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).

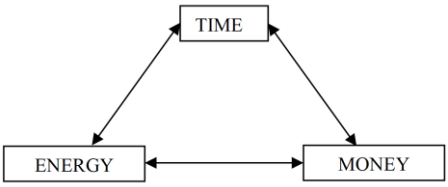

Figure 1. Convertible Resources

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.

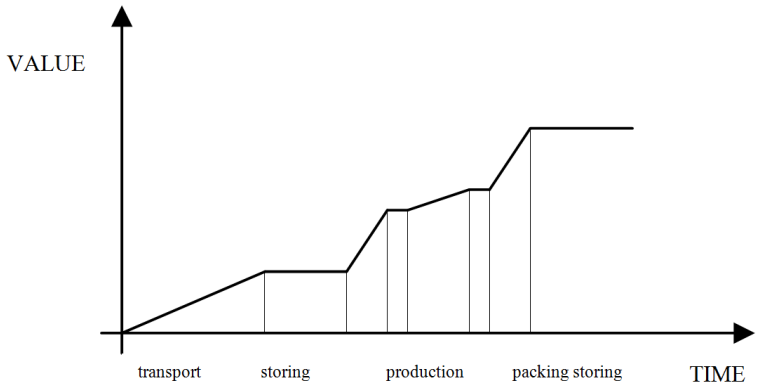

Diagram 1. Value-added and Non Value-added Activities

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.

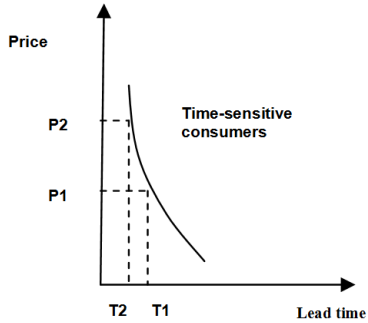

Diagram 2. Time sensitive customer

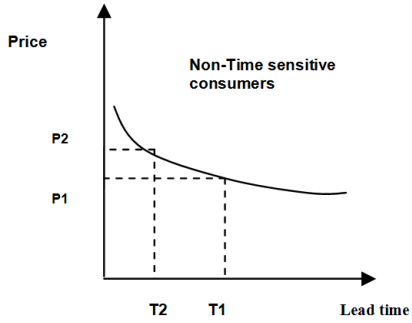

Diagram 3. Non-time sensitive customer

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

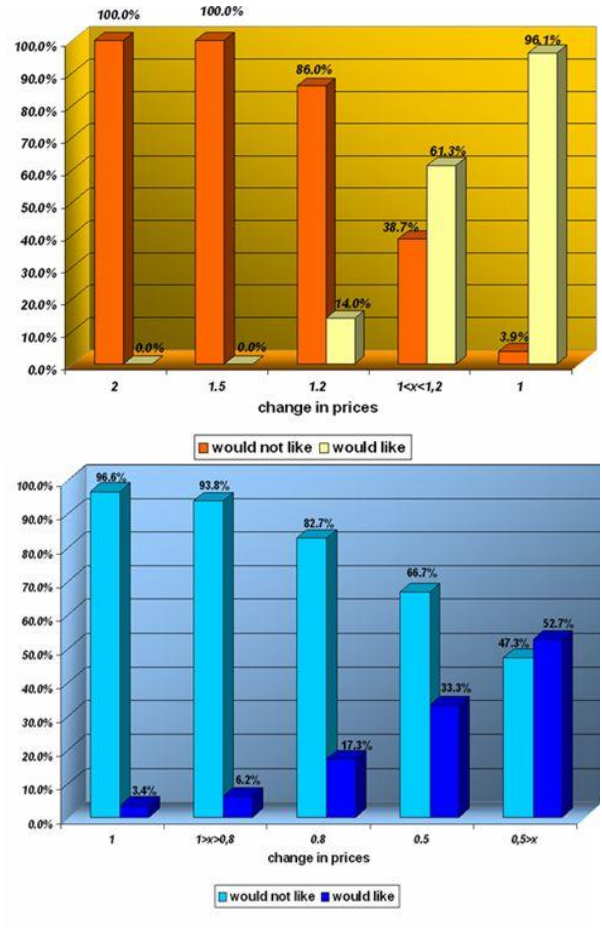

Diagram 4. Willingness to pay in different price level in case of lead time halved

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.

References

[1] Aleff, Hans, Jörg.: *Die Dimension Zeit im Dienstleistungsmarkating Deutscher Universitats*-VerlagWiesbaden (2002)
[2] Becker, G, S.: *A Theory of the Allocation of Time The Economic Journal*, Vol. 75, No. 299. (1965) pp. 493-517
[3] Blount S. Janicik G. A.: *When plans change: Examining how people evaluate timing changes in work organizations* Academy of Management Review Vol. 26 No. 4. (2001) pp. 566-585
[4] Castells, M.: *The Rise of the Network Society Backwell Publishing*, 2nd edition (2000)
[5] Cherlow, J. R.: *Measurong Values of Travel Time Aavings Journal of Consumer Research*, Vol.7. (1981)
[6] Dennis K.: *Time in the age of complexity Time and Society*, Vol.16 No. 2-3 (2007) pp 139-155 Department of Geography University of Utah
[7] Földesi, P. Botzheim, J.: *Solution model for modified Travelling Salesman Problem with Cost Matrix*, Acta Jaurinensis, Series Logistica Vol. 1. No. 2 (2008)
[8] Hummels, D.: Time as a trade barrier Purdue University Press, West Lafayette (2001)
[9] Harvey J. Miller.: *A measurement theory for time geography*, Geographical Analysis 28 (2004)
[10] Hassan, R. Purser R. E.: *Time and temporality in the network society*, Stanford Univ. Press (2007)
[11] Hofstede, Geert.: *Culture's Consequences: Comparing Values, Behaiours, Institutions and Organizations Across Nations*, Thousand Oaks, CA Sage Publications, Second Edition (2001)
[12] Levine, R.: *Eine Landkarte der Zeit*. Wie Kulturen mit Zeit umgehen. München (1998)
[13] Linder, S. B.: *The harried leisure class New York*, Columbia University Press (1970)
[14] Limao, L., Venables, A.J.: *Infrastructure, geographical disadvantage, transport costs and trade*, World Bank Economic Review, 15, (2001) pp. 451-479
[15] Lindquist J. D. Scarborough C.K.: *The polychronic-monochronic tendency model*, Time and Society Vol.16 No. 2-3 (2007) pp. 253-285
[16] Poiesz, T. B. C.: *Strategic Marketing and the Future of Consumer Behaviour* Edward Elgar (2007)
[17] Stalk G.: *Competing against time: How Time-Based Competition in Reshaping Global Markets* The Free Press, New-York (1990)
[18] Torre R. R.: *Time's Social Metaphors – An empirical research* Time and Society Vol. 16. No. 2-3 (2007) pp. 157-187

[19] Usunier, J. C. Florence, P.V.*: The time styles scales* Time and Society Vol.16 No. 2-3 (2007) pp. 333-366
[20] Wajcman, J.: *Life in the fast lane? Toward a sociology of technology and time* The British Journal of Sociology Vol. 59 Issue 1. (2008)
[21] Waller M. J. et al.: *The effect of individual perceptions of deadlines of team performance*, Academy of Management Review Vol. 26 No. 4. (2001) pp. 586-600