Teaching instructions for FURNITURA MANUFACTURING

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ABSTRACT

Students are given a qualitative description of the materials supply, manufacturing and distribution of the focal company, along with a letter from its CEO.

The letter from the CEO is an assignment to prepare a report that will aid in deciding on which distribution structure that is most suitable, along with calculations of total costs for each possible structure. It is also required that estimations of future profitability are included, since structural alterations in some cases might render new sales opportunities. All calculations should include estimations of different total service levels, since these are also consequences of managerial decisions, and hence can not be regarded as given.

In this version of the case, however, students are not required to conduct any calculations. The task is rather to problematize the given situation with their basic logistics training as a starting point, and to prepare for a more thorough investigation by:

1. Identifying the parts of the company's flows that are affected by the possible structural changes.
2. Identifying relevant cost and service elements upon which to base calculations.
3. Proposing a structure for the investigation and decide how and at which level of detail cost- and service calculations should be conducted.
4. Write a report on the above three.

The case gives students the opportunity to apply their basics logistics knowledge on a real life-like situation, in which relevant facts and clues to the problem are embedded in a 'messy' description of a company's operations. Basic constructs such as totals costs thinking, cost-versus-service trade-offs, and general problematization skills are trained.

Key Words: Flowcharting, Systems approach, Systems analysis, Cost vs. service, Total cost model, Logistics structure, Distribution, Direct delivery, Office furniture, Sweden.

1. Theoretical area & key learning points

This case is useful for training the following logistics fundamentals:

- Basic flowcharting.
  - Students are trained in sorting out necessary information from a semi-structured, qualitative description of a manufacturing company's material flows, from supplier base to customers, and translating this information into a flowchart.
- The systems approach (e.g. Stock & Lambert, 2001, p. 4).
  - By forcing students to formulate the problem themselves from a 'semi-given' situation, students are trained in defining the overall system, studied system, and components, and how these relate.
- Cost vs. service trade-off, total cost concept (e.g. Stock & Lambert, 2001, p. 28)
  - The case requires that students not only consider *that* costs and service interrelate, but also *why*, *how* and *to which extent*, by applying total cost reasoning.
  - Linked to total cost is the question of customer service. Students are required to link cost calculations to various aspects of customer service and to service levels.
  - The case also takes into account that not only cost, but also *revenue* can be linked to service, giving opportunities to discuss the importance of service beyond the classic tradeoff between costs for service and costs of lost sales..
- Logistics structure and service / costs.
  - Service level is determined not only by e.g. capacity in a given function, but also by e.g. structure. In this case, this is illustrated in the form of alterations to a company's distribution structure.
- How to conduct a logistics investigation (e.g. Taylor, 1997 p. 1-17).
  - Students are trained in structuring and breaking apart a complex logistics problem – from a systems perspective – into manageable pieces, and sorting out the most relevant parts to investigate in more detail.

2. Additional material

Available along with these teaching notes are some slides. These are available for use at the teacher's discretion. There are also some supplementary documents with data (see discussion on relevant & irrelevant information under section 6 below).

Note: *In its original version this case also allows for complete calculations, i.e. the data that students might request in the initial report are available. Please contact the author to check for availability of such supplementary material.*

3. Supplementary reading

Apart from course literature onlogistics, some other reading might be useful for students. Taylor (1997, pp. 1-17) offers a framework for analyzing logistics and supply chain cases that might be useful. An alternative in Swedish can be found in Aronsson *et al* (2003, pp. 165-169).

4. Possible uses of the case

This case can in its current form be used in several ways, of which a few possible are:

- As a self-study assignment. Based on these teaching notes, teachers can write a supplement to the case in the form of a feigned 'correct' consultant report (i.e. the initial report that the CEO asks for in section 1 of the case).
- Basis for a lecture. Students prepare by reading the case and reflecting over the assignment from the CEO, but do not prepare any reports or presentations. The lecturer gives his/her view on how the assignment can be approached.
- Basis for a discussion seminar. As above, but students prepare an oral report of how they would approach the investigation at hand. The lecturer acts as discussion leader, and can moderate the discussion in order to cover the necessary points.
- Basis for a written report and one or more seminars. As above, but students prepare a written report that is orally presented and discussed during a seminar. One possibility is to start with a discussion seminar before reports are written, and then gather once again to present and discuss reports.

5. The task

The task that students are expected to solve is presented in section 1.2 of the case. In short, students are required to do the following:

1. Draw a flowchart of the (material) flows from suppliers to customers, and in this identify the studied system, i.e. the parts that will be affected by the alternatives given by the CEO. Discuss and identify the alternatives that should be compared (scenarios). ***Note:*** *This part of the task is not as clearly stated in the letter as the items below. It is however the author's belief that this first step is necessary to bring structure to the investigation, and it is also in line with the recommendations of e.g. Taylor's (1997) framework.*
2. Discuss and identify relevant costs in the studied system, and relate these to relevant service elements, different service levels, and flow segments. Describe necessary calculations.
3. Similarly, discuss and identify how revenue is linked to service. Describe necessary calculations in order to predict future profitability for the different scenarios and service levels.
4. Specify which data that will be necessary in order to actually complete the calculations.

6. Additional instructions to students

Teachers should of course use the case at their own discretion, but some words of advice can be given based on the author's experience of using it in various teaching situations.

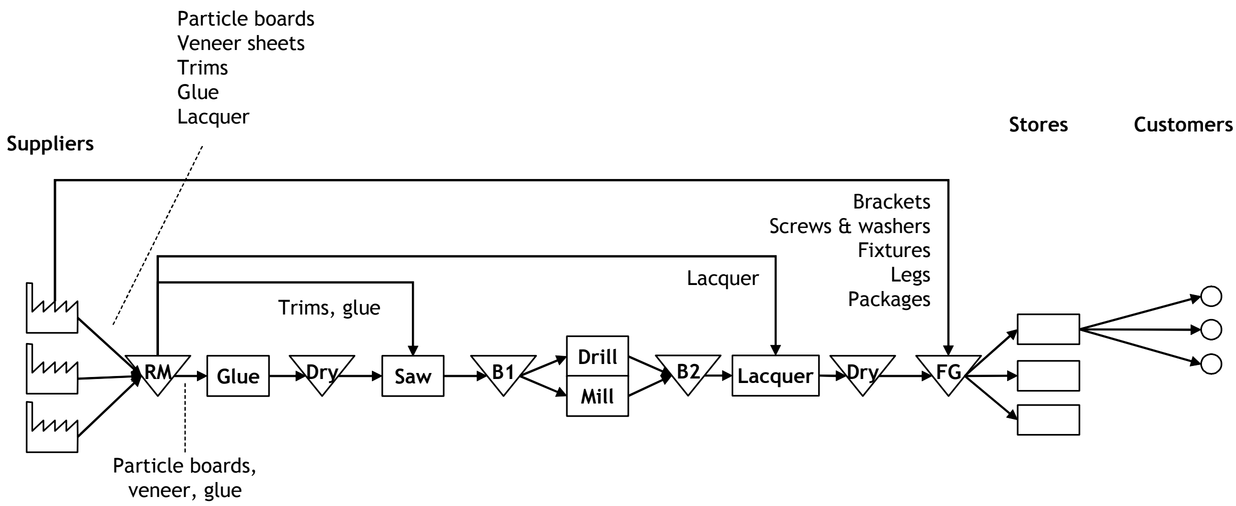
- **To design or not?** It is common that students treat the case as a design assignment (which it is not), which leads them into long discussions on how to improve the manufacturing process, IS/IT-systems, etc. This can of course be used as a pedagogical point regarding the importance of first identifying the studied system and setting boundaries for the investigation, before going into a detailed analysis. This can however cause some frustration and also trick students into wasting valuable writing- and seminar time on off-topic work. Therefore, it can be worthwhile emphasizing that there is a strict assignment given in the letter from the CEO. Urge students to study this very carefully, and perhaps start them off with a session during which you together discuss what the assignment actually is. ***Note:*** *Using the case as a design assignment is of course possible, there is however no additional material available to support this at the moment of writing.*
- **Transportation system.** Some students tend to over-emphasize the importance of the freight forwarder's transportation system, and suggest that direct distribution implies that one or several of the terminals can be skipped, thus saving time and money. In essence, 'direct distribution' can by the inexperienced case reader be interpreted as 'direct transportation'. This can again perhaps be used as a pedagogical point of the same kind as above. If not, it can be a good idea to discuss with students the normal boundaries between goods owners' and freight forwarders' systems, and that the important issue from the goods owners' point-of-view is *that* goods are forwarded at a certain price, time, etc., not *exactly how*.
- **Given information.** The case contains information that is relevant for the assignment, but also a lot that is not, both within the case text and the supplementary documents. Some students tend to believe that only the necessary information to solve a certain task is given, meaning that they consider all case information crucial. Again, this opens for a possible pedagogical point since real-life situations for logisticians (or any other business professional for that part) rarely are that neat.
- **Investigation framework.** Just as not all given information is relevant, neither are all steps or checklists in analytical frameworks such as the one proposed by Taylor (1997). In fact, Taylor states: *The purpose of this introductory chapter is to outline a framework for analyzing supply chain situations. However, it must be emphasized that this is not a prescriptive approach that can be applied without thought to all situations, rather it provides a series of checklists of factors to consider. The case analyst must determine which checklist, or part thereof, is relevant to the case in question.* (Taylor, 1997, p 1).

7. Main elements of a solution

The exact contents of a 'correct' solution and the required level of detail will vary depending on e.g. the course literature that is recommended. Since textbooks differ in how they portray e.g. total logistics cost, it is up to each teacher using the case to decide on what is relevant in the courses they teach.

7.1. Studied system & flowcharts

From the given information, it is possible to draw a detailed flowchart from suppliers, through manufacturing, to customers [slide #1]:



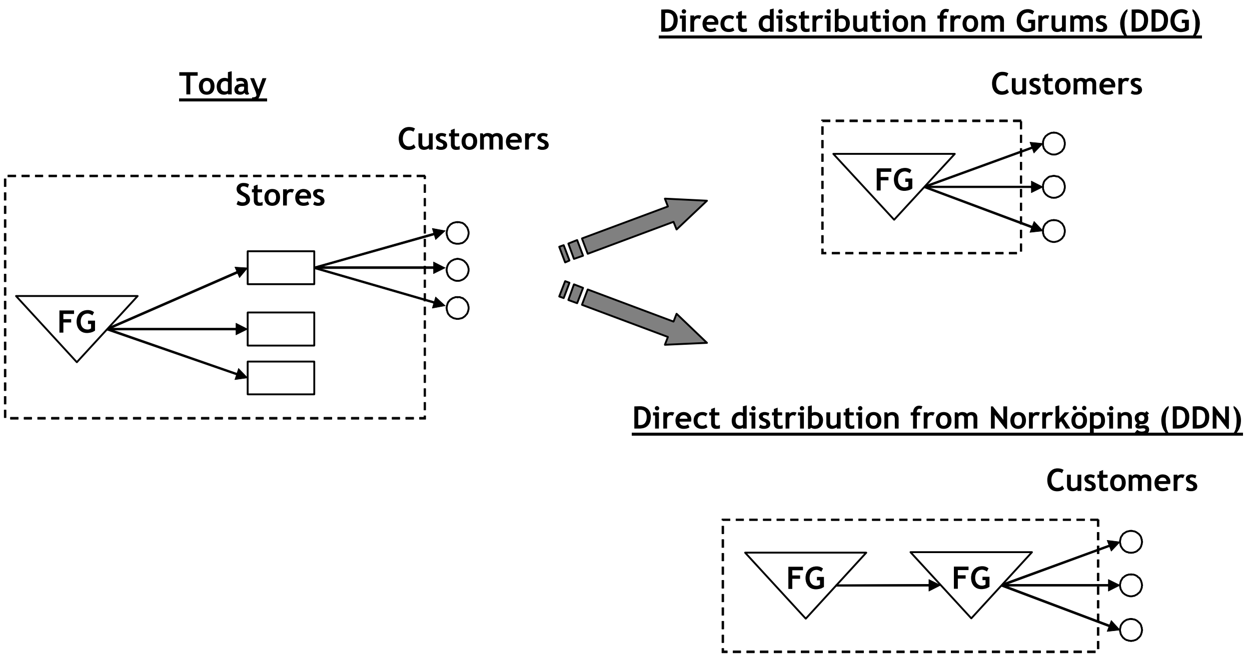
The CEO requires that the affected parts of the company's flows are identified. When the assignment and given information is studied in close detail, only a very small portion of the flows charted above become relevant to include in the studied system.

System boundaries should be drawn so that only the finished goods inventory and the distribution to customers are included. No alterations to materials supply or production are included in the alternatives given in the assignment, and it is not expected from students that they themselves propose any additional alternatives.

With the given alternatives, three scenarios shall be compared:

- The current weekly distribution (Today).
- Daily direct distribution from current warehouse in Grums (DDG).
- Daily direct distribution from new DC in Norrköping (DDN).

An illustration of these can look as follows [slide #2]:



7.2. Costs and service

This section is based on the total cost concept as presented by Stock & Lambert (2001, pp 8-9, 28-31). In that model, five logistics cost elements are linked to customer service in terms of *place and time utility;* in essence making products available for the customer at the right place & time.

Starting with the service aspect, customer service is discussed by Stock & Lambert (2001, pp. 98-101) in terms of *pretransaction, transaction,* and *posttransaction* elements. All of these groups may of course be relevant for Furnitura Manufacturing (FM) in some sense, but in this specific case the CEO is interested in finding out how revenue and costs are related to service levels in relation to the two proposed changes to the distribution system; changes that specifically alter the characteristics of the transaction between FM and their customers, and subsequently the associated order cycle. These teaching notes therefore focus transaction elements that are directly associated to achieving time and place utility. It could of course be argued that the shortening of the order cycle time should be viewed as a pretransaction element, given that the rationale is to increase sales if possible.

One common way of looking at transaction elements is from the perspective of 'the perfect order', i.e. *on time, complete and error free* (Stock & Lambert, 2001, p. 130). The most important aspects of this are discussed further in section 7.3 below.

Regarding costs, the five cost elements in the model are related to either or both of the material flows or the information flows of the studied system. Very little information in the case support any discussions regarding the information flows, therefore any such costs are disregarded here. This is of course a possible (and likely) point for discussion with students.

In section 7.4 each of the five cost elements are discussed from a material flow perspective. Graphical illustrations of where each relevant cost element originates can be found in section 7.4.7 and in slides #3-5.

7.3. Most important elements of customer service

The elements below are those that are deemed most important in this specific case. When it comes to discussing service as a total cost- and revenue driver, these should however not be discussed in isolation; some kind of reasoning in which these are weighted together should be applied.

Order cycle time / lead-time. This is as mentioned above the main rationale behind proposing a new distribution structure. By switching to daily direct distribution, average order cycle time will be shortened drastically. This element is however mostly related to the quantum leap change (i.e. the structural change) in this case, and less to any incremental changes within each scenario. It is therefore more essential to focus on aspects of service that are more closely related to the possible incremental changes that can affect cost levels within scenarios.

Lead time reliability / accuracy. Even if the proposed structural alternatives can allow for overnight delivery, it is not given that this will be achieved for every order. For instance, it is mentioned that pickers have the possibility to balance demand fluctuations between days in the current distribution, an option that no longer will be available. Therefore, ensuring on-time picking and dispatch of all orders becomes an issue of securing picking and dispatch capacity, which in turn is a question of cost.

Picking accuracy. Order picking also affects accuracy in terms of what goods that are actually delivered. In the case of the automated Norrköping DC, its capacity is stated to be fixed, but on the other hand automation might increase accuracy. It is however not possible to relate this accuracy element to any cost element in this specific case.

Stock availability / stock-outs. Since the proposed alternatives alter the time window for delivery to the customer, it might become necessary to look at safety stock levels.

7.4. Cost elements

In the following sections, each of the five logistics costs of Stock & Lambert's (2001) total cost model are discussed. These are further divided into cost elements related to their origins in the material flows; graphical illustrations of this can be found in section 7.4.7 and in slides #3-5.

7.4.1. Transportation costs

Transportation costs in this case arise when forwarding goods from the finished goods warehouse in Grums either to stores [T1 in slide #3], directly to customers [T2 in slide #4] or via the Norrköping DC directly to customers [T3 & T4 in slide #5]. These costs are relevant to include, since shipment distances and sizes (weight/volume) will vary between scenarios; weekly shipments to stores in today's distribution will in the future be transformed into shipments consisting of single customer orders directly to customer sites. Shipments will likely become more frequent, and the average shipment size will be smaller.

In terms of customer service, transportation activities will most likely have its strongest impact on lead time accuracy. If one assumes that transportation services are bought from the same provider in all scenarios, it is doubtful if there will be any major differences. A reasonable delimitation could therefore be to disregard service level in relation to transportation costs.

Calculations

Calculations can be done at varying levels of aggregation. The most accurate would probably be to simulate freight pricing for each shipment based on historical sales data, for each scenario respectively. For the current structure, this would require consolidation of weekly sales data per retail store, whereas for the two DD scenarios each customer order would induce one separate shipment.

Information on freight pricing is available in the supplementary material. Even though there is not sufficient data for including exact calculations, students should be able to use this material for discussing necessary calculations and required data. The following table illustrates the results that these calculations ought to produce:

	Scenario		
Cost element	**Today**	**DDG**	**DDN**
Grums → Stores	**T1**	n/a	n/a
Grums → Customers	n/a	**T2**	n/a
Grums → Norrköping	n/a	n/a	**T3**
Norrköping → Customers	n/a	n/a	**T4**
Total transportation cost	**T1**	**T2**	**T3 + T4**

Note: *Apart from the above, some students might argue that the transportation from stores to customers [* in slide #3] should be included. It is however stated in the company description that customers are responsible for picking up the goods themselves, i.e. FM does not have to carry this cost in today's distribution. However, this transportation cost will become FM's to carry when switching to direct distribution.*

Required data

- Historical sales data on customer order level.
- Product weights/physical volumes.
- Store locations and distances from Grums.
- Customer locations and distances from Grums and Norrköping.

7.4.2. Warehousing costs

Warehousing costs that vary due to number and/or location of warehouses are in this case costs for staff, equipment and buildings in either of the two warehouses. Looking at the Grums warehouse first, very little information is given regarding buildings and equipment, and it is also relevant to discuss whether or not these costs [*** in slide #5] would change if the DDN scenario should be chosen. It can be argued that the current warehouse building (and equipment) on site in Grums can not be liquidated in case of a move to Norrköping, why FM would be stuck with (parts of) these costs anyway, rendering this cost irrelevant for comparison purposes. More information is needed to discuss any possible alterations of these costs.

Warehouse staff costs will however change between scenarios. In the description it is stated that pickers have a certain capacity and that demand is balanced between days by utilizing the slack offered by the weekly dispatch schedule. The current picking staff causes a certain salary cost [W1 in slide #3].

This will not be the case in the DDG scenario, since customers will expect next day delivery of all ordered goods. Since it is also stated that demand can vary a lot between days, students ought to realize that picking capacity is an important issue to consider in conjunction with desired service level, see section 7.3. If picking capacity does not meet demand, some orders will be delayed which means lead time accuracy will suffer. Since picking capacity is an effect of the number of pickers, there is a clear relationship between service level and cost [$W2_1$, $W2_2$ … in slide #4] in this specific case.

For the DDN scenario, it is stated that FM will pay a yearly rent [W4 in slide #5]. It is however not exactly clear what is included in this rent, so the terms for utilizing the Norrköping DC needs closer investigation before exact calculations can be made. It is also stated that the four pickers in Grums will become redundant in this case, causing lower warehouse staff costs [W3 in slide #5].

Note: *Some students might argue that for both the DD scenarios some storage space might be freed up in the retail stores, as well as some materials handling. The investigation is however done on behalf of one focal company and not the entire Group, which owns the retail stores. It could however be discussed which perspective is best from a SCM point-of-view (and of course whether or not the changes will be large enough to consider for any of the individual stores).*

Calculations

For the current situation (Today), the warehousing cost consists of the salary costs for the four pickers, along with costs for buildings and equipment. The former can be calculated as the salary cost for a picker multiplied by the number of pickers (given in the case). The latter needs further investigation and some reasoning. For the DDG scenario, some reasoning on the relation between picking capacity and demand will be necessary. Several different service levels are possible to achieve by adjusting the number of pickers employed. Service level can be determined by comparing historical daily demand data with capacity.

It is stated that one picking order takes on average 3 minutes to pick. If it is assumed that pickers work for eight hours per day, each picker has a maximum capacity of 8 x 60 / 3 = 160 picking orders / day. Total capacity is therefore 4 x 160 = 640, which is well above the stated 4-500 for today's distribution. However, it is also stated that sales can vary heavily between weeks as well as days. Given that as many as 4200 products can be sold one week, and that up to 50% of one weeks sales can occur during one single day, the maximum demand for picking capacity when distributing directly can be as much as 0,5 x 4200 = 2100 picking orders day (one sold product generates one picking order). It is obvious that more detailed calculations than this will become necessary. The following table illustrates the results that these calculations ought to produce:

	Scenario		
Cost element	**Today**	**DDG**	**DDN**
Salaries Grums, fixed capacity	**W1**	n/a	**W3**
Salaries Grums, variable capacity	n/a	**$W2_1$, $W2_2$ …**	n/a
Buildings & equipment Grums	***	***	***
Rent Norrköping DC	n/a	n/a	**W4**
Total warehousing cost related to service level	**W1 (+ ***)**	**$W2_1$, $W2_2$… (+ ***)**	**W3 + W4 (+ ***)**

Required data

- More detailed information on Grums warehouse: location, operating costs, actual picker capacity etc.
- Information on terms for the Norrköping DC.
- Salary costs for pickers.
- Historical daily picking order data.

7.4.3. Order processing & information costs

This cost element is in its entirety related to information flows, which are disregarded for this case, see section 7.2 above.

7.4.4. Lot quantity costs

Since there will be no changes in production- or procurement order quantities, lot quantity costs will not change due to any of the proposed alternatives. Therefore, it is reasonable to delimit this cost element.

7.4.5. Inventory carrying costs

Inventory carrying costs (that vary with the amount of goods stored) are relevant to include in the investigation. With today's distribution, the delay between order placement and dispatch offers a possibility to balance demand in order picking between weekdays. This buffering effect also applies to finished goods availability; it is possible (to some extent) to react to stock-outs and replenish the finished goods inventory before dispatch is due. When switching to daily direct distribution this buffering possibility will vanish, which in turn might call for a re-dimensioning of safety stocks.

In the DDN scenario there will also be a shipping buffer of finished goods in Grums, which implies a difference in total stock levels in between the two DD-scenarios. Also, both the DD scenarios imply that goods waiting for customer pickup in stores will no longer be an issue, it can however be debated whether this causes a large enough cost to consider [** in slide #3].

Calculations

Calculating inventory carrying costs is by no means a simple task, but one common way of doing this is by multiplying inventory value by a determined carrying cost percentage. To determine this percentage, it is necessary to find out all the quantity dependent costs of inventory for today's distribution (which will in fact be the cost for this scenario) and divide it by the current inventory value. This in turn is calculated by multiplying current average stock levels with product values. Average stock levels can be calculated if safety stock levels and replenishment quantities are determined; the latter are actually given in the case. However, since replenishment quantities (i.e. production quantities) will not differ between scenarios, it could be argued that it will only be relevant to calculate inventory carrying costs due to safety stocks. For today's distribution, inventory carrying costs can then be calculated by multiplying safety stock level with product value, and in turn by the determined percentage [I1 in slide #3].

In the case of scenario DDN, it is necessary to find out the policy that will govern the size of the dispatch buffer in Grums. No safety stock will be necessary here; this will only be necessary in Norrköping, the inventory that absorbs customer demand. However, the buffer size will vary depending on how frequently produced goods will be shipped to Norrköping. When this is determined, the inventory carrying cost for this buffer can be calculated [I3 in slide #5].

In both the DDG and DDN scenarios, safety stock levels will have to accommodate for daily fluctuations in demand. Since both locations cater for overnight delivery, these stock levels and subsequently costs will be the same regardless of location. Since stock-out frequency is an effect of the number of items in safety stock, there is a clear relationship between service level and cost [$I2_1$, $I2_2$ … in slide #4 & #5] in this specific case.

The following table illustrates the results that these calculations ought to produce:

	Scenario		
Cost element	**Today**	**DDG**	**DDN**
Safety stock Grums	**I1 (+ **)**	**$I2_1$, $I2_2$ …**	n/a
Shipping buffer Grums	n/a	n/a	**I3**
Safety stock Norrköping	n/a	n/a	**$I2_1$, $I2_2$ …**
Total inventory carrying cost related to service level	**I1 (+ **)**	**$I2_1$, $I2_2$ …**	**$I2_1$, $I2_2$ … + I3**

Required data

- Current safety stock levels.
- Current inventory carrying-related costs.
- Historical daily sales data per product.
- Product values for all items kept in finished goods inventory.
- Policy regarding dispatch buffer in Grums for scenario DDN.

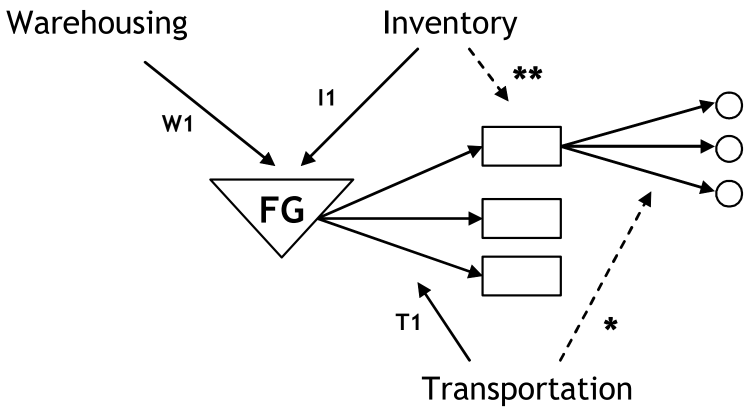
7.4.6. Other costs

Even though not explicitly included in the applied total cost model, it should be noted that some other costs actually can be affected in the current case. The most obvious is that a sales increase quite reasonably will affect raw material costs. It is stated that capacity is sufficient for a sales increase, meaning that no investments or staff increases will be necessary; subsequently, no other increases in manufacturing costs will be likely.

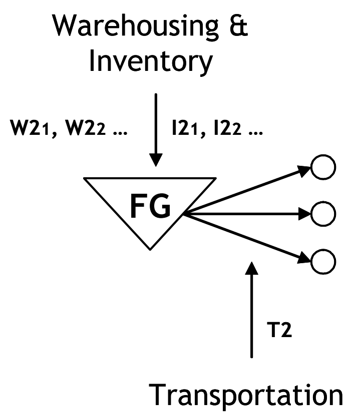
7.4.7. Cost origins in the material flows

Regarding the material flows, the following cost elements are most obvious in the affected parts of the flows [slides #3-5]:

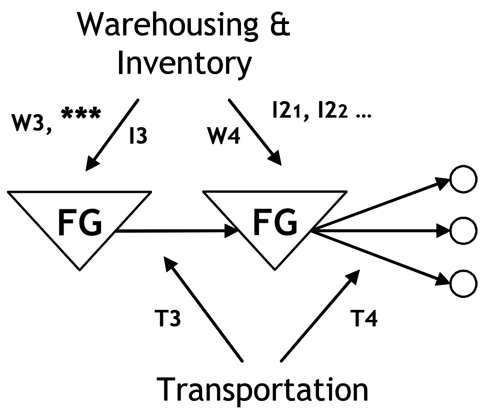
Scenario Today



Scenario DDG



Scenario DDN



7.5. Estimation of profitability

Apart from describing necessary calculations and data regarding costs, it is also required that ways of estimating future profitability are discussed. This is necessary since a high service level can increase revenue, but also costs, i.e. it is not obvious which combination of distribution alternative (scenario) and service level that will be most profitable.

An obvious measure of profitability is bottom line result. The baseline for such a comparison could be the income statement for the last fiscal year (supplementary material). To compare scenarios and service levels, it is possible to add (or subtract) total cost differences, i.e. the difference between total costs for scenario Today and each of the possible DDG/DDN options respectively. For such a comparison it will however also be necessary to estimate the possible sales increase associated to the overall service level, and add this to revenue. This is by no means a straightforward task; it is stated by the CEO that an 'impeccable delivery service' might render a sales increase of ten per cent, but how good does service have to be to be considered impeccable? And how much does it have to decline in order to achieve a lower increase than ten percent, or perhaps no increase at all?

With the given data it is at best possible to discuss some kind of crude appreciation. One suggestion is to compare today's distribution to six different options, two distribution alternatives with high, medium and low service levels respectively. In the case of the high service level, a sales increase of the full ten per cent might be used, whereas for the medium service option an increase of five per cent could be applied. Subsequently, for the low service option, an unaltered sales volume could be used. For each of these six options, a cost- and revenue difference from today could be calculated and used to estimate future profitability.

Other ways of estimating profitability could of course also be applied along the same lines of reasoning. Bottom line result estimations could for instance be supplemented with estimations of changes in ROA (return on assets). Such estimations would, apart from the above, also require that the calculated differences in stock levels are used to estimate changes in current assets.

8. References

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9. Acknowledgements

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