According to the summary about the results of the last research contracting is on an acceptable level. Our customers evaluated the invoicing performance of the IBU (Infrastructure Business Unit) on very good level with relatively lots of excellent values and perspectived an improving tendency. On the whole our customers considered the performance of IBU on acceptable level.

The main areas, which have to be intervened are following:

- Changing our ‘way of thinking’: FROM ‘Why cannot we do it?’ TO ‘How can we do it?’

- Revising our administrative systems: simplification, modernisation
- Development of IT supporting: efficiency, further electronisation
- Improving the inside cooperation of different professional departments: efficiency, reduction of time factor
- Development of railway network: quality and safeguarding
- Advancing in the questions of warranty
- Diminishing of service influencing effect of human factor

The current cost and charge calculation at the MAV Co. is the refined version of the first one introduced in 2003. As many important questions are not decided even at European level (e.g. the Marginal Cost vs. Full Cost debates), there might be changes in the short and in the long run as well. On the other hand, it is not only the European legislation that influences the market prices and costing behaviour of the IM, but users and the road competition are of high importance. There are some changes that are already foreseeable for the Hungarian infrastructure pricing scheme.

1. The IM now has a relatively low-quality dataset about the actual traffic performances. Real time measurement of the performance is only available in case of services for the freight trains. This is why the IM started an ICT project to obtain actual, real time measured data from all segments of the railway transportation. The system is based on electronic log booking of station events. The second step will be the automation of data input from signalling systems from 2010.
2. The price system should be based more heavily on gross tonne kilometres, as this is the best indicator for track wear and tear. Research is already started to clarify the changes to the current system.
3. The network graph has to be detailed. Now the owner of industrial tracks is not indicated in the accounting system. If a shipper or any third party maintains an industrial track, different prices should apply for consignment and marshalling.
4. Shunting technologies differ from station to station. The current prices do not cover differences in the shunting technology. The reason is the missing details of cost data.
5. Border crossing procedures differ from border station to border station. The differences (similarly to shunting) are not represented by prices because of missing cost data.
6. The Network Statement does not contain anything about the warranty obligations of the IM. Users want the IM to introduce refund in case of delayed trains and to provide different levels of guaranteed paths. The cost structures behind these expectations have to be elaborated in the short run.

Most of the practical debates around railway pricing are definitely *not* about the charging principles, but about the actual level of charges. Users are less interested in econometric research at this field, but they pay attention to the total amount that they have to pay for the access to the tracks. The current levels of charges all across Europe vary from 10-12% cost coverage to 10% profit (110% of costs). Harmonisation of pricing regimes does not help much if it simultaneously ignores the question of the level of charges. On the other hand, the level of charges should be discussed with all the national governments, as it is the government that has to pay for the uncovered costs of the railways. State budgets have different limitations in each country. Therefore, an incentive for harmonisation should care about this matter as well.

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Improving the Quality Assurance. Methodology for a Better Enterprise Data Adapted for the Rolling-Mill Rolls Manufacturing Area

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Abstract: In engineering and manufacturing quality control and quality engineering are involved in developing systems to ensure products or services are designed and produced to meet or exceed customer requirements. These systems are often developed in conjunction with other business and engineering disciplines using a cross-functional approach. Quality assurance is the activity of providing evidence needed to establish quality in work, and activities that require good quality being performed effectively. All those planned actions necessary to provide enough confidence that a product or service will satisfy the given requirements for quality. Quality assurance covers all activities from design, development, production, installation, servicing and documentation. It includes the regulation of the quality of raw materials, assemblies, products and components, services related to production management, production, and inspection processes.

Keywords: quality assurance, cast-iron rolls, improvement, manufacturing

1. Introductory notes

Todays demands for flexible and economic production of hot-rolled strip can only be met by automation solutions which are based on in-depth technological process modeling know-how, high-performance control systems and a comprehensive understanding of hot-rolling logistics.

Production logistics is the term used for describing logistic processes within an industry. Also, the purpose of production logistics is to ensure that each equipment and technologies is being fed with the right product in the right quantity and quality at the right point in time.

The manufacture of rolls is in continuously perfecting, the requirements for superior quality rolls are not yet completely satisfied, in many cases, the absence of quality rolls preventing the realization of quality laminates or the realization of productivities of which rolling mills are capable.

Logistics activities are searching constantly for ways to improve process capabilities, shorten throughput times, improve quality, and cut costs. Many manufacturing and quality engineering books describe the specifics of defining process capabilities or optimally designing logistics systems. In many cases, the need for improvements may be obvious. In fact, to many private or public sector organizations, these improvements may be necessities.

The production logistics, as an important component of logistics systems in production companies, covers planning, management and monitoring of the material flow – from raw-material warehouses and various production stages to warehouses for finished goods. In the complete value cycle, production logistics follows procurement logistics and precedes distribution and reverse logistics. The technological manufacturing process of the rolling mills rolls, as well as the quality of material used in manufacturing them, can have a different influence upon the quality and the safety in the exploitation. Our proposal approaches the issue of quality assurance of the rolling mills rolls, from the viewpoint of the quality of materials, which feature can cause duration and safety in exploitation.

The quality assurance research fields can be defined through the general research area, throught the different experiments effectuated in the laboratories, and, also, throught the modern calculation programms, optimization technologies and the better capitalization of the manufacturing data.

In the rolling industry, the quality of the product (of the rolls, in this case) is in directly accordance with the quality of technologies (defined by the casting equipments, materials, applied procedures, etc), and also, by the quality of the manufacturing process (charging, melting, innoculation, laddle treatment, casting, cleaning, etc).

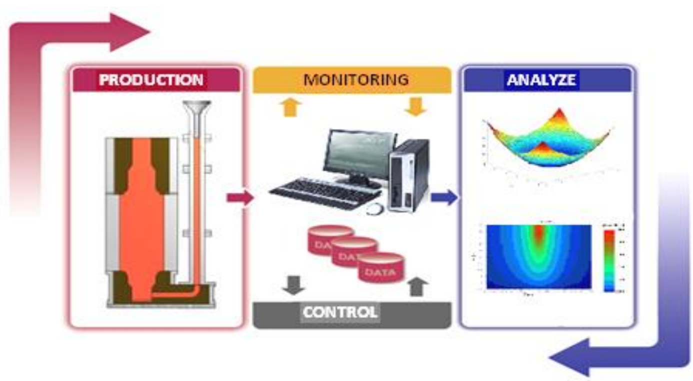

Figure 1. The Quality Assurance in Rolling-Mill Rolls Manufacturing Area

Roll material and the groove design are major factors affecting rolling performance and roll life. The entire operations from selection of raw materials to dispatch of finished products go through a series of quality control checks conducted by a team of metallurgists. The computer controlled emission spectrometer analyses the bath samples of the hot metal to ensure current chemistry of both the final products. The products are tested for surface hardness by the conventional hardness testing equipment along with sample checks; in the laboratory to confirm to specification defined by the customers. The metallographic and mechanical tests are carried out to ensure the over all internal soundness, in particular, the quality of bound between the shell and core.

Figure 2. The Rolling-Mill Rolls Manufacturing Area's Quality Assurance Fields

Depicted, developed, specified process and methods have been institutionalized for achieving the quality requirements of products of various grades. Synchronization between all activities and sub process are maintained to build desired properties in rolls. The quality assurance general fields in the rolling-mill rolls manufacturing area in Figure 1 are presented, graphically. In Figure 2 the quality assurance fields are presented and the domains which are specifically for the rolling-mill rolls manufacturing area.

2. Improving the Quality in Rolling-Mill Rolls Manufacturing Area

Improving quality involves applying appropriate methods to close the deficiencies between current and expected levels of quality as defined by standards. This activity can use the quality management tools and principles to understand and address technical system deficiencies and improve the future technological processes. A range of quality improvement approaches exist, from individual problem solving, rapid team problem solving, and systematic team problem solving to process improvement and redesign and organizational restructuring or reengineering. The improving quality must include:

- the approach to quality improvement
- the spectrum of quality improvement approaches
- the performance improvement
- analyses of efficiencies

Quality improvement methodology has evolved over the years. Early quality assurance efforts assumed that improvements could be readily attained by adding new or more things, such as new machines, procedures, training, or supplies. It was believed that simply adding more resources or inputs would improve quality. People working to improve quality learned that increasing resources does not always ensure their efficient use and, consequently, may not lead to improvements in quality. In fact, in many cases, the quality can be improved by making changes into the systems without necessarily increasing resources. Interestingly, improving the processes not only creates better outcomes, but also reduces the cost of delivering services by eliminating waste, unnecessary work, and rework. Inspecting main activities or processes is another approach that managers have used to identify and solve problems. These methods tried to increase the control over the technological processes, in scope to avoid the eventually mistakes inefficient processes, or imperfections. The approaches can examine how activities can be changed for increase the performance. The role of approach is recognizes that both the resources (inputs) and activities carried out (processes) must be addressed together to ensure or improve the quality of products. The methods which define the quality improvement are consisting in following steps:

- identify, also determine what to improve;
- analyze, also understand the problem;
- develop, also hypothesize about what changes will improve the problem and develop solution strategy based on these changes;
- test and implement, also test the hypothesized solution.

Figure 3. The Steps in the Quality Improvement

The quality improvement is not limited to carrying out these four steps, but rather emphasizes continuously looking for ways to further improve quality. When improvements in quality are achieved, teams can continue to strive for further improvements with the same problem or address other opportunities for improvement that have been identified**.**

2.1. Step one: Identify

The goal of the first step, identify, is to determine what to improve. This may involve a problem that needs a solution, an opportunity for improvement that requires definition or a process or system that needs to be improved. This first step involves recognizing an opportunity for improvement and then setting a goal to improve it.

2.2. Step two: Analyze

Once areas for quality improvement have been identified, the second step is to *analyze* what we need to know or understand about this opportunity for improvement before considering changes. The objectives of the analysis stage can be any combination of the following:

- clarifying why the process or system produces the effect that we aim to change
- measuring the performance of the process or system that produces the effect
- formulating research questions, such as the following:

To reach these objectives, this step requires the use of existing data or data collection. The extent to which data are needed depends on the quality improvement approach chosen. Techniques to analyze problems include clarifying processes through flowcharts or cause-effect analyses, reviewing existing data, and, when needed, collecting additional data.

2.3. Step three: Develop

The third step, *develop*, uses the information accumulated from the previous steps to explore what changes would yield improvement. A hypothesis is formulated about which changes, interventions, or solutions would reduce the problem and thus improve the quality of products. A solution strategy is then developed based on this hypothesis. It is important to remember that at this point the hypothesis remains a theory, as it has not yet been tested. A hypothesis is a tentative assumption made in order to test its consequences. It is based on roll makers knowledge and beliefs about the likely causes and solutions of the problem.

2.4. Step four: Test and implement

This step, *test and implement,* builds on the first three. A hypothesis is tested to see if the proposed intervention or solution yields the expected improvement. Because interventions that prove to be effective may not yield immediate results, allowing time for change to occur is important in the testing process. The results of this test determine the next step, also the start the improvement process (if the proposed change did not produce an improvement), the modify the proposed change (if the proposed change yields improvement that is not completely satisfactory) or begin the implementation of the change or intervention (if the proposed change yields satisfactory improvement).

3. The Spectrum of Quality Improvement Approaches

3.1. Rapid Team Problem Solving

Rapid team problem solving is an approach in which a series of small incremental changes in a system is tested—and possibly implemented—to improve quality. Like individual problem solving, this approach could be used in any setting, although it generally requires that teams have some experience in problem solving this approach quickly. Rapid team problem solving may involve cause analysis, but implemented in a less rigorous fashion than in systematic problem solving.

3.2. Systematic Team Problem Solving

Systematic team problem solving is often used for complex or recurring problems that require a detailed analysis. It frequently results in significant changes to a system or process. This approach is a detailed study of the causes of problems and then developing solutions accordingly. This detailed analysis usually involves data collection and therefore often requires considerable time and resources.

4. Process Improvement

The most complex of the four approaches, process improvement, involves a permanent team that continuously collects, monitors, and analyzes data to improve a key process over time. Process improvement is often used to assure the quality of important services in organization. Since this approach is often used to respond to core processes of a system, various stakeholders contribute to the analysis stage.

In sum, experience with quality improvement has rendered it a simpler, more robust methodology, and the application to a wide range of settings has become clearer. In all of these approaches, the methodology and principles remain unchanged, though their specific methods may vary.

5. Analyze, Improve and Control

The data profiling, sometimes called data discovery or data quality analysis, is the essential first step in any data improvement program. Data profiling provides a wealth of information about the integrity of the technical data specific for the processes and illuminates potential problems in the workflows. An effective data profiling approach allows to structure a data quality solution to address the specific nature of the data quality issues.

After identifying the data issues in the data profiling phase, it's time to begin correcting these issues. In the data quality phase, is necessary start to improve the quality of information throughout the enterprise by creating business rules to correct, standardize and validate the data. The high-quality data is essential to successful technical operations.

An effective data integration strategy can lower costs and improve productivity by ensuring the consistency, accuracy and reliability of data across the enterprise. In this sense, ensuring the source data is consistent, accurate and reliable through a data quality process is the foundation for any successful business initiative.

After data quality establishes corporate standards for information and data integration creates a unified view, the entreprise (foundry) is ready to begin expanding on the value of its data and enriching its view of the specific customers, products and partners.

When the data enrichment is complete, the entreprise (foundry) has a unified, high-quality, and value-added view of its corporate data, and a solid base to make sound, informed business decisions. But the company will always be getting new data. Without the capability to maintain the integrity of that data, the benefits of all integrated system work start to disappear. Data monitoring builds on initial data quality and integration initiatives by providing the technology to examine data over time, enforce continued adherence to business rules, and prevent good data from going bad. Data monitoring helps you maintain consistent, accurate and reliable data.

Figure 4. Methodology for a better enterprise data

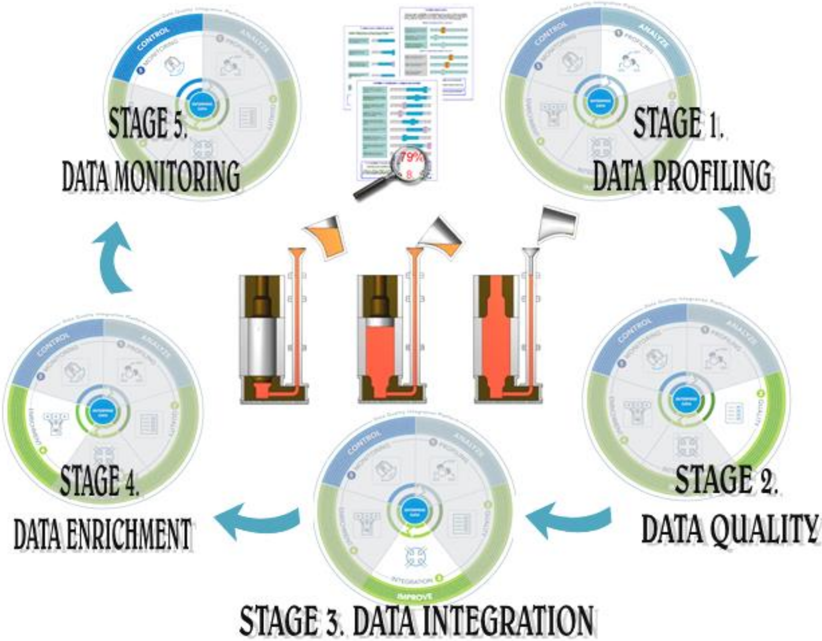

Figure 5. Methodology for a better enterprise data adapted for the Rolling-Mill Rolls Manufacturing Area

The entire methodology can build a better enterprise data and will make various analyze, improve and control data (Figure 4). This is achieved through five methodological building phases (stages):

- Stage 1, also data profiling stage, also inspect data for errors, inconsistencies, redundancies and incomplete information
- Stage 2, data quality stage, also correct, standardize and verify data
- Stage 3, data integration stage, also match, merge or link data from a variety of disparate sources
- Stage 4, data enrichment stage, also enhance data using information from internal and external data sources
- Stage 5, also data monitoring stage, also check and control data integrity over time

6. Conclusions

This methodology can help any technical and technological analyze, can improve and control data in any enterprise area. The methodology provides the foundation to understand and improve the quality of data in any metallurgical organization. These mission-critical efforts require a complete, end-to-end approach to data quality. In this sense, the implementation of this methodology can help the general entreprise activity. We can ennounce the following advantages:

- drastically reduce the time and resources required to find problematic data;
- catalog and analyze data and discover data relationships;
- discover the quality, characteristics and potential problems of information before beginning the processes;
- verify and validate data accuracy to improve the overall accuracy of customer records, product data and other information;
- ensure that high-quality information;
- enhance the value of product data with commodity coding and categorization details;
- detect when data exceeds pre-set limits.

Data monitoring has become a key component of a complete data-quality and data-integration practice, giving organizations the tools they need to understand how and when their data strays from its intended purpose. Monitoring also helps identify and correct these inefficiencies through automated, ongoing enforcement of customizable business rules. Data monitoring ensures that once data becomes consistent, accurate and reliable, it remains that way, giving confidence to professionals who make information-based decisions in any organization.

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Some Approaches to the Integrated Steel-Making Processes Performance Improvement of an Existing Steelmaking Processes

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Abstract: In modern production workflow optimization is very important because of the direct influence on production expenses. Also the continuous pressure of competitive companies forces the production of cheaper products but maintaining high level of quality and flexibility of the workflow in the same time. To achieve this goal it is necessary to apply new methodology, empirical data and theoretical models to solve practical problems and achieve optimal results. Organizing is the process of arranging resources (people, materials, technology etc.) together to achieve the organization's strategies and goals. The way in which the various parts of an organization are formally arranged is referred to as the organization structure. It is a system involving the interaction of inputs and outputs. It is characterized by task assignments, workflow, reporting relationships, and communication channels that link together the work of diverse individuals and groups. Any structure must allocate tasks through a division of labor and facilitate the coordination of the performance results. Nevertheless, we have to admit that there is not a best structure that meets the needs of all circumstances. Organization structures should be viewed as dynamic entities that continuously evolve to respond to changes in technology, processes and environment.

Keywords: performance improving, steel-making processes, plant management, workflows

1. Making a Steel Casting - Overview

The making of a steel casting is a long and complex process. A large investment in capitol equipment is required for the melting of steel, manufacturing of cores and molds and the cleaning and heat treating of castings. Additional major investments for support equipment and facilities are required for sand reclamation systems, dust collection devices and bulk material handling systems.

A typical casting begins when an order is entered into the Steel Production Control program. This entry adds it to the production schedule which in turn creates a demand for raw materials (i.e. sand, binder, scrap steel etc.) and manufactured items such as cores.

Typically, the core room reacts first, getting the necessary cores ready for setting as the molds are being made. Next, molds halves (upper and lower) are made and sent to the assembly area. At the assembly area, molds are flow coated and cores are set in place. The mold is then closed up for pouring.

As the assembled molds are being staged on the pour-off lines, a heat is melted in the arc furnace. Molten steel from the arc furnace is brought to the molds on the pouring lines in a refractory lined pouring ladle. Once poured, the molds are allowed to cool before being sent to the shakeout. At the shakeout, the castings are separated from the sand mold. The sand is sent to a reclamation system so that it can be reused in the molding process.

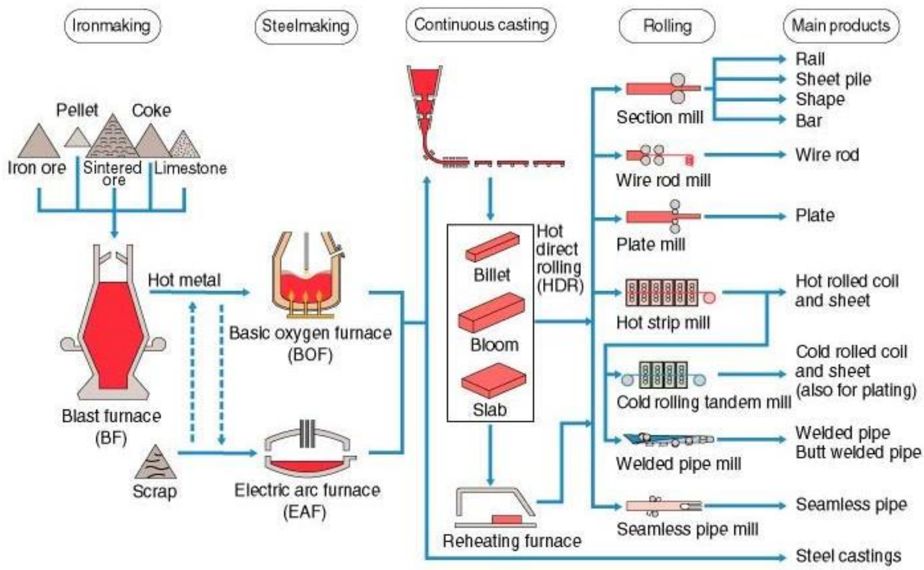

Figure 1. The making of a steel casting

As castings are removed from the shakeout they are sent to the cleaning room where they are 'finished' to the customer's specifications. Processing in the cleaning room includes shot blasting, cut-off, welding, heat treating and inspection.

2. Integrated Steel-Making Processes

An integrated steel mill has all the functions for primary steel production:

- iron making (conversion of ore to liquid iron),
- steelmaking (conversion of pig iron to liquid steel),
- casting (solidification of the liquid steel),
- roughing rolling/billet rolling (reducing size of blocks)
- product rolling (finished shapes).

The principal raw materials for an integrated mill are iron ore, limestone, and coal (or coke). These materials are charged in batches into a blast furnace where the iron compounds in the ore give up excess oxygen and become liquid iron.

2.1. Integrated Process for Iron-making

An integrated steel mill starts with iron-bearing materials, principally iron oxides, which are reduced to molten iron in blast furnaces using the carbon of coke as the reducing agent. The coke is produced on site from coal or is purchased. In coke making, coal is heated at 900-1200C in an oxygen-deficient atmosphere to remove volatile components. The remaining residue is coke. About 1.23 metric tons of coals are needed to produce 1.0 metric ton of coke. This process is carried out in refractory bricklined ovens, with coal introduced in a pulverized state through ports in the top of the ovens. The ovens are heated by coke-oven gas, which burns in flues located in the oven sidewalls. After conversion is complete, the oven doors are removed, and the coke is pushed out of the oven and transported to water quenching towers. The cooled coke is crushed and screened in preparation for the blast furnace. Volatiles removed from coal during conversion to coke are further processed to recover useful by-products. A single mill may operate as many as 500 coke-producing ovens. An overview of the integrated process for making steel is shown in Figure 2.

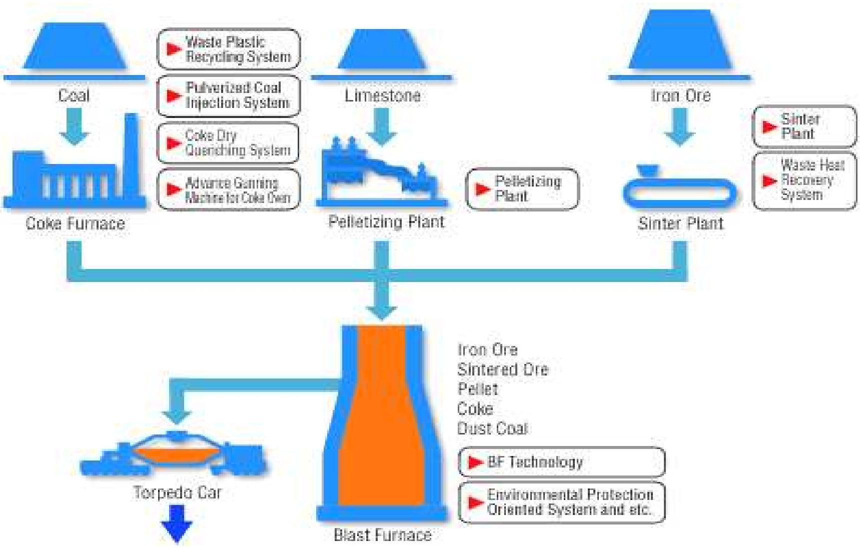

Figure 2. The Integrated Process for Steel Making. Ironmaking Division

Two primary processes are used to prepare the charge for the blast furnace, pelletizing and sintering. In pelletizing, unbaked balls are formed from iron ore combined with a binder. These balls are heat treated in an oxidizing furnace at the mine and shipped to the mill where they are fed into the blast furnace along with coke, fluxes, and often sinter. In producing sinter, iron ore fines, coke fines, water waste sludge, limestone, and air pollution control dust are agglomerated and heated. Heat for producing sinter comes from ignition of the coke fines. The heated mass is fused, cooled, and sized before being sent to the blast furnace. The sintering process aids recycling of iron-rich waste products, but few installations remain because of difficulties in meeting regulatory compliance.

2.2. Integrated Process for Steel-making

The liquid steel, which is produced in large quantities, has to undergo downstream processing. For this purpose it is given certain shapes, dimensions and weights by means of casting. In an integrated iron and steel mill, the capacious casting shop lies, in terms of material flow, downstream of the steel plant and upstream of the rolling mills. Steel is cast according to the ingot or continuous casting method. Ingot casting, which involves pouring the steel portion by portion into permanent (ingot) moulds, is gradually decreasing in importance and used only for high-weight pieces that are to be processed further by forging.

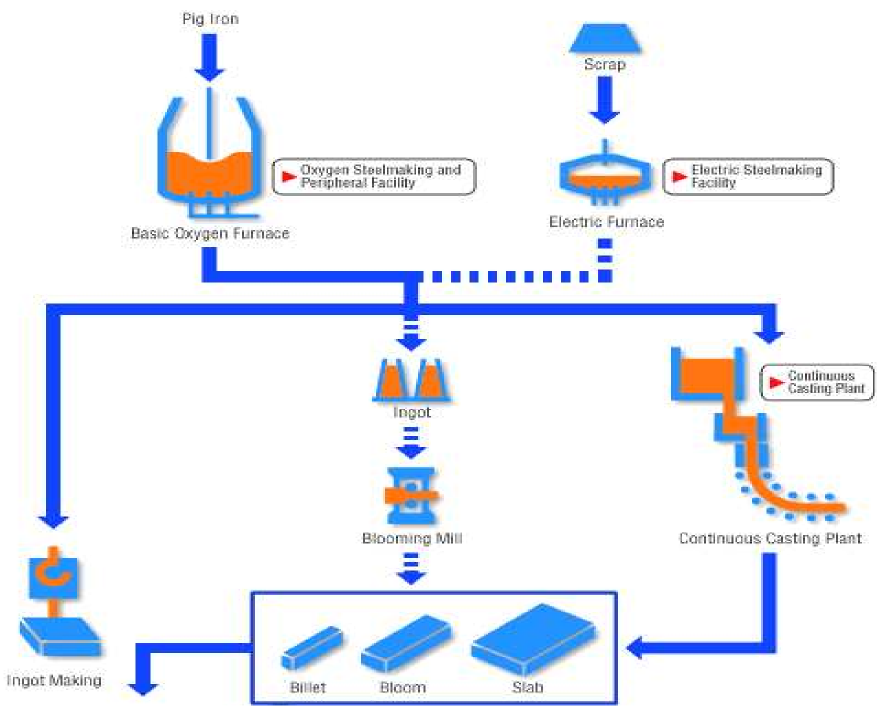

Figure 3. The Integrated Process for Steel Making. Steelmaking Division

Increasing importance is being attached to scrap recycling for reasons of optimum raw materials utilisation and environmental protection. Steel offers everything needed in this respect, making it a particularly eco-friendly material.

2.3. Integrated Process for Continuous Casting Processes

In the continuous casting process, the liquid steel passes from the casting ladle via a tundish, in closed-stream mode, into a short, water-cooled copper mould. The shape of the mould determines the shape of the strand. Before the start of casting, the bottom of the mould is closed-off by means of a link-type chain or so-called dummy bar. As soon as the required metal level has been reached, the mould is subjected to vertical oscillations so that the strand does not adhere to the mould wall. The incandescent strand, once solidified in its surface zone, is withdrawn from the mould, firstly with the aid of the dummy bar, and then by pinch rolls, while the mould is continuously replenished with liquid steel from the top.

Because of its liquid core, the strand has to be carefully sprayed and cooled with water and supported on all sides by rollers until it has solidified completely, thereby avoiding any breakout through the still thin surface zone.

The main components of a casting machine are shown in Figure 4. Essentially, a casting machine consists of a liquid metal reservoir and distribution system (a tundish), a watercooled mold, secondary cooling zones in association with a containment section, bending rolls, a straightener, cutting equipment and a runout table to cooling beds or directly to a product transfer area.

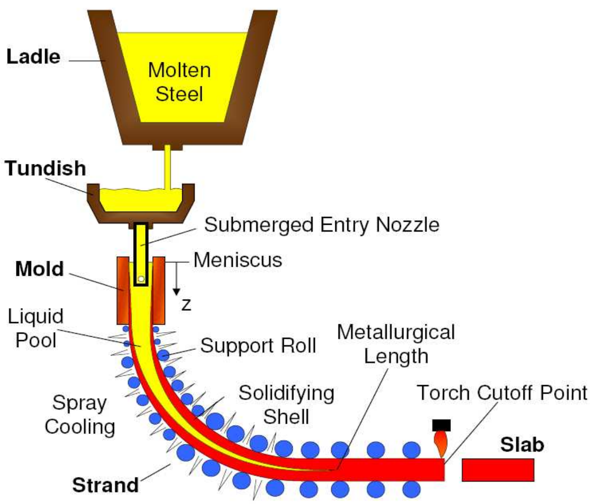

Figure 4. Cross section of a Slab Caster

A casting machine can have a number of casting strands each of which is associated with an independent mold, secondary spray water cooling zone, containment section, etc. The number of strands depends principally on the shape being cast (slab, bloom, billet etc.) and the heat size.

Solidification of the liquid steel starts in the water-cooled mold and continues progressively as the strand moves through the casting machine. Freezing begins at the liquid steel meniscus level in the mold forming a shell in contact with the walls of the mold. The distance from the meniscus level to the point of complete solidification within the machine is called the metallurgical length.

After straightening, the cast section is cut to the desired length either by torches or shears. The hot cut lengths are then either conveyed by a run-out roller table to cooling beds or grouped and transferred directly to subsequent hot and cold-rolling operations.

2.4. Integrated Process for Rolling

Rolling is the most widely used deformation process and for the reason that there are so many versions the process has its own classification.

Continuous rolling mills can be classified according to the arrangement of stands or passes. These are in line in a continuous mill and line abreast in a looping or cross-country mill. Looping and cross-country mills require the workpiece to be bent or turned between stands and are used therefore for rolling rods, rails or sections. Continuous mills are used for plates, strip or sheets. They all require a large capital outlay and are only justified when a large demand for the product is guaranteed.

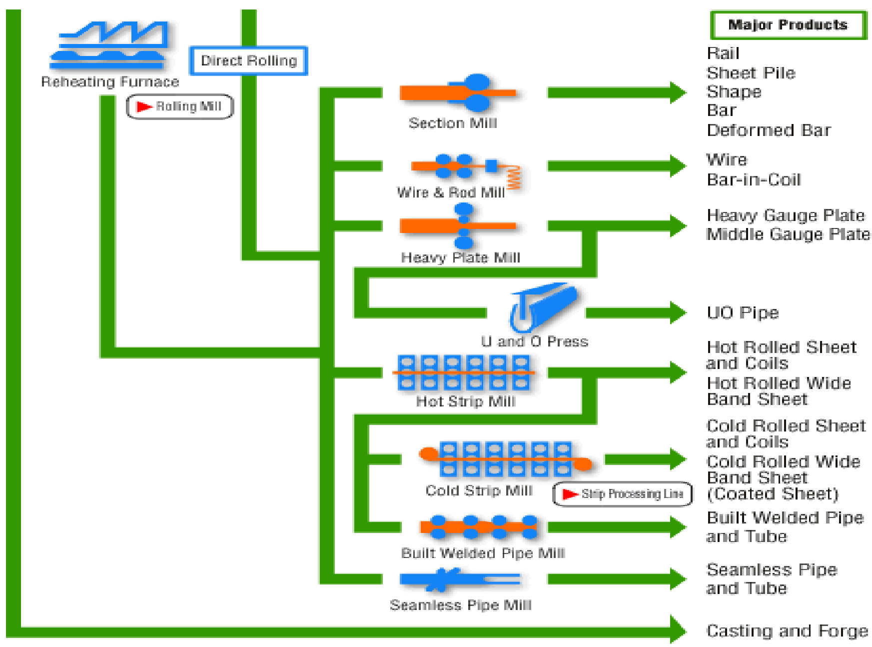

Figure 4. The Integrated Process for Steel Making. Rolling Division

Hot rolling is one of the shaping processes that follow primary forming (ingot/continuous casting). Hot strip and plate are hot-rolled flat products. In conventional (wide) hot strip mills the feedstock (slabs) is heated in reheat furnaces and then transferred to the roughing train. Shortly after leaving the furnace, the slab passes through a descaler to remove the so-called primary scale. Directly downstream of the finishing train are the runout roller table including cooling section and coiler. Precise control of the finishing temperature in the last stand and of the coiling temperature is required so as to impart the appropriate mechanical properties to the hot strip. The strip is cooled with water, the water rate being controlled as a function of strip speed and temperature requirements.

3. Laboratory for Process Metallurgy

The main activities are basic and applied research in the field of melting of steels for the steel and casting industry, continuous casting of steel and hot working of steel. The research activities are performed in close cooperation with other laboratories and departments of the Faculty Engineering Hunedoara and with the steelworks within the Arcelor Mittal – Hunedoara branch.

- study and introduction of new technologies in steel melting process in electric arc furnaces and induction furnaces, optimizing of decarburization, refining and deoxidation in vacuum devices and ladle furnaces, optimization of alloying for the targeted analysis and advanced deoxidation.
- verification of the technological specification of steelmaking processes on the basis of modern steelworks technology of automatic inspection of processes with computer assisted systems.
- evaluation of existing technology from the economy and market point of view.
- technical support at introduction and optimal use of measurements-control systems for steelmaking processes (introduction of direct measurement of oxygen and automatic sampling of melt and slag, control of vacuum process in VOD and VAD devices by means of the PAT measuring technique).
- development of models for complexes steelmaking processes, such as oxidation of carbon. development of algorithms to deoxidation of melts, selection and choice of technology for modification of non metallic inclusions, selection of non metallic additives for formation of slag and their economical use.
- optimization of casting parameters dependent on chemical composition and behaviour of steel during casting and solidification. Study of the influence of solidification mode, concentration of phosphorus, sulphur and other impurities, overheating of the melt on solidification, study of primary and secondary cooling for prevention of crack formation during solidification.

Also, the modern production plant would no longer be imaginable without automated manufacturing processes. In the steel industry, computers are used for production data capture, materials flow tracking and control, process optimisation, and many other tasks. The plants and facilities in the steel industry are varyingly well-suited to automation.

Mechanical, chemical and thermal processes are in need of automation in this respect, with drive-related and logistical problem solutions also requiring consideration. A high degree of automation is achieved for fast processes, such as in rolling mills, where performance is predominantly linear. Installations with differing degrees of automation therefore exist one beside the other. Initially solitary solutions involving lines or process automation systems have, on the whole though, evolved into complex and, in some instances, fully integrated system landscapes.

The increasing "communication" of the production stages and rapid advances of the metallurgical and shaping process technologies necessitate the new and further development of suitable plant and equipment components. It is essential to ensure that the experience gained not only in production but also in maintenance can be channelled back into the fields of design and construction. Cooperation with manufacturers is a particular challenge in that respect.

4. Conclusions

The classic approach to steel production organises iron and steel mills into the production stages of ore preparation, coke, iron and steel making, shaping (rolling, forging, pressing), and steel finishing (coating) or downstream processing. In spite of these individual processes, steel production is a self-contained manufacturing complex, i.e. a system of individual units that are interlinked in terms of logistics and communication. To control such systems with regard to their technical characteristics as well as metallurgical and mechanical equipment, and to preserve the high fixed asset value, it is necessary to have organisational and tactical units in place which, at enterprises of the steel industry, are concentrated under the heading of "plant engineering". An accompanying element of this is plant management, which encompasses the activities in connection with new construction, modernisation, media supply, automation and communication engineering, and maintenance. It involves planning and organising the production plant and equipment, maintaining the availability and functional reliability that is economically necessary, keeping the production units state-of-the-art, and adapting them to the infrastructure of the constantly changing steel production environment.

The routes for producing iron and steel, as well as the product developments and fields of use for the steel grades have reached a very advanced state, yet still offer diverse potentials. The steel industry continues to face challenges with regard to innovations in plant and process engineering, product development, and product application, particularly in the use of steel as a resource-conserving lightweight material.

The trend of development in near-net-shape cast steel products, which began with thin slab casting-rolling plants, has been pursued consistently further and has led to new technical solutions and technologies.

The aim of plant management is not only to measure the performance of existing or future iron and steel mill installations against achievable output and yield but, additionally, to use the current state of the art in such a way that plant and equipment with a higher level of operational readiness and safety are realised, along with improved product quality and reduced costs.

In our efforts to characterize and improve the performance of an existing steelmaking process or in our quest to generate useful knowledge as a basis for the development of new manufacturing routes, measurements and models should be considered as two interdependent requirements. Without measurements, our models are incomplete and unsatisfactory. In addition, as engineers and applied scientists, we have an obligation and a responsibility to facilitate the transfer of new knowledge into the realm of operating practice. In this context, the preeminent aim of collaborative activities between our educational institutions, industrial organizations, government funding agencies, and professional societies it is so necessary.

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Insourcing Model for Food Storage and Forwarding

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Abstract: The result of a joint study accomplished by the Institute of Enterprise Management at the Budapest Tech and the Department of Logistics and Forwarding at the Széchenyi István University is published in this paper. The aim of the research was to examine the Hungarian logistic market in the point of view of food forwarding and storage. In this approach we were interested in food with special demands as well. Chilled or frozen food transport and storage require special terms and conditions. In order to establish a model for helping the decision making we investigated the characteristics of these fields of logistics. Using our model we can determine the length of time necessary to return. In this paper we publish the theoretical background and the model itself.

Keywords: modelling, insourcing, outsourcing, transport, warehouse, investment

1. Introduction

Last year a group of companies saw us about setting up a model in connection with investment decision making. The central issue was insourcing: whether it is worth to insource some services so far hired and if yes, what is the length of time of return. As a special condition, costs of investment can only be financed from savings arising because of giving up hiring the service and doing it by own. During setting up the model we faced several issues. We had to know what to expect from the strategic decisions so first we had to pay attention to the questions of outsourcing and insourcing in order to have theoretical background [1], [4]. Than considering the market characteristics we set up the model. The next step was collection of the input data. Using this dynamic model enables the managers to see the costs in the long term in graphical form as well.

2. Outsourcing and Its Advantages

Outsourcing or contracting out is defined as a subcontracting process to a third-party company so that the firm can concentrate on its core competences. The principle is that the company should take care only of its most important activity.

Hereby they have some advantages. Mainly the background processes are outsourced such as:

- payroll calculation
- bookkeeping
- accounting services
- administration
- software development
- transport
- customer service

The decision about any field of the production or service to be outsourced requires high level management or owner approval. Thanks to the global network systems' effectiveness and that the expert skills and competences can be reached from anywhere outsourcing has become popular. Lots of reasons can be found to confirm the decision on outsourcing. Most of them are in connection with cost saving. On the other hand benefit rising are expected as well. We can find a lot of advantage of outsourcing:

- The company can focus on its core competences so it can allocate its resources more effectively.
- It is usually risky to invest in order to use new technologies. It has a lot of cost as well because in the technology market we can observe a rapid development. Keeping up with the latest innovative solutions ties up a lot of resources and is very costly. In case of outsourcing we have to pay only for operation of new technologies.
- High quality products and services are necessary to provide to retain the consumers. In this point of view the most important to offer these products and services at reasonable prices. Saving money on outsourcing a certain process can help to keep the prices lower than the competitors.
- As according to the subcontract the same amount of money must be paid monthly the cost can be planned.
- The structure of the organization can be fit for purpose and can be aligned with the strategic goals. Clarity and transparency regarding the expectations of different aims can rise.
- Economies of scale.

- Due to the supply market and the contractual commitments the interest of the company can be represented more effective against the third-party service supplier e.g. in the field of assumption of risk.
- Seasonal peaks can be handled without increasing resources as the third-party company can be more flexible.
- Access to highly skilled manpower.

These days time can be handled as a production factor. Time is money. The rapid reaction in the corporate market can play a key role in order to meet the consumers' changing needs. The development process of products and services often requires creativity, ingenuity, and talent. These factors are not always available inside the company. Some advantage can arise because of the change of cost structure: variable costs can turn into fixed cost.

3. Criticisms of Outsourcing

Outsourcing of course can have some disadvantages too. Outsourcing of a production or service often means that the place of work changes. In case of large enterprises it can heavily damage the local labour market. If we talk about call centres, insufficient language skills and different cultural background can easily mean lower quality in serve. Sometimes certain services cannot be outsourced completely. Face to face connection cannot often be replaced by call centres. Lots of people are not convinced e.g. of telebanking or internet banking.

There are some works that need very high-skilled manpower and specialized skills. Outsourcing these works such as programming cannot be fair just because of lower salaries to foreigners. In this case native workers and experts will not find job.

Outsourcing could lead to communication problems. Keeping connection with the staff of the third-party company is more difficult than it is inside the organisation.

Measuring of the quality of the service outsourced is very important so that we can enjoy at least the same level of the service as previously. Contracts must be detailed enough regarding these circumstances. Sometimes lower prices match lower quality.

Outsourcing the IT systems, the control of business secrets and information can easily move to the third-party company. Outsourcing certain activities security risks can arise. People no longer directly employed belong to this group too.

4. Insourcing and Its Reasons

Contracting in or insourcing is often defined as the opposite of outsourcing. Activity previously provided by a third-party company or hired moves to an internal entity. The decision about insourcing requires high level management or owner approval as well. Workflow can become more transparent. Lot of advantage can be gained by acquiring control of critical services or production. Economies of scale can be reached by insourcing too. If the company has the work does not need any special skills done by its own employees cost efficiency can be achieved. A company for example can carry out some background activities or additional services on its own if it is capitalized enough. In this case, in fact we can point out that the services so far hired must be provided by the company itself. The cost of an activity provided by a third-party company includes the cost of work itself and the benefit of the third-party company. This benefit can be interpreted as a surplus burden what should not be covered by the company if that activity were provided by an internal, but stand-alone entity.

However, the question arises: whether the investment which should be implemented in order to carry out the insourcing returns within a reasonable period of time.

5. Risks of Insourcing

The insourcing is a strategic decision. It is necessary to examine whether the company has competencies to carry out that activity itself.

Insourcing will only be a better solution than taking the services of a third-party company if certain conditions are given inside.

It can be very difficult to meet some basic requirements regarding cost efficiency, as follows.

- It may require high volumes production
- High investment costs
- Problems may occur at any point in the supply chain

If the process of insourcing fails or the internal stand-alone entity is not able to carry out the tasks at a suitable level of quality the company have to restore the original state. This process generates very high sunk costs. The fact of failure itself can affect the value of the shares of the company in the stock exchange. The company may not be able to cooperate with the previous third-party company. Seeking a new suitable partner can take a lot of time.

If an inappropriate insourcing action affects on product line or service regarding volume or quality, consumer behaviour and satisfaction can change. Customers may decide to purchase substitute goods of the competitors.

Although insourcing is not clearly an ill-structured problem it is an important strategic decision. Therefore decision making must be based on a lot of preparatory work. While in case of outsourcing references and obtaining objective information can help to choose a suitable third-party company, in case of insourcing we do not have such experiences.

6. Requirements - the model

During the process of setting up the model lots of connections and links between characteristics in the logistic market had to be taken into consideration. Lot of information had to be collected. It is very important that the input information is relevant and reliable. The model is able to handle several combinations of decisions in connection with forwarding and storage as follows in Table 1.

Table 1. Decisions on Insourcing

Warehouse	Dry goods	HIRED
	Chilled goods	INSOURCED
	Frozen goods	HIRED
Rack		INSOURCED
	Container	HIRED
	Pallet	INSOURCED
Vehicle, Size A	Not refrigerated	HIRED
	Refrigerated	INSOURCED
Vehicle, Size B	Not refrigerated	HIRED
	Refrigerated	INSOURCED
Fork lift truck	Type 1	HIRED
	Type 2	INSOURCED
Human resources		HIRED

Theoretically it means that we have lots of possible cases altogether:

$$n^k \tag{1}$$

Where:

- n: number of the decisions.
- k: number of possible ways we can carry out the activity.

We can decide on 13 cases. They can have 2 different solutions because the company either hires the service or does it on its own. So the number of the different solutions for the forwarding and storage problem:

$$n^k = 2^{13} = 8192 \tag{2}$$

We can count on 8192 cases. All these cases are relevant and can be explained. Carrying out all these cases would have been hopeless if we had wanted to count on all of them. That's why a dynamic model was necessary to be set up for this decision-problem. [2], [3]

Many data on warehouse and vehicles has to be handled by the model. Our model distinguishes the fixed cost and the variable cost as well. Examinations were performed on the optimal number of vehicles required to serve the needs.

Considering the storage we have to calculate the cost of building and maintenance vs. rental costs. If we examine the transporting, regarding the own vehicles data is handled according to the Table 2.

Table 2. Cost of Vehicles

Fix cost	Lease	
	Insurance	
	Annual technical inspection	
	Taxes	
Variable costs	Fuel	
	Annual distance to be travelled (km)	
	Consumption (litre/100km)	
	Maintenance	
	Toll	Quantity (up to the number of vehicles)
		Cost of unit

Considering the human resources three groups of employees must be distinguished:

- Lorry drivers
- Fork lift truck drivers/storekeepers
- Administration

According to the current legislation based on gross wages the model meets the requirements as follows. The model calculates the total amount of employer's burden including:

- Pension insurance contribution,
- Health insurance contribution,

- Additional health contribution (fixed),
- Employers' contribution,
- Vocational contribution.
- Possibilities to add some tax free services (e.g. cafeteria services) must be also included.

Further adjustment is possible to make the model more effective. If we decide to build an own warehouse we can count on three stages of the process: 'in course of construction', 'ready', 'in use'. If the warehouse is already built up that does not mean that it can be used. It is necessary to have some legal authorisations in order to use the storage. During this period of time costs arise in connection with booth keeping up the building (included the guarding) and hire. The amount of this money is handled in our model as well. According to the wishes, in the 6th year vehicles will be sold and new ones will be bought. In the model there are cells for these incomes and the costs too. As a possible output the costs compared are shown in Fig. 1. All incomes and costs are displayed as net present value.

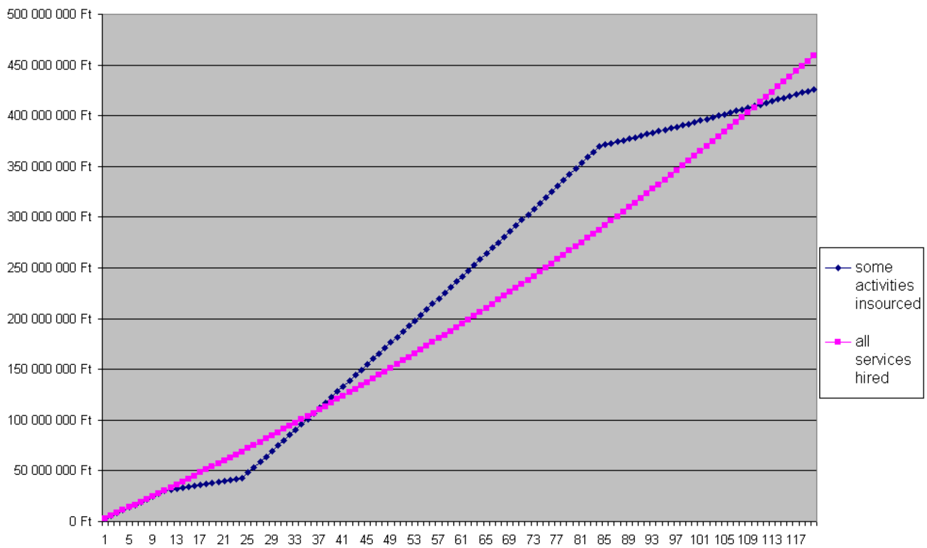

Figure 1. Comparison of costs before and after insourcing

We can talk about some general requirements in model construction. Solutions must be displayed in graphical way and the model must be easy to handle. The model must manage the financial conditions too e.g. cost of lease, inflation. These tasks are considerably complex and need algorithms worked out well. Setting up our model we have taken these requirements into consideration.

7. Conclusions

The present study has shown us the model. The knowledge of basic theoretical background is useful to know what to expect from strategic decisions. The deep practical knowledge of the activity is strictly necessary too.

Essentially, all strategic decisions are ill structured but a robust estimation can be reached by setting up a dynamic model. In this way the decision on insourcing or hiring will be valid and established. Basically, the aim is to achieve a more efficient cost structure.

The investment (the insourcing of the activities) is returned if the cumulative costs of the changed situation within a fixed period are lower than the costs of the original situation. In this point of view original situation means that nothing changes i.e. all the activities will be hired like so fare. We talk about changed situation if at least one of the activities will be insourced. The fixed period is 10 years. Due to this long period of time regarded as a long term there will be some uncertainty in the forecasts.

We believe that a model despite this uncertainty must be able to give a robust estimation and reflect the market trends. Of course, there are market trends that cannot be predicted. Handling these situations is a challenge of the top-management.

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Using Degradable Foam Cushioning in a Product – Packaging System

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Abstract Our daily life is pervaded with the plastic materials. Although these devices, materials and foams provide numerous benefits, they also cause a significant environmental waste problem. From this aspect if we investigate the field of packaging, the result will be very complex and disillusionizing. Very huge amount of the plastics used by the packaging industry whose counteraction is the main task of the different type of engineers.

In first part of this paper, I investigate those parameters, which increased the demand of packaging materials and which are the most important parameters which can affect the product – packaging system and which are the basic defence solutions against these effects.

In the main part, I investigate the possible ways which can help us to solve the continuously changing environmental requirements. In this process, the Environmental Degradable Plastic (EDP) foams can be a possible solutions, but not enough is known about the biodegradation process of synthetic plastic and plastic based foams.

These information are essential to develop and re-think the process of systematic approached product - packaging design methods. This paper describe the complexity of this development, which would be a possible right way to use environmental plastics and keep the products in safe.

Keywords: cushion, EDP, packaging development

1. Introduction

In a logistic system when we have to design a "suitable" product - packaging system, we always meet a many-degree-of-freedom system where we have to solve or expose many questions and problems both in economic and engineering aspects. In this paper I investigate the field of cushioning, and which problems and questions are in this field. Closing the paper I try to explain those ways or methods which we have to use during a product – packaging development if we would like to pass the more and more strictly environmental requirements, for example the degradability of packaging materials.

2. Nowadays' changes in the packaging

Nowadays, if we try to analyze a products Life – Cycle (for example an electronic product), the most of the papers in this field investigate only the products LC. Those professionals, who are work in, developing or researching in the packaging know that the packaging system of a product, hide very wide range of potentials which are be able to minimize and decrease the packaging waste which mostly arises from the manufacturing and logistics processes.

Arguments which increase the packaging material demand [1]:

- Demographic and life-style changes (ageing population, increased demands on health and hygiene, convenience required, - Packaging in harmony with product and brand image , individualism, etc)
- Technological changes (electronic and home shopping)
- Supply chain management changes (IT as a supplement to packaging communication, virtual corporations, etc)
- Manufacturing changes (concentration on core business and out-sourcing, part-manufacturing, etc.)
- Problems with package design methods (counting only the "household" stresses, empirically development, "over-packing", etc.)
- Environmental issues (pass the more and more strictly 5R requirements)

As we re-think the above mentioned facts, we are able to recognise that these were the modifier elements which converted the packaging's classic 3P function to 5R. To pass more and more from the 5R (Reduce, Reuse, Recycle, Buy Recycled, Rot (Compost)) requirements, we have to re-think one of the most huge packaging waste indicator, the nowadays applied cushioning systems.

3. The appearance and the importance of the most common dynamic mechanical stresses

The packaging system is mostly set-up based on four components:

Product (with its critical elements) → consumer packaging → collector package → transportation packaging (with the fixing system).

The package-product system has to withstand the rigors of the distribution environment. The hazards of distribution are many and varied. In the most cases is usually difficult or impossible to predict what a product-package system is going to encounter.

During distribution there is a need to be concerned dynamic forces encountered due to [2]:

- dropping, throwing and other abuses caused by the manual loading, unloading and handling of packages,

- the stresses applied by mechanical handling equipment,
- vehicle impacts,
- vehicle vibrations.

The previous four conditions result in impact and vibration to the product - package system. As a consequence of that from the viewpoint of package cushioning design the two significant factors are shock and vibration.

Goods are protected from shock and vibration by isolation. Isolation is generally attained by placing resilient means -cushioning materials- in the package system. In concept, the package cushioning is designed to protect the packaged item of known strength from the known shock and vibration in the given environment.

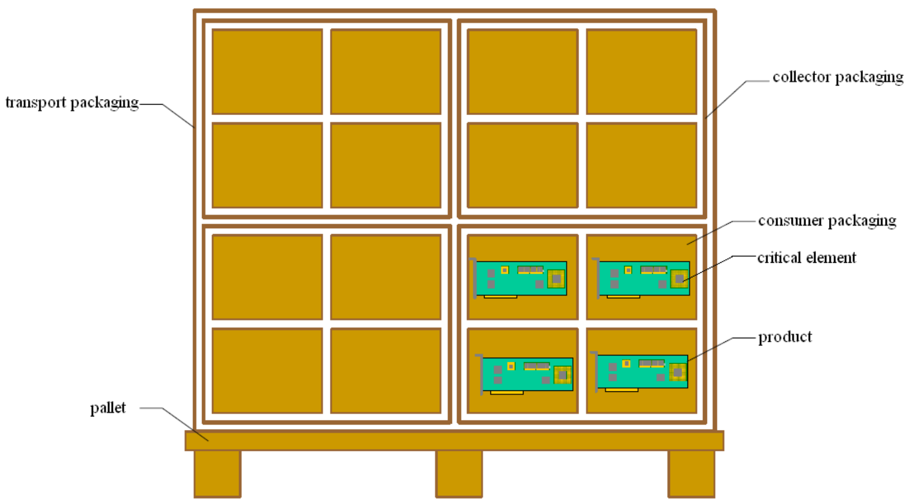

Figure 1. Product-packaging system (source: own drawing)

3.1. Shock and vibration isolation theory

- The mechanical shock

A mechanical shock occurs, when an object's position, velocity or acceleration suddenly changes. A shock may be characterized by a rapid increase of acceleration (x) followed by a rapid decrease over a very short time (t).

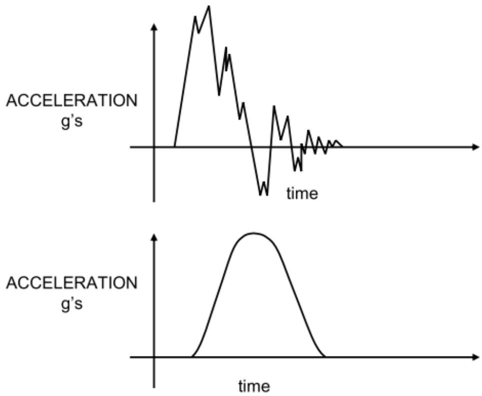

Figure 2. Representation of Mechanical Shock (source: own drawing)

Practically there are two kind of basic sources of the shock stresses.

The vertical impacts are from the falling off of the packaged products, but this is the same stress if a hoisting engine put down the load, very rude. The source of the horizontal impacts from the braking, acceleration of a vehicle, etc.

The package damage (and of course the product damage too) is related to three factors involved in mechanical shock:

- Peak Acceleration,
- Duration,
- Velocity Change.

The velocity change is numerically equal to the area beneath the shock pulse. So knowing any two of the factors allows to estimate the third [2].

- The vibration stress

The vibration forces issuing from the road bumpiness, the unbalanced and moving weights on the vehicles, the spring system of the transport devices, the characteristic of the keeping on the vehicle on the road and of course its mixture. The elements of the a theoretical system is shown on Fig. 3.

The vibration sensitivity of a product is characterized by input frequencies of the environment, which can cause resonance at the product, at the critical element of the product. To identify the vibration frequency there is need to know

- the natural frequency of the product,
- and typical forcing frequencies of distribution.

The natural frequencies of products are determined using vibration test with sinusoidal motion [3].

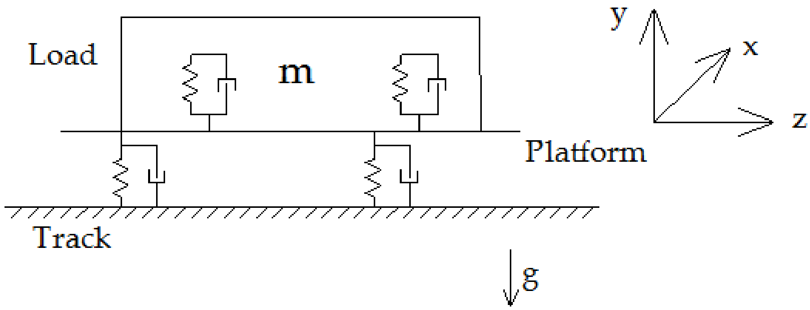

Figure 3. Track –vehicle – load system model (source: own drawing)

Table 1. The forcing frequencies of distribution vibration

Type of the transport	Frequency range [Hz]	Conditions
Rail	2 – 7 (Suspension) 50 – 70 (Structural)	Moving freight car
Truck	2 – 7 (Suspension) 15 – 20 (Tires) 50 – 70 (Structural)	Normal highway travel
Aircraft	2 – 10 (Propeller) 100 – 200 (Jet)	Flying aircraft
Ship	1 – 11 (On deck) 100 (Bulkheads)	Water and propeller vibration

During the development of a new product-packaging system, we have to count with the mixture of these mechanical stresses.

4. Cushions and movedampers as the potential solutions of defence

4.1. The theoretical system of cushioning and movedamping

The common method of shock isolation in packaging design is the use of cushioning materials. The cushion pads are inserted on the several sides of the packaged products. The theory of shock isolation with linear springs is valid only for a small deflection of the isolation medium. For larger deflections the stiffness of the cushioning material becomes nonlinear.

1. Viscous damping model with linear stiffness characteristic.

For this model, Suhir [4] presented the following equation for a single-degree-of-freedom (SDOF) system [8],

$$M\ddot{x} + C\dot{x} + Kx = 0 \tag{1}$$

where M is the mass of the system, C is the damping coefficient, and K is the spring stiffness coefficient, which is assumed constant. Therefore, this model is only applicable to the linear system.

2. Un-damped model with nonlinear stiffness characteristic.

In order to describe the nonlinear characteristics of cushion buffer, Suhir [9] suggested another form of equation for the same vibration model:

$$\ddot{x} + Kx + \alpha x^3 = 0 \tag{2}$$

In this model the damping is ignored. Furthermore, K remains a constant in Kx, only the parameter α is applied to reflect the nonlinear behaviour in αx^3. This approach introduces a nonlinear feature with respect to displacement, and stiffness coefficient as a constant in its linear part. It is generally insufficient to detect the dynamic behaviour quantitatively by virtue of this nonlinear model practically, because the parameter of nonlinearity α cannot be obtained directly from the nonlinear stress-strain curve of the cushion buffer.

A mathematical model of packaged product is depicted in Fig. 3., in which the buffer is idealized as a vibration system assembled with multi-unit nonlinear springs with unit stiffness coefficient k_c and damping ratio ξ. This system with multi-components provides sufficient flexibility to describe the arbitrary shapes of cushion buffer [5] [6].

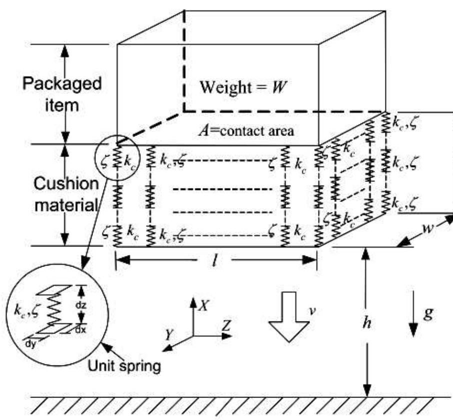

Figure 3. Mathematical model of packaged product [6]

4.2. Testing of cushioning materials and systems

Application of the shock and vibration

The behaviour of isolators is characterized by dynamic cushioning curves. A cushioning curve shows how a particular packaging material of a given thickness behaves at different impact conditions. Curves are generated by dropping a series of known weights onto a cushion sample from a specified height and measuring the amount of shock experienced by the weights as they impact the foam.

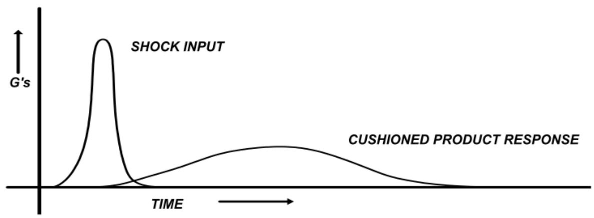

Figure 4. Idealized shock input and cushioned response (source: own drawing)

The testing represents a product dropping on a cushion from a height likely to be encountered during shipment. Practically cushioning curves are curves of maximum transmitted acceleration as a function of static stress for given thickness of material at different heights of free fall. The "static stress" is the unit loading, and is defined as a quotient of packaged weight and the area of the medium in engagement with one side of the item. Similarly height of free fallen correspondents to accepted practice specifications in discrete increments.

In package design cushioning curves are applied by selecting the figure corresponding to the actual packaging parameters. Generally the primary consideration in package cushion design is the protection against shock. But if the packaged product has a resonant frequency falling within the vibration frequency range during transportation, vibration isolation characteristics of the cushion system also have to be considered.

Successful vibration isolation of packaged systems desires significant damping of the isolator. A high damping factor of the cushioning material guaranties that the vibration amplitude doesn't become excessive in case of resonance, if the environmental conditions include vibrations of frequency equal to the natural frequency of the isolation. Degree of vibration isolation of the cushion system depends on the relation between transmissibility and the ratio of vibration frequency and the natural frequency of the cushion, which is a function of the loading stress and the thickness of the isolator. Because of many variables and unknowns transmissibility data are obtained in the praxis empirically. The natural frequency for nonlinear cushioning material can be determined by applying the stress strain relationship for isolation material.

The main property of isolation materials is their capability to absorb, store and dissipate energy. Effective cushioning recovers after impact to maintain its isolation ability for subsequent impact events. As was mentioned isolation materials have only at small deflections a linear behaviour, at large deflections they show consequently nonlinearity. In that case, equation for force – deflection under dynamic fails, that the only successful way of design is to make use from experimentally properties of the materials.

There are:

- compression versus strain characteristics (test on the Fig. 5.),
- cushioning curves (maximum acceleration versus static stress characteristics),
- creep characteristics (hysteresis loop),
- resonance behaviour, natural frequency of the isolator.

Compression strain characteristics make possible to determine the compression deflection of the cushion due to weight of the packaged product. The compression stress is calculated from the weight of the package contents and its bearing area.

Figure 5. The damping ability test on a sample, made on the TEXTENSER FY-33/3

Cushioning curves allow the determination of cushioning thickness of the given isolation material, which provides the sufficient shock absorption.

Creep characteristics give information about thickness loss of the cushion during storage. Knowledge of natural frequency makes possible to avoid "excitation" frequencies during transportation.

Furthermore recovery is an important indicator for the loading capacity of cushioning materials. If recovery is too low the permanent deflection of the isolator increases, the breaking distance of the cushion decreases, the resultant kinetic energy can no longer in the desired way absorbed.

To complete the design and development of a new cushioning form in a product packaging system, we have to know the behaviour of the exact cushion system with other parts of the packaging system, and of course with product.

In these cases, we can choose from three type of evaluation method:

- integrity testing,
- general simulation,
- focused simulation.

Focused simulation is the most powerful approach available for reshipment package performance testing. It is also the most demanding in terms of test preparation equipment and facilities. In a complete form focused simulation starts with development of detailed knowledge about means and modes of distribution:

- the transportation vehicles and their loading,
- the stacking situation,
- atmospheric profiles and extremes.

The best way to simulate those parameters, is to apply international standards (ISO, ASTM, ISTA, ec.) and their methodologies.

On the following figures (Fig. 6., 7.), results (the measured g values) of a free-fall (shock) and vibration test can be seen.

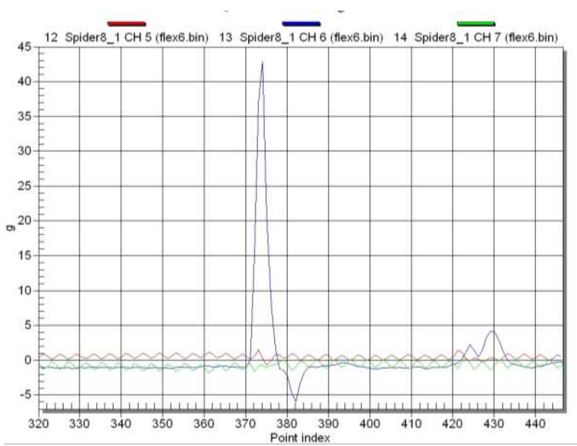

Figure 6. Answer figure of a drop test (measured on the critical element of the product)

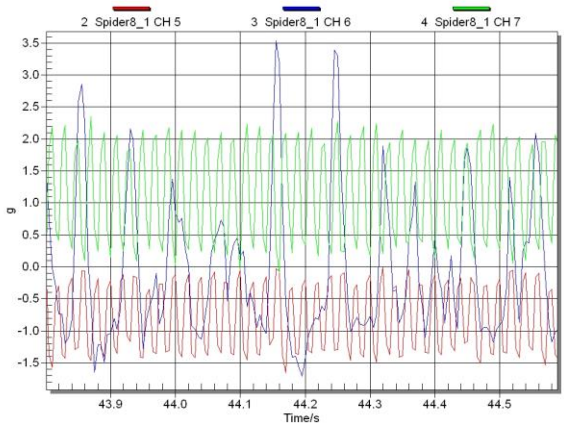

Figure 7. Answer figure of a vibration test (measured on the critical element of the product)

As I mentioned above, it can be clearly seen, that the right decision of a new constructed cushioning system, with a new characteristic material, is a very difficult and complex process[7].

4.3. Plastic foams as the most common applied product defender

Plastic foams are synthetic polymers that are used widely throughout the world for various applications. One of the main industry, which use the plastic foams in huge volume is the packaging industry. In the packaging industry, we divide the produced devices for two parts:

- Consumer plastic foam devices
- Industrial plastic foam devices

In the following, I mention and investigate only those plastic foam which are used for industrial needs.

The cushioning characteristic's of these materials are determined not only by their density (specific weight), but also by their structure [7].

EPS(PS-E) expanded polystyrene foams: PS is an elastic formed, rigid, closed cell foam. Its recovery is rather limited. The material is not hygroscopic, thus cushioning material hasn't got a tendency to absorb water vapour. PS-foams assure successful protection for package contents which are at risk of corrosion. EPS is often used in form of loose fills.

Polyurethane foams: Polyurethane foams are formed by the reaction of polyols and diisocyanates. The chemical blowing is a result of the reaction of the agents, carbon dioxide arising during the procedure produces the foam structure in the cross linked polymer. Depending upon the types of polyol there are two types of polyurethane foams polyether and polyester types. Polyurethane-ether foams are characterised by their irregular open cell structure. Polyurethane-ester foams have a regular cell structure, that can be controlled in a wide range. The two kind of materials have somewhat different static stress-strain characteristics. Polyurethanes are produced in flexible, semi-rigid and rigid forms. The shock absorbing properties of PU foams increase with foam hardness, while recovery and elasticity decline. Consequently on repeated exposure to identical stresses, this fact may cause problems with rigid grade of foam as there is a continual decline in recovery.

Special features can achieved by additives, for example flam retardancy or antistatic characteristic.

Polyethylene foams: PE foams are closed cell, non-cross-linked materials, produced by extruding polyethylene thermoplastic in conjunction with a blowing agent (carbon dioxide or hydrocarbons). PE foams have very good cushioning characteristics, with special additives father desired properties like antistatic behaviour can be assured. PE-X foams are chemically link crossed materials with a high water resistance and thermal isolation capability.

Polypropylene foams: PP foams are in the same way produced as PE foams, materials are somewhat similar in appearance, but will have different characteristics.

5. "Green" foam cushioning?

The foams provide numerous benefits but they also cause a significant environmental litter problem. Biodegradation may provide solution to the problem but nowadays the biodegradation developments work only with the consumer packaging (for example: shopping bags, foils) and not enough is known about the biodegradation process of synthetic plastic and plastic based foams.

Changes in polymer properties due to chemical, physical or biological reactions resulting in bond scissions and subsequent chemical transformations are categorized as polymer degradation [8]. Degradation reflects changes in material properties such as mechanical, optical or electrical characteristics in crazing, cracking, erosion, discoloration and phase separation.

Depending upon the nature of the causing agents, polymer degradations have been classified as:

- photo-oxidative degradation,
- thermal degradation,
- ozone-induced degradation,
- mechanochemical degradation,
- catalytic degradation
- biodegradation

In the following schematic figure, we can follow the method of a degradation process (Fig. 8.).

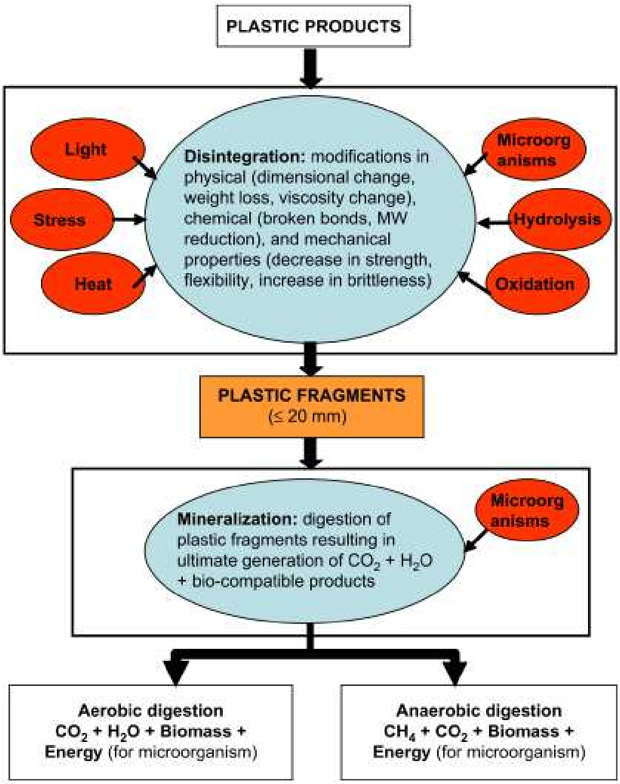

Figure 8. The schematic figure, of a degradation process (source: Krzan, 2006)

Degradation can be defined as a process which leads to a deterioration of any physical property of a polymer which used as a cushion in our product packaging system. In the practice, there are many parameters, which are also able to influence on the degradation of our cushion. These factors:

- Chemical composition
- Molecular weight
- Hydrophobic character
- Size of the molecules
- Introduction of functionality
- Additives
- Chemical bonding

- Methods of synthesis
- Effect of substituent's
- Effect of stress
- Environmental conditions

5.1. Potential serviceable environmental friendly cushions

The Environmental Degradable Plastics [9] (EDP) can be synthesized either from petrochemical or natural resources of vegetal, aquatic, and animal origins. The feedstocks are derived by three main routes: biosynthesis (e.g. fermentation by microorganisms), chemosynthesis (e.g. chemical synthesis and polymerization processes), and a direct application of natural materials with or without chemical modification (e.g. fibers or extracts). Groups of starting compounds currently utilized or being developed for the production of EDPs are shown in *Table 2*.

Table 2. List of classes of polymers used for the production of EDPs (source: Krzan et al 2006)

Biological origin	Synthetic origin
Proteins	*Aliphatic polyesters*
Albumin	Poly(glycolic acid), PGA
Casein	Poly(lactic acid), PLA
Collagen/gelatin	Poly(lactide-co-glycolide), PLAGA
Fibrinogen/fibrin	Poly(b-malic acid), PMLA
Wheat gluten,	Poly(e-caprolactone), PCL
soy protein	Poly(alkylene succinate)s
Zein	Poly(p-dixanone), PDO
Polysaccharides	*Poly(ethylene terephthalate)*
Animal	*modified copolyesters*
Heparin	Ecoflex, EastarBio,
Hyaluronic acid	Biomax
Chitin/chitosan	*Poly(vinyl alcohol)*
Vegetal	*Polyamides*
Cellulose and derivatives	Copolyamides
Lignin	Poly(ester amides)
Starch and derivatives	Poly(amino acids)
Microbial fermentation	Poly(b-hydroxy alkanoate), PHA
Dextran	Poly(b-hydroxy butyrate), PHB
Xanthan	Poly(b-hydroxy butyrate-co-valerate),
Pullulan	PHBV
Plant algae/extracts	*Pseudopoly(a-amino acids)*
Pectin	Poly
Inulin	(a-amino acid ester)
Alginate	Poly(ester-ureas)
Carrageenan	Poly(iminocarbonates)
Agar	*Polyanhydrides*
Gums	*Poly(ethyleneglycol)/poly(orthoester)s*
Xyloglucan	*Polyphsophazenes*
Levan	*Polyurethanes, PUR*
	Poly(ester urethane), AU
	Poly(ether urethane), EU
	Poly(urethane urea)s, PUU
	Polyolefins

This list is a good representation of the potential solutions, but from the many different version we have to choose only those which can be able to pass not only on the very strictly environmental regulations, they have to pass – on that level as the well known normal plastic cushions – the very high level mechanical requirements too.

5.2. What we have to know to be "green"?

As well known from many papers, if we develop a new product – packaging system, it is ineluctable to clear and define the many times mentioned logistic stresses, which includes both mechanical and environmental stresses.

If we can describe these stresses clearly, for example by a data logger, which be able to store the following parameters during the whole logistic link, we can start to choose the potential right EDP foam.

Parameters which ineluctable using any kind of movedamping system:

- Number and duration of the impacts [ms, m/s^2]
- Vibration stresses [s, m/s^2]
- Temperature and humidity inside the packaging [^oC, Rh%]
- method of manipulating and handling

Additional parameters, we have to know, if we would like to use EDP foams:

- Storage times (at raw material supplier, packaging supplier, product manufacturer, distribution center, etc.)
- Degree of sunshine or light exposure

These additional information also have to be the base data of the development because, as I described in the earlier chapter, there are many types of EDP foams which answer differently to the described stresses. Many of the biological origin EDPs don't like the humidity. The water vapour can be able to decrease their physical characteristics, and of course it also influences the cushion characteristic. Other way, many of the synthetic origin EDPs are sensitive to the temperature and to the light exposure. These effects, if we don't care about them can be able to start a disadvantageous process, which also can be able to modify the characteristic of the cushion.

6. Conclusions

Summarizing the paper we can clearly see that the innovation of new type movedamping system, is a very complicated task. We have to know everything about take product, about the characteristic of each cushion material (both normal and degradable), about the possible environmental and mechanical stresses, etc. This development process additionally have to be connected with the product development, which have to be done parallel with the development of packaging system.

Therefore, there is a huge potential for conducting research and large-scale biodegradation studies in this field to make valuable contribution in solving environmental and resource depletion problems of the world.

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A Fuzzy Approach for Finding an Ideal Location of Industrial Park Area

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Abstract: The volume of the development of the industrial areas is highly influenced by the country, the region, the area and the city. The investment, the settlement and infrastructure are basic conditions, but the qualification, the developing ability and the enterprise of the labour are also essential in the long run. The aim of the model presented in this paper is to determined how to investigate the potential of a given area. The developed model can be a decision-making tool, which can be applied in a given urban planning. This tool applies multi-criteria evaluation in order to analyze the suitability of different areas to locate a new industrial area. The question is what kind of strategy, calculations and decision-supporting models help the business enterprises to designate their park or settling in an industrial area. The asymmetric representation of fuzzy exponents is able to handle the human thinking driven uncertainty like loss aversion and other possibilistic features of socio-economic decisions

Keywords: facility location, decision making, fuzzy objective function

1. Introduction

The word „region" is generally used for geometrical impoundment of earthly space, and it doesn't matter whether the region has any common homogeneity. On the other hand the expression of region refers to a territorial unit, which has something in common in the field of cohesion. Regions classified by one or more characteristics can be separated mainly in three groups:

- region set on the basis of a single characteristic
- region determined on the basis of several characteristics
- complex region

Further grouping made by geographers:

- homogeneous region
- nodal region
- planning or programming region

Homogeneous regions have the feature that their parts are very similar in regards of some different criteria. The planning regions are mostly separated by administrative, planning and information collecting criteria. A region is called nodal region when it is concentrated around something due to the spatial density, create a spatial intersection and become an agglomeration. Further separation of nodal regions can be made if the agglomeration until the administrative borders are examined as well, or in other case if the borders are not taken into consideration. The definition of regions is very flexible and there is no commonly accepted version among representatives of scientist.

In the regional science and analysis the benefits of localization and concentration are often emphasized, they also affects the decision about the premises by considering the economy of the territorial concentration, the source of the local benefits of the industry, the innovation clusters, the expanding poles etc.

The local advantages could mean the global effects and the long-term competitive advantage for companies [3]. On the basis of the regions and the regional science effects it is not accidental that Industrial Parks become mostly next to cities, proper infrastructural facilities and other suitable conditions.

2. Definition of Industrial Parks

It is not clear what the exact definition is for an industrial park. There are many different terminologies known (innovation park, business park, Eco-park, industrial park) in the literature. The Industrial Parks has the characteristic that comes from global-local paradox of regional knowledge of advantages from local concentration. Companies which cluster to Industrial Parks are grouped in one place, usually next to cities and good infrastructural facilities.

The plants within a specific area can utilize infrastructure systems.The transport links and some common facilities (e.g. storage, service units) are usually solved and also more and more services joined to the cooperation within the industrial area (e.g. security services, surveillance, financial services, restaurant, social, health care etc.).

„At the same time the industrial areas are well isolated from the settlements, they formed separate parts (of the settlements), because there is not the resident rather the productive functions dominated" [6].

The areas for commercial utilization, zones, regions means the widest category of the Industrial Park's definition. In several cases these are synonyms but the purpose to make it clear is being noticeable. Distinct from the industrial zone or area, in UNIDO (Industrial Development Organization of UN)'s most documents shows industrial estates, which has distinguish features such as (UNEP 2001):

- is located on relatively large area (this is typically 40-80 ha)
- the established companies could also access to public facilities (water, electricity, etc.) or other public services. The basic technological infrastructure is also available.
- development is correspond with other development plans (especially regional- and settlement development).
- you can find different kind of common (centered) and administrative function in this area, in addition many type of business services – so as managerial, technical and financial - are also available [6]

The industrial areas are expected – not only by the firms, but even by the society and community – today to save energy and not to pollute the air and the water. Sustainable development is supposed to be the aim of their actions. They try to decline exhaust fumes by the means of well-organized logistics and transportation. As the tendency shows, the industrial parks (eco-parks) are highly needed. On the whole they can be energy-saver, since the companies aggregate at a certain area, thus – supposing good infrastructural conditions and well-organized logistics – they can contribute to maintainable development.

The volume of the development of the industrial areas is highly influenced by the country, the region, the area and the city. The investment, the settlement and infrastructure are basic conditions, but the qualification, the developing ability and the enterprise of the labour are also essential in the long run. Measuring this is a hard work, however certain indicators are available.

The question is what kind of strategy, calculations and decision-supporting models help the business enterprises to designate their park or settling in an industrial area. This paper finds a new answer to these tasks.

3. Location decision or location potential

In the last years lot of experiences have been gathered all over world on the development of industrial parks. In spite of the existence of these industrial park areas, in the literatures we can find just few common strategy and methodology for their evolvement.

The scientist mainly deal with this process form the side of companies, namely as a location problem. They are interested in that how to choose a location of company for itself. We call it as a location decision problem. In the literatures we can find very similar way to approach this situation. Here we have to mention some strategies, which can be applied to all the phases: selection, design and planning of location, design the physical structure.

These decision methods are mainly based on the micro- and macro-economical and social factors of a given area. Nowadays proximity to markets and infrastructure or labour availability are still the main factors of industrial location and industrial park selection. The only one has been changed is the analysis, which is also extended for environmental impacts [1]. The selection of the most suitable emplacement to locate an industrial park through an integrated planning is a complex decision problem. This decision problem has to consider different criteria that help to achieve the objectives of industrial parks.

There were some experimentation in connection with looking for a chance that where an industrial park would be established. These were not academic studies, but simply expectations without any correct information about its verification.

On the one hand more criteria should be existed than we usually have to consider, for instance social, economy, infrastructure, planning, Furthermore these subjective factors can be modeled analytically by fuzzy sets. Therefore, the aim of this study is to show that if there is a geographical area, for example as a region area, which has got a potential from objective factors, than we can enlarge this factor with subjective factors. In this way the potential indicates the possibility of establishing an industrial park in this area.

4. The model

The aim of this model is to determined how to investigate the potential of a given area. The developed model can be a decision-making tool, which can be applied in a given urban planning. This tool applies multi-criteria evaluation in order to analyze the suitability of different areas to locate a new industrial area.

First the model has been divided into three levels. Phase 1 is the geographic area selection, the evaluation and selection of the areas and evaluation of specific zones. Initially an analysis is done to regional scale. This analysis studies a wide area. The aim of this phase is to evaluate the necessity of the development of new industrial areas in which emplacements would be the most suitable to locate them. These process determines the evolvement potential for industrial park of a given area (P_i), where (i) denotes the number of area, which are analyzed.

The second phase (Phase 2) delimits the objective factors, which must be influenced by the potential of the areas and which area would be the best to locate a new industrial area. Once the hierarchic levels have been established the following step is to define several variables, which are grouped in categories and subcategories. These categories and subcategories represent intermediate levels, which affect the decision. The variables begin analyzing the existence of requirements that are necessary for the industrial development and these variables finish evaluating if there are enough resources. The categories, subcategories and indicators must be clearly defined within each main group. We call this basic potential.

The main categories are the social (S_i), the economical (E_i), the infrastructure (I_i) and rules (R_i) (Table 1). All factors can be evaluated by any parameters, if there is not, we would decide about the existence of them by yes or not.

Table 1. Categories and subcategories

Categories	Subcategories and its indicators
Social	- Demography (birth and death rate, migratory balance, etc…) - Education (percentage of person with different education, etc…) - Labour (unemployed ratepercentage of person with different education, etc…) - etc.
Economy	- Economic activity (efficiency of sectors, existence of industrial branches, etc….) - costs (resources, labour, waste, etc…) - etc.
Infrastructures	- Transport (land-, rail-, air transports, etc…..) - Energy, water (drinking and waste water, electrical energy, etc…..) - Recycling (recovery facilities, waste management, etc…..) - Communication, IT (internet, phone network, etc….) - etc.
Rules	- Legal and law frame - Taxes - Subsidy

It is evident, that the potential can be defined as a function of these variables. We have to naturally complete the categories with subcategories as well. If necessary it can be extended the suitable categories. It is reasonable, that $P_i = f\,(S_i\,, E_i\,, I_i\,, R_i)$.

A possible form to evaluate the potential of an area can be given with the following formula (Equation 1). We give the way how to add the independent variables.

$$P_i = a_S S_i + a_E E_i + a_I I_i + a_R I_i \tag{1}$$

The (a) shows the weights of a given objective parameters in a given area. Naturally is reasonable, that the equation can be extended further parameters which are needed to compare the potentials of two or more areas. Here we have to mention that this equation only contains the possible objective parameters. It does not give suitable information about the effect of subjective parameters of a given area.

The third phase of the model (Phase 3) delimits the subjective factors, which must be influenced the potential of the areas that which subjective factor modifies to the potential of an area. In this study we have chosen the inclination to establish business, as a parameter, which modifies our basic potential (also the basic function).

To analyze this subjective factor we can use the fuzzy logic, which is an extension of the classic logic, which recognizes more than real and false values [4]. Therefore, a proposition can be represented by different degrees of veracity, which permit a mathematical formalization in order to handle and analyze information, whose interpretation needs subjective and imprecise concepts, so the fuzzy logic is very useful to treat phenomenon of the real world that is characterized by its complexity and uncertainty [2].

For instance, if there is a subjective factor, which is influenced on the potential, we can analyze as an power function on the basic potential. This is called Pi*, where (*) signs the modified potential, which has got a fuzzy exponent. This exponent varies the slope and the shape of the potential function (see Fig. 1.). The value of (*b*) is higher than 0, and less, equal or higher than *1*.

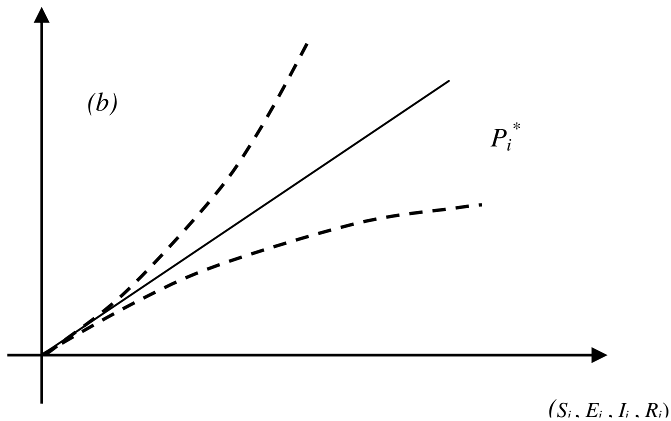

Figure 1. The curve of evolvement potential with fuzzy exponent

If we extend the Equation 1 with the represented fuzzy index, we could define the following step. Let P_i is equal to 100, then the modified potential (P_i*) will show the real potential with subjective parameters. So we can find an area, where a higher or less chance can be found for establishing an industrial park.

$$P_i^* = (a_S S_i)^{b_S} + (a_E E_i)^{b_E} + (a_I I_i)^{b_I} + (a_R I_i)^{b_R} \tag{2}$$

In practical the fuzzy exponent can be determined by the inclination to establish a business in a given area as we have already mentioned above. If we want to collect suitable information about it, for instance it is a good method if we turn to the registry court. By means of the data about the new and cancelled enterprises the above fuzzy exponent can be defined. Naturally we have to give a suitable value/weight for each category like private entrepreneur, small size enterprise, middle size enterprise or multinational enterprise in the area. The weight can be the absolute value of being established enterprise in a given area in the last few years.

5. Application of fuzzy exponents

In our paper an asymmetric fuzzy solution for unvaried function $y = b + aX^{\beta}$ (where *a, b,* $\in \boldsymbol{R}$) is applied [3].

The asymmetric representation is able to handle the human thinking driven uncertainty like loss aversion and other possibilistic features of socio-economic decisions (see Fig. 2. and Fig. 3.).

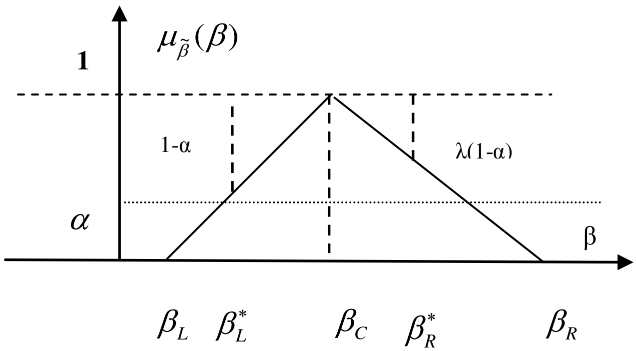

Figure 2. Asymmetric representation of exponents based on different 1-(α-cuts) [3]

$$y = \frac{1}{1+(1+\lambda)(1-\alpha)}(b+ax^{\beta_C}) + \frac{1-\alpha}{1+(1+\lambda)(1-\alpha)}(b+ax^{\beta_C-(1-\alpha)(\beta_C-\beta_L)}) + \frac{(1-\alpha)\lambda}{1+(1+\lambda)(1-\alpha)}(b+ax^{\beta_C+(1-\alpha)\lambda(\beta_R-\beta_C)})$$

Where: $0 \le \lambda \le 1$ (3)

The continuous formula is:

$$y = \frac{\int_{\beta_L}^{\beta_R}(1-\mu(\beta))(b+a\,x^{\beta})\lambda(\beta)d\beta}{(\beta_R-\beta_L)-\int_{\beta_L}^{\beta_R}\mu(\beta)\lambda(\beta)d\beta} \quad (4)$$

where $\lambda(\beta) = \begin{cases} 1 & \beta \le \beta_C \\ \lambda & \beta \ge \beta_C \end{cases}$

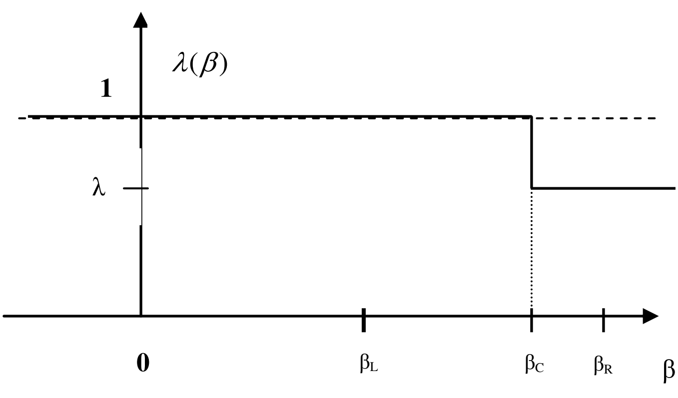

Figure 3. Characteristic function for λ(β) [3]

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