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CHANGE TO GREEN IN INTRALOGISTICS

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ABSTRACT
This research contribution shows existing potentials in greening intralogistics as one major part in a green supply chain management concept. Different categories such as warehousing, buildings, layouts, transport systems and even IT are discussed and described contributing to an overall green intralogistics scheme. These outlines are enriched by an expert survey in intralogistics showing awareness among German automotive and machinery companies concerning green intralogistics concepts and measures. Though there are some hurdles and anxiousness about such green investments, a general trend towards such concepts in intralogistics is obvious and will attract further research and attention from manufacturing companies.

1. INTRODUCTION

Increasing economic growth and the accretive globalization lead to an increasing demand for transportation services. This causes a growing transport volume as well as an increase of ecological damages. At the same time ecological attention increases in society and people become aware of how entrepreneurial behavior effects the environment. Hence, it is necessary to change business strategy in order to accomplish an environmental responsible behavior and to keep up competitiveness simultaneously. To achieve sustainability it is necessary to pursue sub-goals as economic and social action (Lange, 2008, p. 41).
Only by regarding all three aspects (ecology, economy and social), short term aims can be reached. Economic sustainability is important to sustain natural livelihood for future generations. Therefore it is important to deal with the environment in a responsible way (Grunwald et al., 2006, p. 33).
Economic sustainability is reached by economic objectives, which ensure the long-term success of a company and the ability to compete (Pfohl, 2004, p. 151). Preservation of a future and worth living society counts to the aims of sustainability (Kraemer, 2008, p. 33). The three categories must be balanced. Thereby the weight of the categories cannot be reduced due to demand of another category. Unfortunately this is regarded quite often in practice: A concept of economy always meaning increasing input counts to the prejudices in business practice (Scharlau, 2009, p. 34).
The aspects of green logistics lead to an effective change. Because of that the question occurs which aims should be followed and if these categories can be combined. These can be subdivided and analyzed in the reduction of emissions and the reduction of costs as well as energy. The ability of a company to compete is depending on the ability to react to costumer's demands, which change faster and faster. This brings a much higher multiplicity of parts along. Through that demands towards production logistics increase, which has to achieve more with less resources.
An analysis of the warehouse transportation systems supplier 'VanDerLande Industries' showed that 24% of total logistics costs are caused by intralogistics (Kranke, 2008, p. 28). Because of that it has become obvious that an improvement on sustainability is necessary and would have positive impact.
This research bothers with the question, where rooms for improvements can be found in the categories of intralogistics and how they work out economically. The single rooms for improvements with the aims of a reduction of emissions, energy savings and savings of costs are analyzed and evaluated trough an expert survey.

2. POTENTIALS IN INTRALOGISTICS

In manufacturing it can be observed that the ability to compete with economical aims will be reached (Cansier, 1996, p. 278). Thereby all categories in production become obvious and can be seen as potentials. They refer to production processes, so that the manufactured products should have low costs.
A comprehensive analysis shows that further costs have to be regarded when calculating sales price. This includes the costs for resources, production expenditures, costs for development as well as transport costs. Intralogistics can be influenced directly and meets the categories hall layout, means of transport, stock, the assignment of new technologies respectively systems as well as transport packaging, which will be explained below.

2.1. Hall layout

In the area of intralogistics the layout of production halls determines logic costs extensively, which cannot always be influenced. Lean production approaches, which also demand optimal choice of locations for the particular steps of manufacturing, are preferable (Reuter, 2009, p. 63). This appendage can be pursued, when a new production location is planned on green grassland, for example. Here, locations can be chosen in an early stage, so that between particular production locations and warehouse only rare logistical activities are necessary. It is more difficult for already existing halls, which cannot be changed concerning their structural engineering. With the help of an analysis of value streams important spots can be found. The analysis of the value stream diagnoses the inventory level between two

subsequent manufacturing locations and generates measures for optimization (Liker et al., 2007, p. 74).
In assembly plants, which can be seen quite often in the automobile industry, the product is manufactured out of several modules of external suppliers. The routes of transport could be reduced dramatically, if suppliers would settle in industry parks (Klug, 2010, p. 16). For several reasons suppliers can't settle their headquarters in the proximity of assembly plants, so they accept longer transport distances.
A further reduction of total transport distances can also be reached by choice of production type as the assembly line work for example. Routes of transport can be optimized, when employees handle two manufacturing locations one after another instead of always processing equal parts at one location. These changes lead to the fact, that the processed part must not be transported by conveyance, because the employees transport the parts (Thonemann, 2009, p. 378).
Further potential develops by manufacturing lines, which are very close to each other. Here, the processed parts attain the next line by a common slide without extra energy (Reuter, 2009, p. 63).
Routes of transport can also be decreased by constructive changes on the product (Erlenspiel et al., 2007, p. 321). For example a module is produced with two instead of three parts, so that one manufacturing step can be omitted. With the help of such constructive changes also customer-friendly products, which have to be detected and considered, can be generated. For example, illuminists of flood lights can only be accomplished in garages.
One part of resource protection can also be an optimal arrangement of driveways. It is often the case that longer driveways have to be taken, because the direct ways are blocked through other manufacturing lines. Sometimes even optimally designed halls are changed for the worse by later extension. Because of that a new analysis regarding all driving ways is often necessary (Erlenspiel et al., 2007, p. 323).

2.2. Means of transport

2.2.1. Fixed feed systems

Continuous conveyor count to the in-plant transport systems and are generally used for transporting greater amounts of material or continually used materials on fixed routes.
The investment costs and costs of operation can be very high. Because of the fixed transport ways and difficult rebuilding possibilities they cannot be fitted to changing processes. Nevertheless, in the past years these systems have been further developed, so that flexibility is possible at low costs. The costs of operation could be reduced by new technological developments. For example the effectiveness of electric engines could be boosted and therefore a reduction of the energy use about 8% could be achieved, as it is shown in the article of VDMA (Association of German Mechanical Engineering Companies).
Moreover, the energy use can further be reduced by 12 % by the use of arranged actuations. Despite the high saving potential, currently only a third of the electrical actuations are arranged (Volz, 2008, p. 19).
Continuous conveyors generally move at constant speed. In practice, the continuous conveyors are so displayed that the requested limit load is covered and due to the constant use a fixed speed is received. Anyhow, there are times, when no goods have to be transported. In this period the use of the conveyor is not necessary and could automatically switch into standby mode with a low speed (Viastro, 2008).

Furthermore the speed of the upstream and downstream working zones should be proofed. As a result of that a reduction of speed can be deflected and therefore energy can be saved.
One additional point, which counts as potential by continuous conveyors, is the use of fully integrated discharges. For the division of material streams discharge elements as pneumatically processed pusher, which have a high requirement of compressed air and thereby have a high use of energy, are used in practice. To reduce this high use of energy meanwhile integrated solutions dominate, as lifted and canted role discharger for example. They require only 10% of the usual energy use (Materialfluss, 2008).

2.2.2. Conventional feed system

The forklift is one of the most well-known and frequently used discontinuous transport techniques in intralogistics. Possible green savings for forklifts could be achieved by the use of effective processes. This can be achieved by optimized transport processes, as well as by the use of new control strategies and systems. In automatic forklift systems industrial trucks are controlled via funk so that empty drives are avoided. Therefore energy consumption and by excess of a certain forklift fleet also the total number of forklifts can be reduced (Voigt, 2008, p. 36).
Stock costs could be lowered for about 10 to 20 percent in the long term, despite relatively high investments (Günthner, et al., 2009, p. 207).
Another saving concerning industrial trucks could be achieved by the use of environmentally friendly and efficient drive engineering. The deployment of alternative propulsion mechanisms is pushed in the sector of PKW since several years. In 1997 with the Toyota Prius, the first series of hybrid vehicles were brought on the market. After the change of the emission levels of work machines at the latest, this theme reached the attention of forklift producers. The industrial trucks can be suited for cross breeding because of their dynamic drive and load profiles, because of the fact that the percentage of stop and go process for short distances driving in a constant speed is very high (Biermann, et al., 1998, p. 2).
The manufacturers of mobile work machines develop vehicles with composite engines, fuel cells, hydrogen engines or free piston engine in doing so the concept Mild-Hybrid has got the highest market opportunities. The vehicle has got an additional combustion engine across an electronic engine, which can be used as a starter and generator at the same time. Trough the cross-linking of combustion and electronic engine a reduction of up to 25 percent can be achieved (Günthner et al., 2009, p. 208).
Beside the already mentioned approach there are further ideas, with which the need of energy and the adoption of material can be optimized. Trough the adoption of consumption-driven routing in contrast to the classical transports savings can be generated. The consumption-driven routing is linked with the Kanban method (filling method). Thereby small charge carriers are brought to the lines by trailer in fixed journey times. Trailers are small, movable drags, which are pulled by electronic vehicles, and which can be changed in their capacity by either changing the

amount of trailer or the amount of levels and height. The trailer drives between the stock area and consumer location (mostly in one hall). Route and time are fixed so that short ways and security of supply can be achieved with low stock (e. g. 1 time per hour). The charges of the trailer are mixed, which means that several part numbers are delivered by each driving round. The following advantages can be generated by their implementation (Baudin, 2004, p. 113; Takeda, 2002, p. 88):

- Movement at the assembly working spaces will be abated and thereby the contingent of added value increases.
- Lower costs trough less assets at the lines and in the hall.
- Improves the efficiency of the material supply trough the elimination of material movement.
- Decreases the amount of forklifts and thereby decreases costs.
- Improves the safety in the plant by correct organization.
- Supports the method of small carriers.

2.3 Stock keeping

The stock of manufacturing plants is part of the activities in the category of intralogistics. They contain potentials with great impact. As you can see on the basis of the analysis of VanDerLande Industries, about 50 % of intralogistics costs, in particular 35 % of heating- and ventilation engineering and 15 % of lighting engineering is caused by the storage area (Günthner et al., 2009, p. 206).

On closer inspection of these areas in most of the factories potentials do exist and could be changed without bigger efforts and investments.

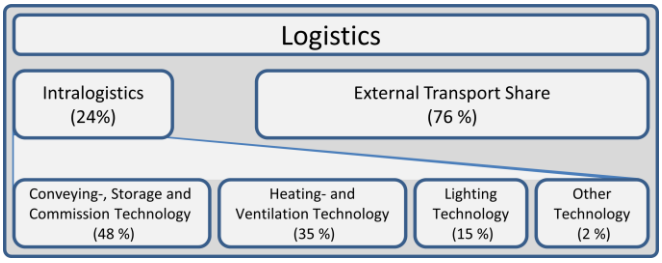

Figure 1: Energy consumption in logistics

2.3.1 Stock locations for articles and materials

Depending on the material group and the product it can be necessary to have several stocks available. One of the reasons for appliance of multiple stocks is the specific product which has to be stored. For example, for flammable materials strict rules have to be followed and thereby these have to be stored separately. Furthermore, an additional stock can be necessary, if several manufacturing halls exist and if these are located in great distance. At this point an integral analysis, which has to answer basic questions, is necessary. In practical it sometimes happens that production halls are planned and built up without considering intralogistics aspects.

When planning stock locations also external logistics should be regarded besides the intralogistics aspects. It would not be effective, if trucks of suppliers would have to drive long distances on factory premises, because this would interfere with internal transport. When choosing stock locations it is to make sure that ways are short and do not cross each other. During the last years the trend has moved towards high bay racking, which reduce the energy demand in combination with software applications (Arnold et al., 2008, p. 569). This is necessary because the demand of space increases, while at the same time available space decreases. This trend requires transport vehicles with other attributes, such as forklifts which can extract boxes out of a height of 20 meters. These vehicles are not appropriate for the transport from stock to production hall, because they have higher energy consumption due to their size. A partly automated feed system can help, by extracting the boxes out of all warehouse areas automatically after demand and paring it at a certain place in stock for the internal transport. The energy use can be reduced even more, if the stored articles are subdivided into material groups. For this purpose an ABC analysis can be used in consideration of the turnover ratio, whereas it should be reassessed continually based on the changing demand (Lasch, 2005, p. 259). Not all material groups are accessed in the same frequency, because for example the amount of boxes is not equal due to the geometry of the parts. Choosing the exact stock locations for particular material groups can reduce transport distances and therefore also energy use.

Through optimizing the boxes turnover ratio and therefore also the driveways can be reduced. Partly the amount of boxes can be increased about 10 to 20%, if these are parked differently (Jünemann, 2008, et al., p. 335). This method automatically reduces the driveways from supplier to factory.

There are also potentials, which do not directly result from driveways. These potentials concern necessary energies for ventilation, cooling, heating and lighting. The food industry requires stocks, which provide constant temperatures. These stocks are cooled with complex controls, so that the required temperature can be reached. The interface to the outside world is considered as disturbing factor, which always occur when new products have to be stored or taken out of the stock. Warm air from outside comes into the warehouse and makes additional cooling necessary. This mixture of air can partly be reduced trough the adjustment of alleys. Here, new zones between stock and the outside world are arranged. After the transport vehicle has entered this zone, the door to the stock opens not until this zone has been approach closed. The warm air can only mix with the volume of the small alley. The energy which is used for cooling is therefore lower (Günthner et al., 2009, p. 210).

Much energy can also be saved in the commission area for B and C articles in stock. For these goods was needed larger storage area. Nevertheless, the complete area is lighted, although fewer employees working there. The guiding idea of the effective design of intralogistics systems should avoid this and light should only be switched on in areas where commissioners work. This could be realized with the adoption of motion detectors as well as light sensors. Hereby up to 40% of energy can be saved for lighting (Günthner et al., 2009, p. 211).

The need for compliance of certain temperatures cannot be essential for certain stocks, if certain products do not have to be stocked. It is possible to establish a new area for those goods. Sometimes a heating of stock halls can be necessary, for example to reach an adequate temperature in winter. The costs to heat this hall are higher than they would be if the forklifts would have encapsulated cam assemblies which have to be heated. This assumes that only employees with forklifts can work in that hall.

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In the range of lighting there are also potentials to reduce energy. In most of the stocks the lighting can only totally be switched of or on. Stock areas, which are passed over very rarely, only need an emergency light. At this point intelligent motion detectors could be useful to reduce the use of energy.

2.4 Green IT

According to a study of the federal environmental agency about 10% of the electric power consumption is spent by information and communication technique. Thereby about 33 million tons of CO_2 emissions are discharged each year. By using innovative and environmentally friendly IT-infrastructure savings of energy can be generated. In practice for nearly every application a separate server is installed, which only uses its own performance level. Moreover, each commission working space is arranged with its own computer system, which boosts the amount of computers. By using visualizations of servers and thin clients the amount of computer can be reduced drastically (Viastore, 2008).

Furthermore, with software supporting systems further can be captured, regarding the packaging of particular goods on the one hand, and transport or rather stock locations on the other hand. Therefore different solutions on the basis of a warehouse management system (WMS) are offered by different software suppliers. With simultaneous consideration of different variables this system assesses the optimal packaging for each product.

Not only the amount of air but also the optimal ways for transportation are regarded. That implies that packaging have to be optimized as far as possible, so that loading spaces can be utilized at an optimum. Therefore the sum of lengths and widths of the different packaging needs to match the length and width of the loading space.

By adoption of a WMS system an optimized loading area is achieved, which leads to a reduction of CO_2 emissions, as well as a reduction for packaging (mmlogistik, 2009).

3. EXPERT SURVEY

3.1. Method of collecting data

As part of the study, 11 logistic experts from different companies had been surveyed. When choosing the different companies, medium-sized and large enterprises with strong relationship to production and logistics activities had been focused. Based on the topic experts from the logistic division were chosen. Duration of employment, gender and age of the experts were not taken into account. The questionnaire was sent in form of a word document via e-mail to the experts. The questionnaire contains 8 (mostly) multiple choice questions. Therefore the required time to answer the questionnaire could be restricted to maximum 15 minutes. The answers of the different questionnaires were evaluated and graphed afterwards.

3.2. Results

To be able to make a final statement, the different questions have to be evaluated first. At the beginning some basic data about the surveyed experts are presented, which were requested with the first three questions of the survey.

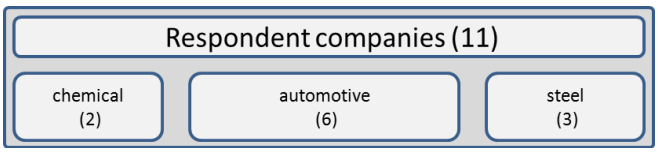

Figure 2: Expert group characteristics

The term ‚green logistics' is mostly associated with ecological awareness and a positive image for a company, as the answers demonstrate, followed by high investments and a negative influence on a company's profitability. Therefore it is to deduce that most companies would be willing to implement green logistics, but they are afraid of the necessary investment. This mental attitude is even intensified by the present state of the economy.

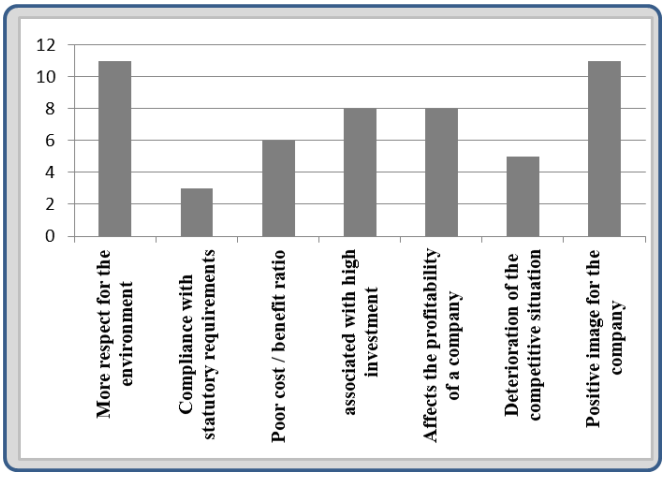

Figure 3: Sustainability motivation

This mental attitude is even mirrored in the answers referring to the *requirements* a structural change has to meet. Therefore an organization's willingness to put changes into practice depends on a positive cost-value-ratio and a short payback period.

It is noticeable that companies hesitate to conduct changes based on trend developments or costumer requests.

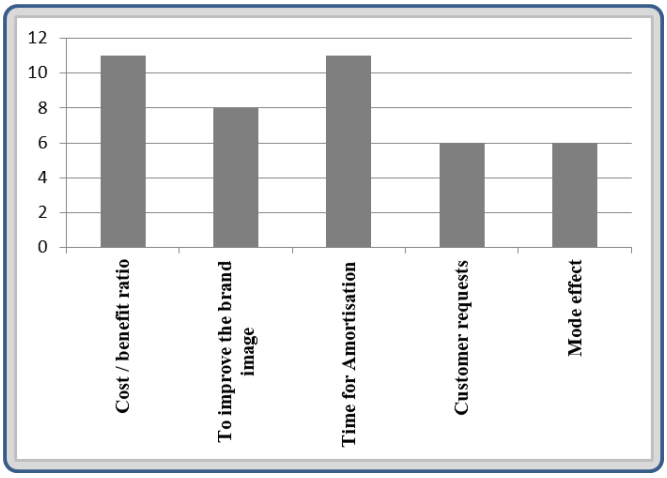

Figure 4: Decision criteria

Subject to constant conditions companies would be willing to implement green techniques, as it is to deduct from the different answers of one question. This statement supports the attitude towards measures which lead the company to an

environment-friendly image, which is thereby given a high priority.

Therefore, companies are basically willing to implement those 'green' measures. When the surveyed experts were asked in which fields of the company 'green' measures are implemented, they named the means of transport and storage field. In these fields existing potential is approached first, followed by the hall layout and Green IT.

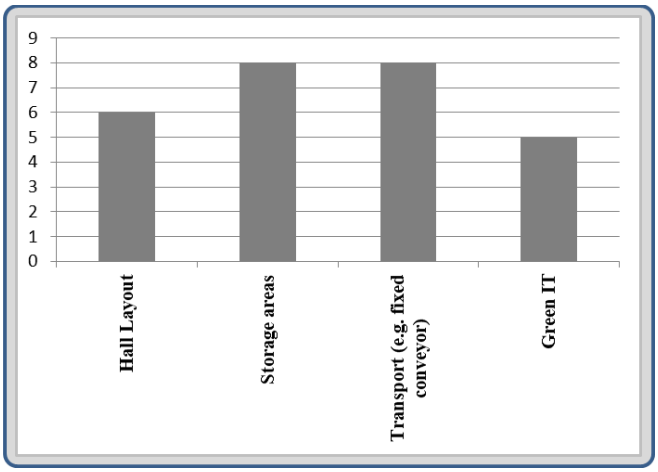

Figure 5: Acting areas

On closer inspection it is noticeable that measures in the different fields are prioritized differently, when they are supposed to meet ecological and economical demands. In particular measures which are supposed to lead to a decrease in transport route lengths are favored.

4. CONCLUSION

Especially in the field of intralogistics great potential for resource-saving and at the same time environmentally friendly processes are available. These are multifaceted and concern different fields. In the scope of this research some potential was identified and elucidated. Some of these potentials do not require large investments even though they do have a positive effect on a company's image and make savings possible. The answers of the survey lead to the conclusion that most companies are willing to put those measures into practice. Especially green logistics measures are favored to influence the company's image in a positive way and to support the environmental protection, but they are not classified as cost-saving measures – through they usually are.

On closer inspection it is noticeable that green logistics measures are even used to save costs. The payback period for these measures is not much worse than for alternative investments. Therefore the way to energy-saving and resource-saving processes is open. In the long run companies that go this way and implement these measures will stand out from their competitors, especially as resource prices are expected to rise sharply.

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