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Potential improvements in dairy and beverage products' supply chain

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Abstract

In modern logistics operating environment and economic competition, it is has become quite essential to have effective and efficient supply chain management. Constant optimization process within supply chain is important to have a great customer service and a way to attain highest profit possible.

Following case study was assigned by groceries manufacturer JSC "Slavmo" located in Petrozavodsk, Russia. Main objectives of case study were to identify current operating environment and propose possible improvement suggestions to be implemented in company to gain benefit in a long term perspective.

As of methodology, both qualitative and quantitative research were used. Majority of research was based on qualitative methods, since precise calculations were needed.

Theoretical background was researched to be subsequently used as a base for potential improvement suggestions. Current operating environment was also defined in order to have a clear picture of actions and improvements to be proposed.

After processing and analyzing gathered information different improvement suggestions to various supply chain parts were proposed: introducing intermittent production rate, utilizing storage area for beverage products and introduction of safety inventory, new distribution pattern and approximate routes.

As an outcome of case study, company has received possible improvement proposals and vision which direction to head next. Some of changes will involve financial investment, other won't. However, presented solutions are meant to optimize supply chain, provide better customer service and generate biggest profit possible.

Keywords/tags (subjects)
Supply chain management, distribution, transportation, groceries manufacturing

Miscellaneous

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1 Introduction

Logistics is all about managing flow of goods from point A to point B. This process consists of complex tasks that have to be completed accurately and fast so that goods would be delivered at right condition, to right place and in needed amount. Nowadays it has become essential to have effective and efficient supply chain management. Economies and population are growing and, as a result, there is a bigger demand for products. Transportation, warehousing, purchasing is inevitable part of supply chain and it requires lots of attention spending from company's side in order to generate biggest profit. Each company strives to generate as much profit as possible and optimizing supply chain is the way to achieve it. The case assigned by the company "Slavmo" is meant to optimize supply chain of company and propose possible solutions to reduce costs.

1.1 Company in brief

Joint stock company "Slavmo" is the biggest dairy products and beverages manufacturer in Republic of Karelia, Russia. It's located in Petrozavodsk. Manufacturing facilities are working since 1983, however, Slavmo trademark has been registered only in 1996. In 1993, after USSR broke apart, there has been a general upgrade of manufacturing process and modern production lines were introduced and implemented. Originally, it was dairy-products oriented manufacturing only, but it has been decided to expand targeted market area and begin producing beverages such as spring water, soda, juices. At the moment, company continues to bring out new products to the market and, at the same time, constantly maintaining high quality. Mission of the company is to provide population with high quality products at relevantly low price.

1.2 Research objectives and methods

The purpose of this thesis project is to suggest improvements to the current supply chain operations of the case company. Those improvement suggestions will consider mostly distribution process, since it's the main research question of the thesis. However, the suggestions of possible improvement will also be related to warehousing

and production. To find a solution to those issues, research would be done in the following way:

1. Theoretical exploration of information related to the area of improvement
2. Description of current working environment in the company
3. Defining possible improvement solutions.

Major research question is going to describe the way, how to achieve improvements in described areas. Question of how wise implementation of suggested ideas are, will be also answered.

Type of research used for thesis project is a case study, since there are current activities at company, which has to be studied and improved for further implementation to advance performance of logistics on practice. To solve case study in the most favorable outcome both qualitative and quantitative methods are used.

Qualitative approach is meant to define and understand underlying reasons for phenomena and processes and it works with non-numerical data. Following case study is based on literature review to acquire theoretical knowledge of the processes. To collect data interview with company's representative is often used practice. Other commonly used methods of information acquisition include surveys, experiments and observations. Qualitative method is meant to answer questions why and how. Meanwhile, quantitative approach deals with numerical and statistical data. This research method is meant to answer narrow question by analyzing quantifiable data using statistics in unbiased, objective manner (S.Fischler). Solution to the case study is going to be based on data collected from interview and other primary sources like literature, online articles and documents.

2 Market research of dairy products

Dairy industry has a lot of value to the Russian economy and employs around 1.2 million people. It is equal to around 0,82% of total population. After USSR collapse in the yearly 90's, milk production and as a result its consumption has significantly dropped. In fact, World Health Organization claims that dairy products are one of the most essential for diet of humans and average consumption of such products should be equal to 320-340 kg a year. To have an insight of current situation of dairy con-

sumption, statistics data is used. In the year of 1990 consumption was 387 kg per capita, however, in 2014 it was just 243 kg on average. Consumption decrease over period of 24 years is 37,2%. In addition, there is a list of regions in Russia, whose consumption is around or even less than 200 kg per person a year. Petrozavodsk is located in Northwest region, which is included in this list. Decrease of consumption is connected with two cause factors: production decrease and fall of citizens' purchasing power. Low purchasing power of population is related to relatively high inflation and low average salary of citizens.

Just in 9 years from 1990, production decrease has reached the figure of 45,16%. This phenomenon is related to the deep economic stagnation, which eventually led to economic default. Nonetheless, dairy industry has adjusted to the situation, even though trend of decrease has been continued but not in such dramatic way. The trend of production and consumption could be seen on the graph. Amounts are presented in thousands of tons.

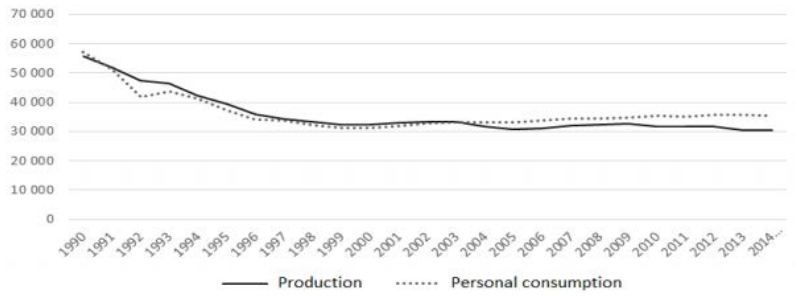

Figure 1. Production and consumption of dairy products

Furthermore, since 2014 dairy industry in Russia is facing challenges of coping with demand due to imposed food embargo from EU countries. This share of market is partially replaced by importing milk products from Belarus. Currently, programs of state support are introduced to stimulate growth of national dairy production. Overall, low dairy production rate is related to fluctuating raw material prices, low profitability of dairy business, low purchasing power of population and reduction of dairy enterprises nation-wide (Guziy, pp. 1-3).

Total number of dairy manufacturers in Karelia is four, including Slavmo. It's also the biggest manufacturer among Karelian dairy industry. It has a share of 1/3 of the whole market. In the following graph, share of local manufacturers are listed.

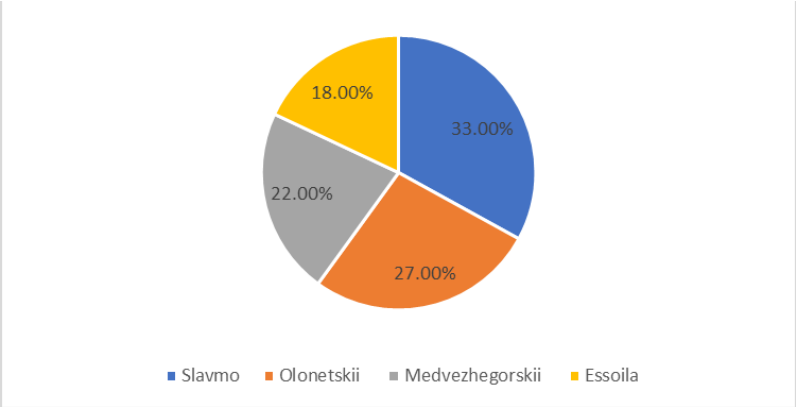

Figure 2. Market share of Karelian manufacturers

Furthermore, dairy products availability on store shelves is quite diverse. Products from different regions of Russia are presented. Most of products coming from other regions are very popular nation-wide. To have an insight on current situation of market share following table could be presented:

Table 1. Share of Slavmo among manufacturers

Product type	**Aver. amount of products**	**Share of Slavmo, %**
Whole milk	30	10
Quark	26	11,5
Smetana	17	11,7
Kefir	15	20
Ryazhenka	17	17,6
Cream	10	0

3 Theoretical background

3.1 Supply chain management

Supply chain encompasses all organizations and activities associated with the flow and transformation of goods from raw materials through manufacturers to the end user, as well as the associated information and monetary flow (Juliana Hsuan, 2015). In other words, supply chain is a complex process, which requires a lot of attention

and constant management. SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries and customers (Juliana Hsuan, 2015, p. 19). It, basically, encompasses SC and becomes the environment for logistics operation. Thus, logistics is an environment for logistics activities.

In order to have perfectly shaped supply chain management there is a need for systemic approach, since all of the intermediary steps like procurement, production and so on are connected and depend on each other significantly. Thus, systemic approach is meant to shape all of activities within SC so they work based on JIT (just in time) philosophy. In other words, to have it working without delays of deliveries or shortages in product availability.

Operating processes of the supply chain could be described in five following steps (Juliana Hsuan, 2015, pp. 25-27):

1. Demand management (activities related to market such as forecasting customer service market coordination)
2. Distribution (connects production to the market)
3. Production (Influences inventory, transport and time for delivery)
4. Procurement (Links stages of manufacturing together)
5. Returns (Closes the supply chain loop)

SC could be described as a network with different steps occur as product development happens. At each step value is added to the system is added and at the end we have a product which has been delivered and ready to be consumed by customer. Describing the sequence of how value is added to the product, Michael Porter's value chain model could be used:

Figure 3. Porter’s value chain

His concept describes on how value is added to the product as passes the steps and achieves more value to the end customer (Juliana Hsuan, 2015, pp. 40-42). Furthermore, according to Porter value chain, it is embedded in a larger stream of activities called value system.

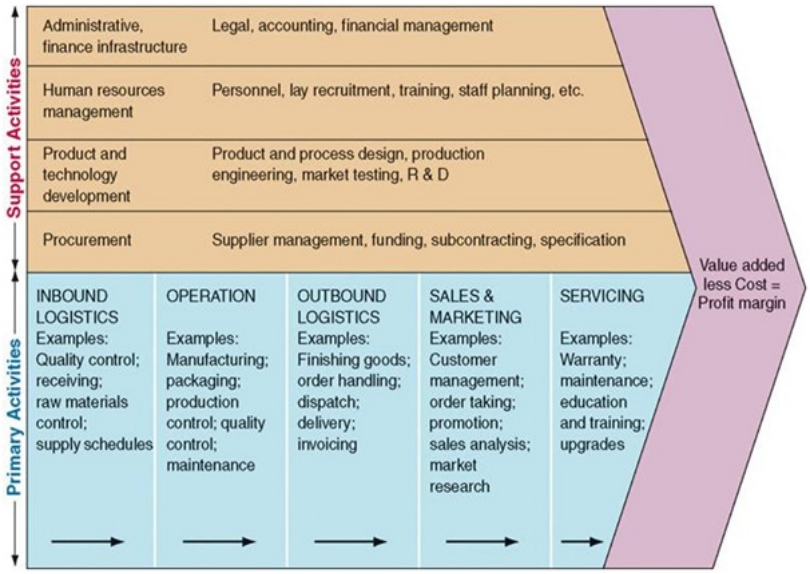

Figure 4. Extended version of Porter's value chain

The main purpose of efficient supply chain management is to deliver products on time, in right condition and in needed amount. However, delivering of needed amounts is not always possible due to Bullwhip effect in supply chain. Bullwhip effect takes place when a distortion of demand information occure as information is moved along the supply chain. Each department in SC has it own ordering process which is based on reorder point and order quantities. Finally, as a demand information moves along the SC to the next party, it shows a numbers which are different from actual demand. Further step in supply chain is, the bigger variance is possible. There are several issues that make Bullwhip effect occur (What is the Bullwhip Effect? Understanding the concept & definition, 2012):

1. Disorganization — Happens between supply chain links
2. Lack of communication — The same cause as previously mentioned
3. Free return policies — Customer may intentionally overstate demand due to shortage and afterwork after there is enough supply, order is canceled
4. Order batching — Applicable if companies do not place and order right away.

5. Price variations — Discounts, promotions can have negative impact on regular order patterns
6. Demand information — Previous demand information is considered, whereas current demand might be different.

To sum up the idea of how bullwhip effect occurs following illustration could be provided:

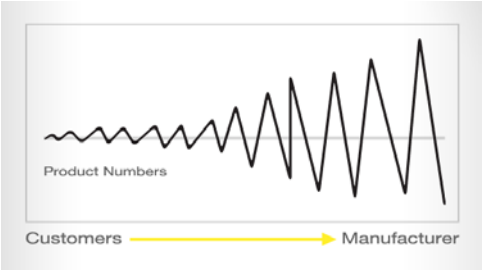

Figure 5. Bullwhip effect

3.2 Warehousing principles

Despite all of the initiatives and attempts of SCM to eliminate warehousing by such techniques as Efficient Customer Response and JIT delivery, etc., SC would probably never be at perfect level of coordination so it would be possible to eliminate warehousing at all. Warehousing plays a significant role in supply chain connecting stages of production process. Nonetheless, warehousing is quite expensive comprising around 2-5 percent of enterprise cost of sales (Frazelle, World-class warehousing and material handling, 2001, p. 3). Furthermore, clear picture of cost breakdown in typical warehouse could be found from this diagram (Frazelle, World-class warehousing and material handling, 2001, p. 148):

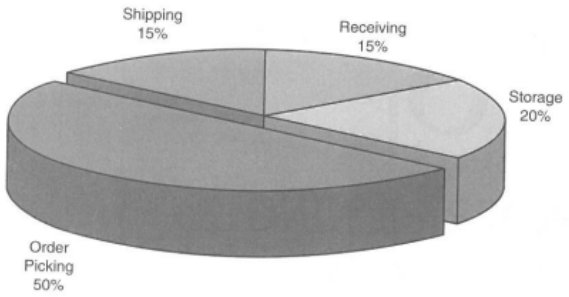

Figure 6. Total cost of distribution

Warehousing functions could be divided in the following pattern (Frazelle, World-class warehousing and material handling, 2001, pp. 10-11):

1. Receiving – includes 3 types of activities. Firstly, receiving items coming into warehouse. Next step is making sure that quality and quantity are as mentioned in order. Finally, forwarding material to storage places or to perform other organizational functions.
2. Prepacking (optional) – mostly applies for cases when materials are received in bulk and there is a need for packaging in merchandisable quantities
3. Put away – Placing arrived products to storage areas.
4. Storage – Keeping products in a warehouse while it's awaited to be demanded.
5. Order picking – Removing items from storage
6. Packaging and/or pricing (optional) – May be accomplished for more convenient use of individual products
7. Sortation – picking of individual batches into individual orders
8. Unitizing and shipping – Includes checking order for completeness, consolidation, preparing paper work, loading trucks and so on.

Warehousing operations are straightly connected to material management and inventory. Inventory is complete listing of merchandise or stock on hand, work in progress or raw materials, finished goods on hand etc., carried out by an enterprise periodically (dictionary.com, n.d.). To control inventory and have precise insight about what is happening in materials management sector, ABC and XYZ analysis are used.

ABC analysis intersects with 80/20 rule in methodology. 80/20 rule or Pareto's principle states that 80% of outcomes occur from 20% sources/cases (Martin, 2015).

When it comes to ABC analysis it's basically applies this principle. Analysis of total inventory is divided into 3 groups: “A”, ”B” and “C”. Category “A” contains most valuable items and has to be controlled constantly. Group “B” reflects less valuable items, however, those items still contribute significant amount of company's revenue. Items listed under “C” category are least valuable and has least significance to enterprise. Since “C” group contains quite a lot of SKUs and could be further divided into smaller group to simplify management of those items.

Table 2. Share of each class in ABC analysis

ABC class	Number of SKUs	Share of value
A	10-15%	60-70%
B	15-20%	10-30%
C	60-70%	10,00%

XYZ analysis is another approach towards inventory management. It's based on demand fluctuations of the product at different periods. Generally, each period is considered to be one calendar month. Three categories are divided in following pattern:

- X items – very little variation

Y items – Some variation are in place. Although demand is not constant it could be predicted to some extent, predictions could be made due to knowledge where obstacles come from. Examples of obstacles could be seasonality, extended lead time, etc.

- Z items – the most variation occurs. Demand for products in this group fluctuates significantly and there is no possibility to predict it.

In X and Y groups trend could be clearly seen. Thus, the process for controlling those items could be simplified significantly. In case of X items, inventory management could be fully or almost completely automated. Safety stock could be kept at low level.

- Y items have to be controlled with more attention. It should be manually controlled and safety stock has to be increased, due to bigger demand variations than in X class items.

Benefit of XYZ analysis (XYZ inventory management, n.d.):

1. Improves accuracy of forecasting
2. Reduces stock-outs with outcoming benefit of improved production stability and efficiency as well as overall customer satisfaction
3. Clarifies service level for SKUs.

Safety inventory is also considered to be an important aspect of inventory management. It is carried to satisfy demand that exceed the amount forecasted for a given period. Safety stock is carried because demand is uncertain and a product shortage may result if demand exceed forecasted (Chopra & Meindl, 2007, p. 304). It is calculated according to the following formula:

$$SS = service\ level * \sqrt{(Avg.lead\ time * st.dev\text{^}2 + mean\ demand\text{^}2 * st.dev\ of\ lead\ time\text{^}2)}$$

Layout of most warehouses is selected according to the flow pattern of products. There are 3 basic layouts used then establishing a warehouse:

1. U-shaped

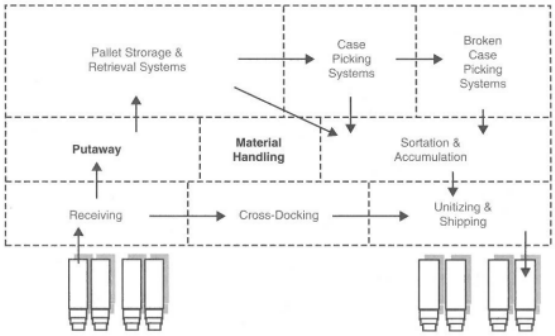

Figure 7. U-shape warehouse layout

2. Straight through

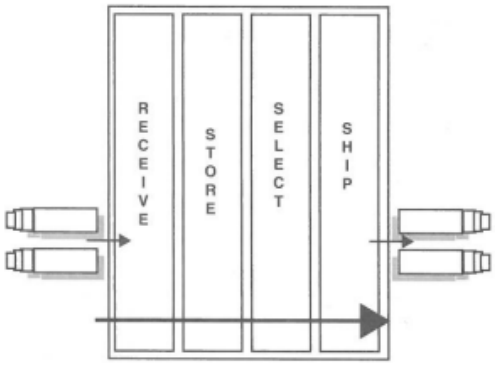

Figure 8. Straight through warehouse layout

3. Modular

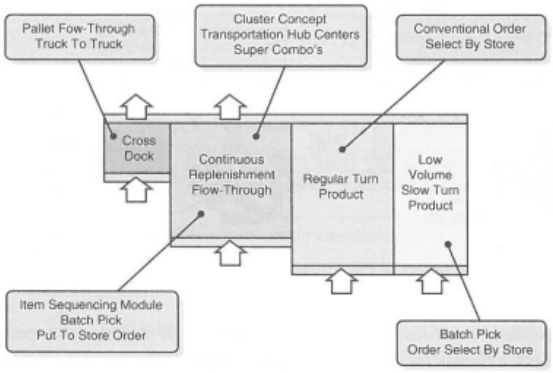

Figure 9. Modular warehouse layout

Pictures are retrieved from (Frazelle, World-class warehousing and material handling, 2001, pp. 194-198)

Layout of warehouse is connected with receiving and put away activities within warehouse. Receiving is a setup activity for everything that is going to happen next. Receiving practices could be divided into 5 groups. First option is to have direct shipping. In some cases, absence of receiving is the best practice. This process doesn't require handling at warehouse at all, eliminating all underlying costs. Next solution is cross-docking. It is an option when DC cannot be avoided, however, in nearest timeframe cargo would be forwarded to designated customer. Advantages of this approach are: utilization of space within warehouse, items are stored in warehouse for a short period of time. This approach is followed by receiving scheduling. In this case, process is based on planning of future DC operations to proactively schedule receipts and provide advance shipping notice information. An advance shipping notice is an electronic notification of an upcoming delivery which is sent is sent from supplier or 3PL to a buyer of service, in advance of shipping (What is ASN?, n.d.). Fourth possible solution is pre-receiving. Pre-receiving implies that information about products arriving to the warehouse is available in electronic form before actual arrival of shipment to the warehouse. Information about incoming goods could be captured on a smart card or RFID tag, enabling immediate input of information at receiving dock. Lastly, receipt preparation option is available. It's based on method that anything related to material processing that can be done ahead should be accomplished (Frazelle, World-class warehousing and material handling, 2001, pp. 74-75,78-79).

Most popular pallet storage systems are (Frazelle, World-class warehousing and material handling, 2001, p. 85):

1. Block stacking
2. Stacking frames
3. Single-deep selective pallet rack
4. Double-deep rack
5. Drive-in rack
6. Drive-thru rack
7. Pallet flow rack
8. Push-back rack

3.3 Distribution

Distribution is the final stage of supply chain management, as successful distribution makes the final products and services available to the ultimate customer (Juliana Hsuan, 2015, p. 127). Apart from that, distribution is also the most expensive logistics activity. It is equal to 44% of most companies' logistics expenses (Frazelle, Supply Chain Strategy, 2002, p. 170). Here is the diagram showing how logistics costs are distributed:

Figure 10. Total logistics expenses

Generally, transport cost consists from two subcomponents: transportation from manufacturing site to Distribution center and from DC to customers. The less warehouses company has, the less is the cost of moving goods from manufacturing facilities to DC. Second subcomponent is related to the transport. It could be outsourced services or vehicles owned by enterprise. If company has a few DC transportation cost would increase since the distance to final customers is increased.

Amount of DC is straightly connected with carrying safety stock in those DC. There is a square root law, which states that safety stocks can be reduced by square root of number of DC:

$\frac{S_c}{S_d} = \frac{\sqrt{n_c}}{\sqrt{n_d}}$, or $S_c = S_d * \frac{\sqrt{n_c}}{\sqrt{n_d}}$

To sum up the idea of how warehouses/Distribution Center is connected with distribution, there is a need to mention that more locations company has, the higher costs are. DCs have fixed and variable costs of ownership. Fixed costs include building maintenance, trucks, equipment needed for DC operations. Among variable costs are employee, and utilities costs such as electricity, water, etc. (Juliana Hsuan, 2015, pp. 138-139)

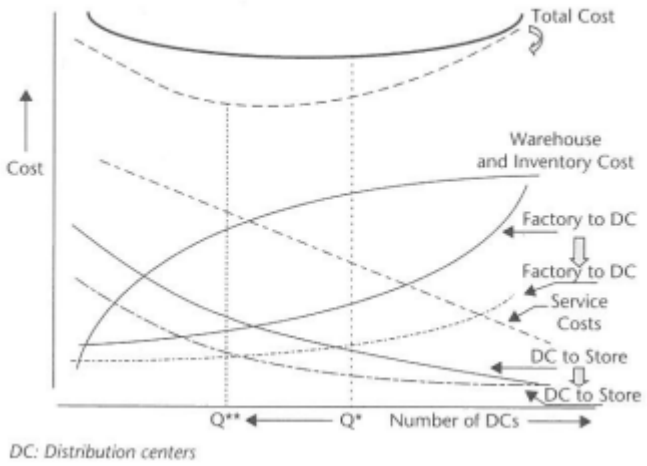

Figure 11. Distribution cost connection with amount of warehouses

The main aim of distribution is to deliver products to the customers with lowest possible price with agreed service level. Efficient Customer Response strategy supports this vision. The vision of ECR is to set up a consumer-driven distribution system in which production is managed by consumers' POS (Point of Sales)-activities. Basically, ECR aims to improve product flow by information sharing between retailers, wholesalers and manufactures. Information that is shared is meant for better understanding between retailers and vendors in order to offer end user required product solutions (Juliana Hsuan, 2015, p. 154). Specific practices of ECR are (Efficient Consumer Response (ECR): Adding Customer Value to the Supply Chain using Collaboration, 2014):

- Switch to more frequent order placement (from monthly to weekly and from weekly to daily)
- Small-lot and frequent delivery (to shorten lead times and reduce inventory)
- Cross-docking to reduce work of sorting and distributing cargo

ECR is connected with VMI (Vendor Managed Inventory). VMI is a business model where buyer of a product provides information to a vendor (seller). Vendor takes full responsibility for maintaining an agreed inventory of the material, usually at the buyer's consumption location.

Benefits of using VMI (Murray, 2018):

- Eliminates the need to have significant safety stock for customer
- Customer benefit from reduced purchasing costs, since data is provided instead of purchase order
- Cost saving in reduced warehouse costs.

Distribution process planning assumes a lot of factors to be considered. Among these factors are:

1. Infrastructure
2. Volumes to be transported
3. Specifications of cargo to be transported (fragile, temperature controlled, etc.)
4. Demand fluctuations

Total distribution costs are comprised from several components:

1. Transportation costs
2. Inventory costs
3. Warehousing costs

Finally, important factor, which has to be considered, is the van or small truck, which is used for delivery. Operation delivery vehicle consist of two group costs: variable and fixed. Fixed cost are the ones which are present and do not change no matter whether vehicle is used intensely or seldom, whereas variable cost are changing according to the frequency of use.

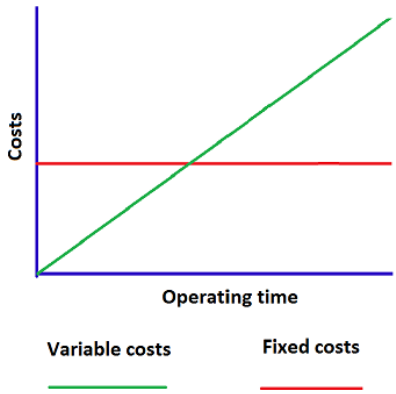

Figure 12. Fixed and variable cost of distribution

Both variable and fixed costs consist of several subcomponents. Fixed costs include:

1. Capital cost
2. Insurance
3. Operating costs
4. Facility expenses
5. Administrative
6. Empty miles
7. Operating margin

It is necessary to highlight a few essential points. Capital cost includes the estimation of vehicles annual depreciation and its residual value after intended period of use. There are two formulas to calculate those values:

$Residual\ value = Purchasing\ price * (1 - b)/100)\text{^}n$, where b is depreciation value (%) and n – intended period of use (in years)

$Yearly\ decrease\ in\ equipment\ value = (H - Residual\ value)/n$, where h and n are purchasing price and lifetime, respectively.

Depreciation value differs from 20 to 30%. According to the classification of commercial vehicles by weight in Russia, there are 3 types of vehicles (Classification of cargo vehicles, n.d.):

1. Small – carrying capacity is up to 1,5 tons
2. Medium – carrying capacity is between 1,5 and 16 tons
3. Big – carrying capacity exceeds 16 tons

Medium sized lorries are the only types of vehicles, which are going to be involved in this project. This decision is caused by introduction of toll collect system “Platon” in Russia in late 2015 (System of charging payment, n.d.). According to this system, cargo vehicle exceeding total mass of 12 tons are obligated to pay fees for using road network country-wide. Small size vehicles have also been rejected since cargo capacity is not enough to cope with distribution amount. Otherwise, there would be a need to increase amounts of vehicles. It would be nonsense, as company would incur significant losses. Operating costs include motor vehicle tax and inspection which has to be done once a year for cargo vehicles with total mass of more than 3,5 tons (Frequency of inspection depends on the age of vehicle, n.d.). Lastly, facility expenses are also applicable to the fixed costs category. Washing, small equipment and heating are factors included in this category.

Variable costs increase proportionally to vehicle usage frequency. Among variable costs following categories could be found:

1. Fuel
2. Lubrication
3. Maintenance and Repair
4. Tires

Fuel costs are one of the biggest expenses in transportation. It accounts for 20-30% of total costs. Fuel consumption is one of the most variable indexes and it could be hard to predict consumption as there are numerous factors affecting it. Here is a list of major factors affecting consumption

1. Driver’s experience
2. Excessive brakes and accelerations
3. Road and weather condition
4. Average speed
5. Proper, on-time maintenance

Lubrication is allocated into separate group from M&R. Reason for this is due to calculation of lubrication costs. Lubrication is calculated from the total price of fuel consumed over a period, whereas M&R is calculated from purchasing price of brand new vehicle. It is not possible to estimate exact amount of expenses, company is going to incur, but average costs are possible to calculate. Lubrication cost approximately

amount to 15% of fuel costs and M&R are expected to balance around 25-40% for light lorries.

Some fixed and variable costs have same value of expenses for enterprise for medium sized lorries, particularly, facility expenses and tires. Facility expenses Reason underlying behind same expenses for tires is that all of medium sized lorries, which are going to be compared further on have 2 axels and 6 tires. In addition, it's hard to calculate tire costs as there are multiple options of different price range available on the market. Thus, facility expenses and tires are excluded from calculation of vehicle ownership cost. This is done to have clear picture of basic expenses company is to incur. Furthermore, cost of these two categories is going to be the same and won't influence total operating cost.

4 Environment of research

4.1 General overview of current logistics operations

To manufacture its dairy products Slavmo purchases milk from local milk farms in Petrozavodsk area at the summer period. Throughout winter season, if there is a lack of milk, milk powder and concentrates might be used. Most of the milk is coming from company's 100% owned subdivision farm located in Shuya, which is 28 km away from factory location Petrozavodsk. After milk is collected and brought to the factory, it is further processed to produce such products as quark, milk, butter, smetana and so on. There are numerous manufacturing lines for different products groups. For example, within quark manufacturing group there are multiple production lines. Each manufacturing line operates every day to satisfy demand of grocery stores.

Slavmo's work is based on make-to-order model. Everything that is produced is shipped away next day. Orders for the next working day are accepted the day before, so that there is a time to produce and consolidate shipments. Distribution network is quite broad. It overlaps the whole Republic of Karelia region, however, due to the fact, that Karelia is barely inhibited region, around 35% of targeted customers live in Petrozavodsk area. Most of the customers are grocery retailer chains such as Magnit, Pyaterochka, 7YA, etc. In addition, there is a retail chain owned by Slavmo, where its

products are on sale for a bit lower price. The main difference between retail chain owned by a company and federal retailer is the frequency of replenishing stock. In case of owned retail chain, if there is an unexpected demand during the day, current stock of the items could be replenished on the same day to cope with demand. Other customers do not have this option available. Deadline for ordering is the previous day. Currently, there are 24 routes cruising around the city to deliver products to retailers and other small business. All of the delivery vehicles are owned by enterprise and consist of GAZ 3309 with refrigerated cargo compartment due to products specifications.

4.2 Production

Dairy manufacturing starts from raw materials collection. Raw material is cow's raw milk. Cow's milk is the only type used to manufacture products. Milk is not processed at farms at all. All of the activities are performed at manufacturing premises. Milk is being collected in the first half of the day and brought straightly to manufacturing facilities in liquid containers pulled by trucks. As it was mentioned main source of raw material is subsidiary farm in Shuya. However, it doesn't cover all of demand and additional suppliers are involved to make sure there is enough raw material for production planned. Area, where milk comes from is quite vast. It's up to 100 km from facility location. Totally, company receives and processes around 60 tons of milk daily.

After milk has been received, it is being tested according to the requirements to comply with standards, regulations and to conform high quality. Quality is monitored at different stages of production. First quality check is done when milk arrives. Second and third checks are done while manufacturing and final product quality check, respectively. Process of inbound activities for milk requires a lot of time. It could take up to 5 hours. After it has been tested, it is stored in containers according to the milk's fat content. This process is followed by thermal treatment. It includes pasteurizing and ultra pasteurizing depending on the final product. Ultra pasteurization is applied for products intended for long shelf life. At Slavmo, it is only various commodities of milk. Other products are treated with pasteurization.

Currently, there are two main product groups: milk products and beverages. Altogether, amount of production lines is 12. Since, major specification of enterprise are dairy products, most of production lines are set to manufacture products from this group. Production lines are modern and able to cope with daily demand. Apart from that, there is a capacity to expand production volumes.

Both dairy and beverages are produced every day. Dairy manufacturing features special procedures of production. It means that once dairy products come out from manufacturing line they are not ready for shipping and consumption yet. Dairy products need to cool down and get infused. For different products there is a different time period. For instance, longest infuse time belongs to smetana. It takes around 12 hours after production.

Manufacturing process of beverages takes place at the same location. All of the beverages are produced from one type of water. It comes from 120 meters deep underground water source located 14 km away from manufacturing premises. Quality check is organized once raw material arrives. Quality check consists of testing for content of different minerals, admixtures, etc. Once everything is tested to comply with standards, water is forwarded to water reservoir, where water gets purified and extra admixtures are filtered. Reservoir is replenished two times a week with fresh water. Production department of beverages operates every day to fulfill demand of the market. Everything produced is shipped away next day. Process of production is as in dairy department and safety inventory in both departments is not carried.

Packaging is purchased from external suppliers for both product groups. For liquid milk products it is mostly cardboard based packaging from packaging company Elopak. For other products from this group it is foil based packaging and plastic. Beverages are packed into cardboard-aluminum packaging and plastic bottles of different sizes. Plastic bottles having volume of 19 liters are reused up to 10 times. They are collected from stores where spring water was sold, and brought back to manufacturing facility, where they are cleaned and used once again. Ready to go products are consolidated in to batches. Company has set minimal number of products in one batch. For instance, for 1 liter of whole milk it’s 15. Thus, the only possible way to order products for retailers is to order in batches. All of products are consolidated into batches by wrapping into plastic wrap film. Once products had been manufac-

tured and batches were consolidated, they are put on the pallets. Pallets are loaded evenly in 3 or 4 product layers depending on the size and product. Generally, products are loaded into 3 layers, however small size products are loaded into 4 or even 5 layers. It is done in this way so upper products would not damage the ones located below:

Product	Volumes	Shelf life (days)	Daily demand (Karelia)	Daily demand (Petrozavodsk)	Batch size	Batches per pallet	Amount of batches per day	Pallets per day (Petrozavosk)	Total pallets
Milk 2,5%	1000	9	11300	3616	15	29	241	8,3	26,0
Milk 2,5%	1500	9	3500	1120	8	15	140	9,3	29,2
Milk 2,5%	900	5	850	272	10	45	27	0,6	1,9
Milk 3,5%	1000	9	4650	1488	15	29	99	3,4	10,7
Kefir 2,5%	500	7	1100	352	15	18	23	1,3	4,1
Kefir 2,5%	1000	5	2800	896	15	29	60	2,1	6,4
Blueberry kefir 2,5%	500	7	3100	992	15	18	66	3,7	11,5
Lingonberry kefir 2,5%	500	7	2500	800	15	18	53	3,0	9,3
Fermented milk 3,5 %	500	5	1000	320	15	18	21	1,2	3,7
Boiled milk 3,5%	500	5	750	240	15	18	16	0,9	2,8
Smetana 15 %	500	7	3000	960	15	18	64	3,6	11,1
Smetana 15 %	330	7	1450	464	6	36	77	2,1	6,7
Smetana 20%	250	7	2000	640	15	40	43	1,1	3,3
Pasteurized milk 1,5%	1000	180	300	96	12	29	8	0,3	0,9
Pasteurized milk 2,5%	1000	180	450	144	12	29	12	0,4	1,3
Pasteurized milk 2,5%	200	180	600	192	27	85	7	0,1	0,3
Pasteurized milk 3,5%	1000	180	500	160	12	29	13	0,5	1,4
Orange flovour milk drink	1000	30	1500	480	15	29	32	1,1	3,4
Ananas flovour milk drink	1000	30	1700	544	15	29	36	1,3	3,9
Butter 72,5%	185	10	900	288	16	50	18	0,4	1,1
Grain-sized quark in container 9%	300	3	1900	608	20	40	30	0,8	2,4
Quark 0%	200	3	800	256	16	45	16	0,4	1,1
Quark 9%	200	3	1050	336	16	45	21	0,5	1,5
Vanilla quark 8%	100	1,5	1500	480	32	45	15	0,3	1,0
			49200	15744				46,4	144,9
Share of city in Karelian market	32,00%								

Figure 13. Dairy products list

Products	Volumes(liters)	Self life(months)	Daily Demand (Karelia)	Demand (Petrozavodsk)	Batch size	Batches per pallet	Pallets per day to deliver (Petrozavodks)
Cranberry juice	1	6	340	153	12	48	0,27
Lingonberry juice	1	6	370	167	12	48	0,29
Flavoured soda 1	1,5	6	280	126	6	36	0,58
Flavoured soda 2	1,5	6	240	108	6	36	0,50
Flavoured soda 3	1,5	6	190	86	6	36	0,40
Flavoured soda 4	1,5	6	175	79	6	36	0,36
Flavoured soda 5	1,5	6	165	74	6	36	0,34
Flavoured soda 6	1,5	6	180	81	6	36	0,38
Flavoured soda 1	0,5	6	250	113	12	72	0,13
Flavoured soda 2	0,5	6	205	92	12	72	0,11
Flavoured soda 3	0,5	6	160	72	12	72	0,08
Flavoured soda 4	0,5	6	175	79	12	72	0,09
Flavoured soda 5	0,5	6	180	81	12	72	0,09
Flavoured soda 6	0,5	6	195	88	12	72	0,10
Spring water(still)	1,5	12	850	383	6	36	1,77
Spring water(still)	0,5	12	1200	540	12	72	0,63
Spring water(still)	0,33	12	550	248	12	90	0,23
Spring water(still)	0,1	6	430	194	12	48	0,34
Spring water(still)	5	6	350	158	1	50	3,15
Spring water(still)	8	6	250	113	1	50	2,25
Spring water(still)	18,5	6	50	23	1	Stored separately	
Spring water(still)	19	6	75	34	1	Stored separately	
Spring water(carbonated)	1,5	6	450	203	12	36	0,47
Spring water(carbonated)	0,5	6	900	405	12	72	0,47
Spring water(carbonated)	0,33	6	500	225	12	90	0,21
Total demand			8710	3920			13,23
Market share of Petrozavodsk	45,00%						

Figure 14. Beverages list

4.3 Warehouse

Warehouse is located next to manufacturing facility. It is designed to keep the products refrigerated until they are shipped. Manufactured products are stored on single FIN pallets. Warehouse is refrigerated constantly to maintain temperature of +6. This temperature is required for dairy products. Besides, beverages are also stored at this cooled warehouse, since there is no other place available and volumes of beverages turnover are not big enough to have additional warehouse. Exception is 18,5 and 19 liters bottles. They are stored in a separate building since they are oversized and require a lot of area.

Warehouse operates based on a cross-docking only. Company applies this warehousing strategy due to high volumes and product specification (small shelf-life, customer's demand for fresh dairy products, etc.). Products are combined by groups. For instance, groups of milk, cottage cheese, smetana, etc. Straight through layout is used and product groups are kept in warehouse according to FIFO strategy. Products arrive to warehouse already in batches and are palletized. For different product groups – different size batches. Batching is carried out during final stage of manufacturing process. Palletizing is also done at this point. Only one product type could be stored at one pallet in warehouse. Pallets are consolidated directly before shipping, according to retail stores' orders. Hence, one pallet could contain beverages and different dairy commodities. Consolidation process occurs following way: warehouse employees have lists of order for different retailer and they pick up those products and set them on a pallet to be shipped. After collection of products is done, pallets are shrink-wrapped and ready for distribution.

Warehouse operations are performed by forklifts, which move goods to designated temporary storage place within warehouse as well as perform loading of palletized shipments onto delivery vehicles. None of the pallet storage systems are used. Barcode identification is the only one technology used. Overall, warehousing operating pattern is quite simple and repetitive.

4.4 Distributions

Distributions are the main challenging aspect of the company. It is quite cost-effective for enterprise as well. Distribution process is handled by Slavmo itself. Products are distributed throughout the whole republic of Karelia region. Another option available for the customers is to pick-up orders from manufacturing premises on their own. Most of the city deliveries occur in the first part of the day and it takes around 35 minutes to have one point served. Serving time consists of driving to the destination point, unloading order, paper work filling. All of the vehicles are owned by company and consist mostly of GAZ 3309 (refrigerated modification). Vehicle has significant consumption of fuel. For 100 km of driving it has different values of consumption depending on the mode of driving. It varies from 17 to 30 liters, in the country and city mode, respectively. Cargo compartment of each vehicle is the same size. It is 5,2 meters long and 2,3 meters wide. Deliveries are daily for Petrozavodsk. For the rest of store locations it occurs 4 times in a week. Delivery vehicles cruise around the city every day and delivering products to retailers. Total amount of retailers is equal to 153 and retailers are scattered around 9 city areas.

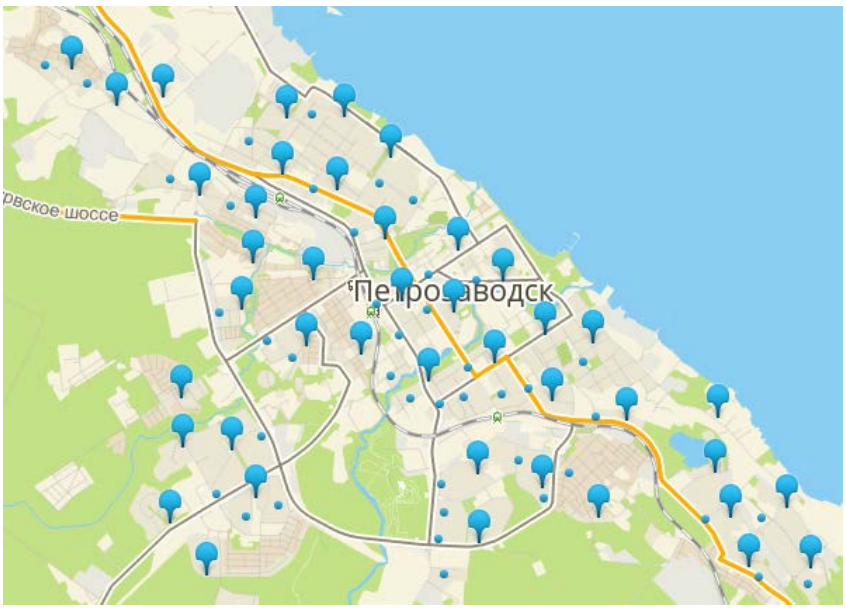

Figure 15. Retailers location map

Vehicles have to come back to warehouse during the day to pick up goods, if necessary. There are two possible pallet consolidations: 1 product type one and combined consolidation. Example, of 1 product type pallet would be product which are in high demand, such as 2,5% whole milk, Smetana 15%, etc. Combined pallets consist of

different milk products. Demand of those products is not high enough to allocate on a separate pallet. Beverages and milk products are never consolidated on one pallet. However, it's common proceed that both dairy and beverages are delivered to stores in one delivery. In addition, there is only one layer of pallet possible to load onto the truck. One layer is due to operating environment. Retail stores do not have facilities equipment to help driver unload pallets from the second layer. Besides, driver also performs unloading operations and it is impossible to unload pallets from second layer without assisting machines to operate within schedule. One vehicle is able to carry 6 consolidated FIN pallets with products.

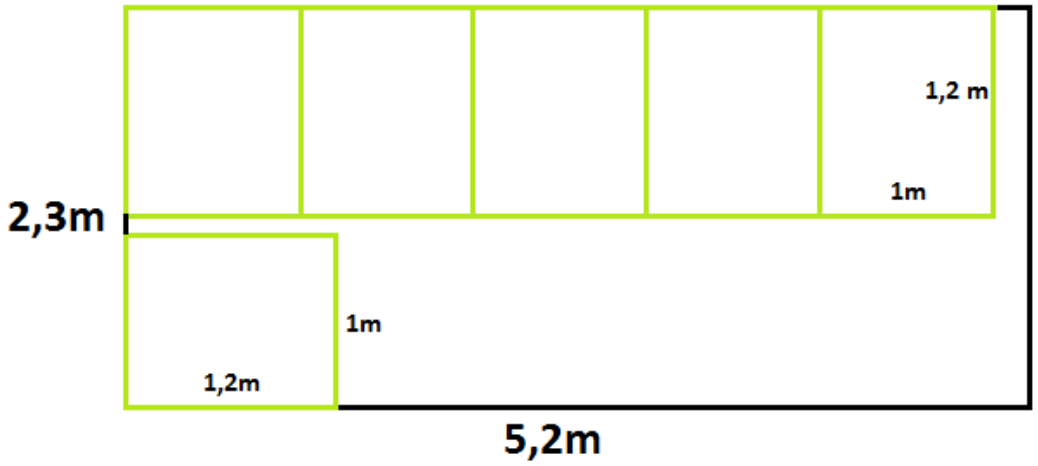

Figure 16. Current vehicle loading pattern

According to the daily demand for Petrozavodsk, there are totally 59 pallets of products and 125 bottles of spring water, which are transported without pallets, are to be delivered.

Vehicles are distributing the products according to the city areas. Totally, there are 9 city areas. At each city area there are multiple number of different retailers. Paper work is done in old-fashioned way – paper version documents. Every time driver unloads the goods he has to get a signature from receiving store supervisor, who ensures everything is in right condition and there are no complaints about amount delivered.

5 Potential improvement suggestions

Over the years diesel prices in Russia are steadily increasing. Over the period of a little more than 8 years from 2009 to present prices have doubled. Apart from that, maintenance cost and spare parts prices have also increased, due to sanctions imposed in 2014. All of these factors combined put logistics of different companies into challenging situation and each company strives to optimize costs, so that performance of logistics continues to be at least at the same service level.

Figure 17. Raw oil price

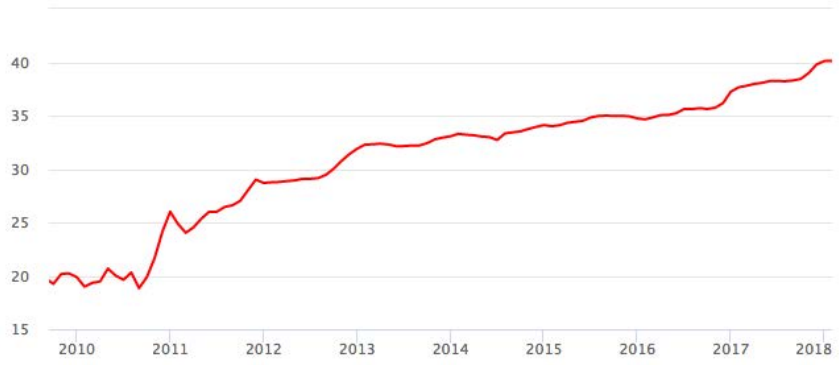

Figure 18. Retail diesel price

As it was mentioned above cost of diesel is growing and according to the trend it will continue to grow. Price fluctuation in Russia is not connected to price of raw oil to a high extent. Among reasons for such rapid growth of prices are: excise duties growth and overall monopoly of oil sector. Prices of fuel directly affect prices on products in stores. Prices are very high compared to purchasing power of population. Average salary is not so big as in developed countries. Therefore, it is rather essential to hold the prices as low as possible. Relevantly low prices and good quality are the keys to success. Slavmo supports this strategy, however, in the changing market situation

and growing competition Slavmo would have to consider some changes in its operations in near future. This chapter of the thesis is meant to describe the procedure of optimizing current business processes of Slavmo in different departments.

5.1 Production and warehousing solutions

Activities of company are mostly connected with perishable products manufacturing. Dairy products produced by Slavmo have quite short shelf life from 2 to 7 days. This is due to the fact that products do not contain any preservatives and artificial admixtures. Still there are products from both dairy and beverages segments which have a shelf life of 6 months. However, it has been decided to focus on beverages production for several reasons such as lower daily demand, extended shelf life of products and amount of production lines is less (two, compared to ten in dairy segment). Daily manufacturing for those products could be changed to more rare production in the same amount. Thus, demand would be fulfilled as previously. In addition, safety stock would be introduced to cope with possible unexpected demand fluctuation. When it comes to daily operations there are underlying costs that have to be considered:

1) Setup + Production costs
2) Staff costs
3) Raw materials availability

Daily operating production lines need more frequent maintenance and more strict control for operations. Apart from that, more frequent maintenance has to be done since wearing out process of equipment occurs faster.

Product which fall under category of long-lasting shelf life are different volumes of pasteurized milk with different fat content and all types of beverages. Beverages have shelf life of 6 months. The exception is still spring water of different volumes. It has shelf life of 12 months. According to the collected from company data, demand for those products is quite low for city of Petrozavodsk. Total daily demand for all of these products is less than a pallet, if we consider each product commodity to be loaded on a separate pallet. In addition, there are 153 stores where these products are present. Therefore, demand for each retail point is tiny and production frequency adjustments could be easily implemented without any risks of order backlogs.

Even though, there is a possibility to change production of pasteurized milk it has been estimated that it would not be economical at the moment. There are certain reasons lying behind this decision. First of all, it is about amount. There is a daily demand of just 4 pallets of products combined together a day or 8710 products to fulfill the market of the whole Karelia region. In volume this could be expressed as 12627 liters. Secondly, there is a limited space in warehouse and additional storage space would be occupied. Finally, increase production of pasteurized milk would require to search for new raw material supplier or purchase more from current ones.

Production is connected to warehousing. Once something has been manufactured it has to be stored somewhere, unless, it is forwarded straight to consignee. Since Slavmo has a warehouse located at the same site where plant is, it's an advantage for efficient SC management. In such cases, manufacturing activities could be easily coordinated. Still, it's cost-effective for master production schedule to make an adjustments to the production rate in a short period of time. Nowadays market situation forces companies to be able to cope with sudden demand fluctuations. Factors contributing to this effect are availability of raw materials, workforce, etc. In order to have a significant share of the market and great customer service, any enterprises have to be ready to deliver more products to market as soon as possible.

To implement this idea Slavmo has to introduce safety stock for products, which have long shelf life. It would allow to pay less attention to this market area. In addition, there would be confidence about ability to cope with surge of demand and have a great customer satisfaction. Surge of demand could occur easily because Slavmo have different channels of distribution. It has its own distribution network, federal retailers and it's also possible for a small enterprise to order as low amount as a batch of any product commodity.

Thus, there are 2 defined issues regarding production and warehousing activities at Slavmo. Firstly, everyday production is not wise according to the total daily demand. Secondly, if production is going to be set based on less frequent intervals of time, there is a need for more warehousing area and safety stock and basic running inventory has to be introduced.

First of all, there has be to defined a schedule of how often shall production occur? To identify this period, demand has to be studied. According to the beverages products demand list, total daily demand is estimated to be 3920 for Petrozavodsk and 8710 products for whole Karelia region or 5682 and 12627 liters of beverages, respectively. Standard deviation is equal to 3-7% depending on the season. Total amount of product commodities is 24. Important factors we also have to consider are limited warehouse space and limited resources. Slavmo doesn't use any external resources like loans and investments, because profitability is not that big enough. Furthermore, Slavmo doesn't want to increase retail prices of its products since dairy market is quite harsh and company would lose significant market share and profit. Like it was mentioned previously warehouse doesn't have any racking storage systems and space is limited due to currently set operations. At following picture, you could see current layout:

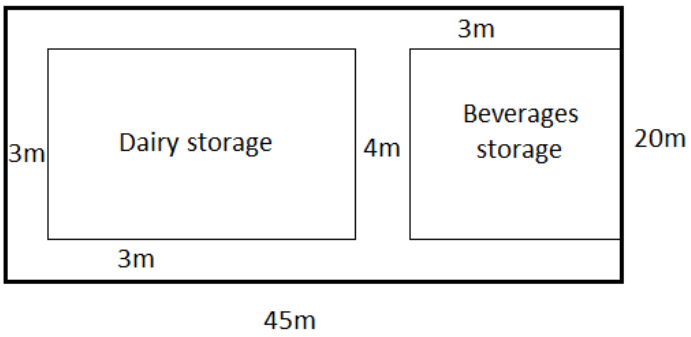

Figure 19. Current warehouse layout

To have an idea how much pallets we could store if layout is kept the same way there is a need to calculate total area reserved for beverages and divide it by the area of pallets. Hence, 195 m^2 divided by 1,2 m^2 is approximately 163 pallets. From this figure we find out that there is enough supply for 5 days. This figure is applicable if there is 1 storage layer of pallets as it is at the moment. This figure is already enough to shift manufacturing into 1 in a 5 days period, from continuous to intermittent manufacturing system.

Warehouse area would be utilized as much as possible. Also, among other benefits of shifting production to proposed cycle are optimized workforce expenses. Even though pay rate in Russia is not high and equals around 150 rubles (2 euros) per hour for people employed in manufacturing area, it still has great affect on organization's

total cost. This is due to fact that dairy industry doesn't generate a lot of margin. Whole production of beverages is operated by 4 persons and production continues on average for 2 hours a day. This is just production time, however, set up time and water tests and purification require additional time. Finally, maintenance would be performed better. To have equipment operating 100% uptime and eliminate waste from manufacturing processes, proper maintenance and asset management practices are to be applied. The success of the enterprise is highly dependent on the output of the production system in terms of quantity, quality, and safety (Al-turki, Ayar, Yilbas, & Sahin, 2014). Thus, introducing 1 in 5 days manufacturing there would be a plenty of time to perform proper maintenance. Apart from that, maintenance costs are expected to decrease, because all required operations with production lines would be scheduled beforehand.

However, it is still possible to go further and optimize current activities and layout of warehouse. It's possible to install single deep selective pallet racking system in beverages area as it is shown in the picture below:

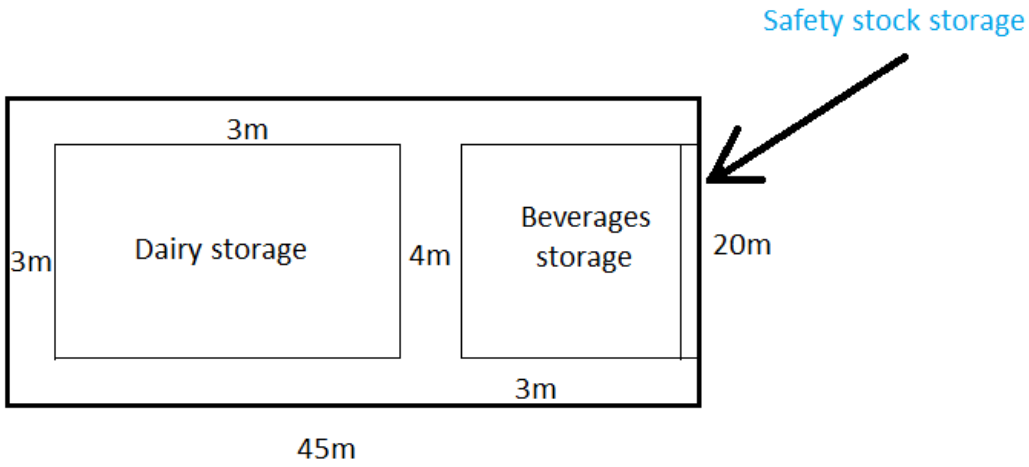

Figure 20. Proposed warehouse layout

As it could be seen there are 1 single pallet racking systems. Their location in warehouse was chosen to efficiently use space.

Safety stock is another great opportunity for the company to implement. As it has been described previously, it has been decided that there is no need to introduce safety stock for pasteurized dairy commodities, so it going to be introduced just for beverages. All products from beverages group would have safety stock. To figure out

safety stock average demand of each product had been considered as well as standard deviation. St. dev. has been defined by finding average from summer and winter season deviation and equals to 3% and 7%, respectively. Figures for each item could be found from safety stock calculation list. The main idea of the safety stock at is to introduce an “airbag”, to be sure that demand is fulfilled at service level of 90%. This service level would be reached if standard deviation for lead-time is equal to 1 day.

Products	Volumes (liters)	Daily Demand (Karelia)	St.devation	Safety stock calculatio	Safety stock in pallets
Cranberry juice	1	340	17	437.9	0.8
Lingonberry juice	1	370	19	476.6	0.8
Flavoured soda 1	1.5	280	14	360.6	1.7
Flavoured soda	1.5	240	12	309.1	1.4
Flavoured soda 3	1.5	190	10	244.7	1.1
Flavoured soda 4	1.5	175	9	225.4	1.0
Flavoured soda 5	1.5	165	8	212.5	1.0
Flavoured soda 6	1.5	180	9	231.8	1.1
Flavoured soda 1	0.5	250	13	322.0	0.4
Flavoured soda 2	0.5	205	10	264.0	0.3
Flavoured soda 3	0.5	160	8	206.1	0.2
Flavoured soda 4	0.5	175	9	225.4	0.3
Flavoured soda 5	0.5	180	9	231.8	0.3
Flavoured soda 6	0.5	195	10	251.2	0.3
Spring water(still)	1.5	850	43	1094.8	5.1
Spring water(still)	0.5	1200	60	1545.6	1.8
Spring water(still)	0.33	550	28	708.4	0.7
Spring water(still)	0.1	430	22	553.8	1.0
Spring water(still)	5	350	18	450.8	9.0
Spring water(still)	8	250	13	322.0	6.4
Spring water(still)	18.5	50	3	64.4	Stored separately
Spring water(still)	19	75	4	96.6	Stored separately
Spring water(carbonated)	1.5	450	23	579.6	1.341640786
Spring water(carbonated)	0.5	900	45	1159.2	1.341640786
Spring water(carbonated)	0.33	500	25	644.0	0.596284794
Total demand		8710		11218.3	37.9
Average lead time		5			
St.dev of lead time		1			
Standard deviation rate		5.00%			
Service rate (90%)		1.28			

Figure 21. Safety stock calculation

Beverages have a certain lifetime and those products couldn’t be stored for years like spare parts. There is a point when products located in safety stock have to be replaced. It’s not possible to store beverages for years like spare parts. All of the beverages have a shelf life of at least 6 months and from time to time safety stock should be renew with new drinks, meaning that products that were stored until renewing should be shipped away to customer to be sold. This is needed so that prod-

ucts located in the safety stock could be easily sold before expiry date. I would suggest setting a replacement point once in 30 days. Reason lying behind this decision is production frequency. According to the production schedule, production happens once in 5 days and 30 days period falls under production day. Beverages area of the warehouse would be empty and SS could be easily accessed by forklift and would be successfully replaced. However, any interval is possible to choose. Only two things are important to keep in mind: replacing safety stock should not occur too often or too rare and it must be definitely done in periods when warehouse is empty to avoid moving cross-docked product.

Thus, according to the calculations of safety stock depicted in the figure 21, almost fits to 13 meter long 3-layer pallet rack located on the right side of the warehouse. The amount of pallets, which don't fit to this rack, is 8. To place leftover pallets in warehouse, there are 2 possibilities: to install additional pallet rack next to middle warehouse aisle and to leave them next to racking system. If first option is chosen, then rest of 8 pallets should be stored in the upper level since they are not that often used. If second option is the way company is going to proceed with, then it will take 9.6 m^2 of storage area.

To figure out whether left racking system is wise to install approximate installation cost of racking system has to be estimated. According to racking system installation company (Calculation of pallet racking system, n.d.) , 3 layer single rack of 13 meters with height of 3 meters would cost 48684 rubles (approximately 680 euros) with installation service. Pallet racking system requires more time to execute activity and since rack would be constantly loaded only for 26% (safety stock amount), rest of 22 pallet slots would be used for items which are shipped in period of 5 days while supply last. To conclude the idea of second rack installation, it has been decided that it would not be beneficial at the moment for several reasons. Firstly, it's volumes of safety inventory. It's estimated to be around 11218 products or equivalent of 38 pallets for 5 days period. Amount of all products almost fit to the rack located on the right side of warehouse. Secondly, demand according to the company internal market research is not estimated to grow. Thus, there will be no need for production expansion and safety stock growth. Finally, my proposal of racking system is meant only for products to ensure safety stock availability. It would be nonsense to have

put regular daily shipment to the pallet rack, as there is still enough space to implement cheapest storage mode - cross-docking.

Block stacking operations are not implemented at the moment since there is no need. Area of storing beverages is sufficient to keep proceeding with 1 layer. Furthermore, with introduction of intermittent (1 in 5 days) production, there still would be no need to use block stacking storage method for ready-made products. However, nothing is everlasting. It is possible that demand of beverages would increase or more storage for dairy products department would be needed in the future. The option to solve this problem is block stacking. This is one of the most cost-effective and convenient ways to store the products in grocery industry. Still, there is important factor to consider while block stacking pallets. Even though, FIN pallet is durable and could be loaded up to 2.5 tons (codificator.ru, n.d.), product packaging material has to be considered. At Slavmo two types juices at packed into cardboard packaging. Since cardboard is not as durable as plastic there should be less layers loaded. Maximum number of layers is 2 for juices, whereas for rest beverages commodities it's possible to have 3 or more layers. This figure comes from batch size multiplied by bathes on pallet. FIN pallet weight is estimated to be around 22-30 kg (How much does the pallet weigh, n.d.). In calculation average of 26 kg should be used. Pallet located on the first layer should withstand mass of 2500 kg, since it is the biggest mass pallet is meant to be loaded with. Total number of layers is calculated from total mass of 2500 kg weight of pallets located on a pallet and weight of pallets is deducted to find appropriate number of layers for cross docking. For instance, 1 pallet of 1,5 liters spring water would have a weight of 324 kg (6 product in a batch and 36 bathes per pallet)

To sum up the idea of improvement suggestions to production and warehousing department, following list of actions have to be considered and applied to improve general performance:

1. Move production rate to intermittent
2. Introduce safety stock
3. Install racking system for SS storage
4. Block stacking in case of demand increase

5.2 Distribution network

Distribution activities of Slavmo encompass quite vast area. Republic of Karelia is the main target area, however Slavmo supplies some retailers with its products in Leningrad oblast', Saint-Petersburg area. However, improvement suggestions are mainly going to concern distributions in Petrozavodsk, since it was a question company has requested to find possible improvement solution for. Nevertheless, if some correlations are found with regional distribution activities, improvement proposals would be stated as well.

Stating point to establish efficient distribution operations is choosing most suitable vehicle for environment it is going to be operated within. It has to be modern and at the same time operating cost should be as low as possible. Vehicle owned by enterprise at the moment are old-fashion and not as reliable as company wishes. Breakdowns of vehicles occur more frequently as vehicle are in previous year. This is caused by wearing out process of engine and suspension. Last time company has renewed its delivery trucks was in 2007. Vehicles are already 10 years old and in next decade there would be a need to replace them. Since, Slavmo prefers to develop by means of own resources only, vehicles replacement could be gradual. For instance, 2 vehicles in year. From this time a lot of time has passed and purchasing new vehicles for distributions is a great opportunity to optimize its distribution related costs. To research this approach, a few refrigerated delivery trucks, which are present on Russian market and fall under category of moderate price, were chosen. Comparison by technical characteristics of enlisted vehicles have been made:

Vehicle	Consumption (city mode), l/100 km	Payload	Price (RUB)	Cargo compartment area (m2)	Pallet fitted
GAZ 3309	30	5000	2300000	13,8	6
Huyndai HD120	24	7000	4800000	14,25	6
JAC N120	25	7000	2885000	11,97	6
Isuzu Forward	22	8000	4120000	11,7	6
Huyndai HD78	21	5000	2487000	9,88	5
MAZ 4370	27	5600	2530000	13,25	5

Figure 22. Vehicle selection characteristics

Decision about vehicle to be chosen is to be done considering both variable and fixed costs. As it has been mentioned prices for petroleum have doubled for the last 8

years. Still, diesel expenses for Slavmo are less than regular consumer prices. Slavmo purchases fuel from a wholesaler. Retail prices currently balance around 40,10 rubles per liter (Dynamics of retail prices for diesel fuel, n.d.), where as wholesaler's price equals to 36,2 rubles as of 1st March 2018. From this figures, we are able to calculate that wholesaler's price is cheaper by 9,7%. Consequently, Slavmo saves significant amount of money.

Fixed and variable costs of transportation were considered to obtain results of daily delivery operations in Petrozavodsk. Following tables of excel calculations depict the results of total cost and its components for 1 year of usage:

	Fixed cost (1 year of ownership)				
Vehicle	Residual value after 10 years	Yearly depreciation	Insurance cost	Operating cost (inspection)	Total fixed cost
GAZ 3309	246961	205304	16750	1510	223 564 руб.
Huyndai HD120	515396	428460	22334	1510	452 304 руб.
JAC N120	309775	257523	22334	1510	281 367 руб.
Isuzu Forward	442382	367762	22334	1510	391 606 руб.
Huyndai HD78	267040	221996	16750	1510	240 256 руб.
MAZ 4370	271657	225834	22334	1510	249 678 руб.

Figure 23. Fixed cost for 1 year of operating vehicle

Variable costs exclude tires and facility cost as it was mentioned previously, since they are estimated to be the same and won't influence vehicle selection.

Vehicle	Fuel	Lubrication	Maint&Repair	Tires and facility	Total cost
GAZ 3309	194400	29160	575000	Same cost since all	1 022 124 руб.
Hyundai HD120	155520	23328	1200000	of vehicle models	1 831 152 руб.
JAC N120	162000	24300	721250	have 6 tyres and	1 188 917 руб.
Isuzu Forward	142560	21384	1030000	facility expenses	1 585 550 руб.
Hyundai HD78	162000	24300	621750	are estimated to	1 048 306 руб.
MAZ 4370	174960	26244	632500	be equal	1 083 382 руб.

Figure 24. Variable cost for 1 year (50 km of daily mileage)

According to the calculation, currently used model GAZ 3309 is best vehicle to select for city deliveries. Average mileage trucks cover over the day is 50 km. Although, this model accounts for the worst result in fuel consumption category, it is still the best option, as it could fit most cargo at lowest operating price. It's second of the most cheap trucks compared to its, same class vehicles, competitors. Truck model Hyundai HD78 has cargo compartment lower than GAZ 3309. Hence, it is suggested to continue operations with same vehicles for Petrozavodsk area. Furthermore, GAZ 3309 is also the best vehicle for delivery operations for Karelia region if delivery point are not located. Deliveries occur less frequently (4 times a week) and delivery points are

located much further from warehouse. In one year there are 90 deliveries to complete. Average daily mileage is not possible to calculate to simplify process of selecting appropriate potential vehicle for regional distributions, due to scattered major cities of Karelia. For instance, second city by population is located 55 km from warehouse, whereas other major cities are at least 200 km away from manufacturing facilities. Consequently, selecting appropriate vehicle for each regional route direction has to be considered as a separate case. Nonetheless, it is still possible to find a point at which other vehicles would have advantage over GAZ 3309. To find this point trial and error method is used. Thus, only if vehicle's average daily mileage equals to or exceed 275 km, there is a reason to consider another vehicle model. Calculations are suitable if enterprise wants to have same cargo compartment area as currently used vehicle. As it could be seen, Hyundai HD78 has lower operating cost, but area for cargo is also less. If demand is not high and there is enough space to fit all the products to cargo compartment of Hyundai HD78, then it is a great option. In this case, company could save around 7% and it fits in cargo compartment, then JAC N120 is definitely the model to choose. In the picture below, total operating cost at mileage of 275 km/day are about the same as for JAC N120. For more distant routes (exceeding 275km), JAC N120 has an advantage over currently used model. Fixed costs are the same as in figure 23.

Total operating cost per year

Vehicle	Fuel	Lubrication	Maint&Repair	Tires and facility	Total cost
GAZ 3309	1069200	160380	575000	Same cost since all	2 028 144 руб.
Hyundai HD120	855360	128304	1200000	of vehicle models	2 635 968 руб.
JAC N120	891000	133650	721250	have 6 tyres and	2 027 267 руб.
Isuzu Forward	784080	117612	1030000	facility expenses	2 323 298 руб.
Hyundai HD78	891000	133650	621750	are estimated to	1 886 656 руб.
MAZ 4370	962280	144342	632500	be equal	1 988 800 руб.

Figure 25. Variable cost for a year (275 km of daily mileage)

Vehicle selection process has to include fixed and variable cost to have a clear picture of vehicle's operation cost. As it is proven even if the fuel consumption is highest among competitor vehicles it's totally fine, as enterprise could save significant amount of money on original purchasing price. Savings are also achieved though out lifetime of vehicle.

At the moment, vehicles are loaded with 6 pallets as it is shown in figure 16. Even if enterprise would load more pallets onto each truck there would be no time for driver

to deliver and unload them. In addition, 6 pallets per vehicle is the optimal solution because unloading process occurs manually and there is a space needed for a driver in cargo compartment to be able to unload. Driver works 7 hours a day and there is a need to reserve 35 minutes to serve each point. Thus, it's calculated that during working day one delivery vehicle could distribute required amount of products only to 12 points. Totally, there are 153 points to be served daily. Thus, 13 delivery vehicles are needed to fulfill daily demand, if deliveries occur in one shift as it happens right now.

Total points / day	153
Service time/point (min)	35
Shift duration (hours)	7
Points served by one vehicle	12
Total amount of vehicles to fullfil demand	13

Figure 26. Vehicle demand to serve city area

According to the map of retailer's locations depicted in figure 15, they are scattered all around the city and average number of retailers for each city area is equal to 17.

Table 3. Amount retailers in each city area and retailer with most number of locations

City area	Amount of retailers	Biggest retailer and its share
Drevlyanka	17	Magnit (7) - 41%
Perevalka	14	Magnit (5) – 36%
Pervomaiskii	10	Magnit,Pyaterockka, 7YA (2 points for each)
Oktyabrskii	20	Magnit (5) – 25%
Center	18	Magnit and 7YA (4 each) – 22%
Sulazhgora	12	Magnit (4) – 33%
Golikovka	24	Magnit (7) – 29%
Kukkovka	21	Magnit (7) – 33%
Kluchevaya	17	Magnit (7) – 41%

Currently, deliveries occur mostly by the retailers. For instance, one vehicle is distributing products for Magnit retailer only. This is done in such way due to tight scheduling of arriving products for federal retailer chains, which include Magnit, Pyaterochka, Dixi, 7YA.

Table 4. Amount of retailers by retail chains

Retailer	Amount of stores in city
Magnit	49
Dixi	13
7YA	17
Pyaterochka	24
Borodinskii	24
Lenta	2
Lotos	9
Onego	2

So, lets consider one city area as an example of delivery process. Altogether, there are from 5 to 8 different retailers represented at each city area. Thus, at least 5 different vehicles have to visit each area every day. Fuel consumption in this case is increased.

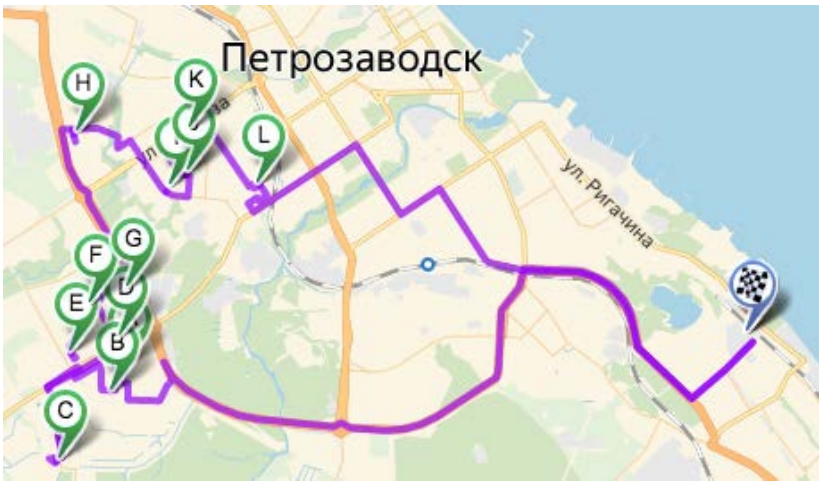

Figure 27. Current distribution for Magnit retailer

This route covers 12 retail point of Magnit retail chain. Total distance covered throughout this route is 30 km. Only 2 out 9 city areas are served where Magnit is present.

Improvement proposal is to shift distribution from retailer based criteria to city areas distribution. This means that one vehicle will deliver products to as many points as possible within one city area. This approach could bring a lot of benefit for distribution department. First of all there areas like Sulazhgora and Golikovka, which have 12 and 24 retailer points, respectively. Sulazhgora district is the most distant area from warehouse location and one vehicle would be enough to serve this area. Golikovka area has 24 point to be served which falls under distribution capacity of 2 trucks. Total amount of stores to be visited for Center, Pervomaiskii and Oktyabrskii areas are 48. So, those areas could be combined in one region and 4 trucks would be occupied to carry out distribution in this district. For the rest city areas distribution should occur in the following way: truck should encompass as many point as possible in one city area. If the city area has more retail points than one delivery vehicle is able to serve, then another vehicle is to deliver products to the point that haven't been supplied this products by previous truck and so on. Here are the examples of distribution pattern:

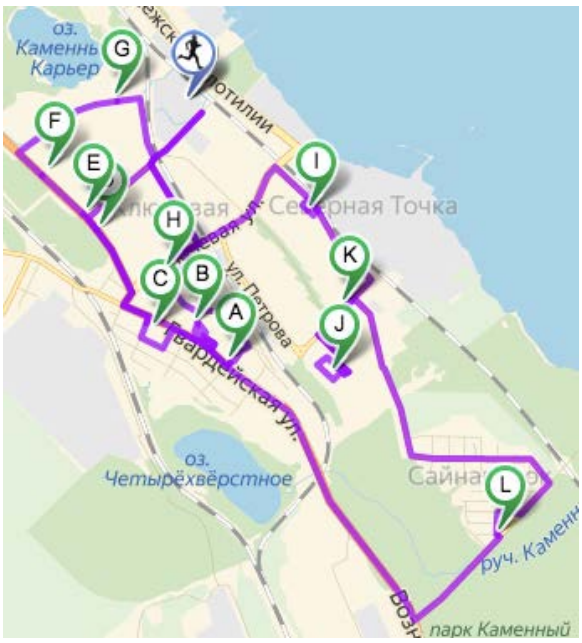

Figure 28. Route for Kluchevaya district

In the figure 28, route for Kluchevaya area is depicted 12 out of 17 retail points would be served. Mileage for this route is 17 km. Rest 5 point would be encompassed by another route. This route will include 5 leftover points in Kluchevaya area and then vehicle will head to Kukkova area, where 7 closely connected different retailers would be served.

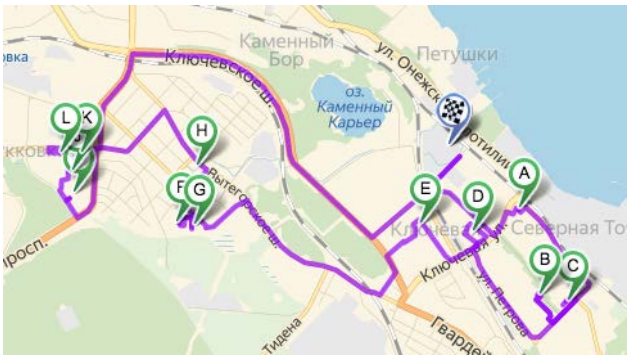

Figure 29. Kluchevaya-Kuukova route

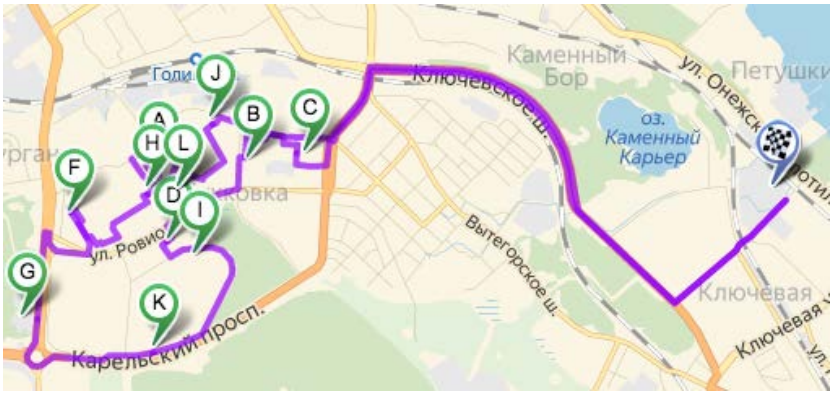

Figure 30. Kukkovka route

Kukkovka is quite a big area to serve. There are 21 stores located in this district. First vehicle visiting this area serves 7 retailers (figure 29). Second vehicle would cruise around Kukkovka district only (figure 30). However, there are still two points are left to be served in Kukkovka. Two points are visited by another vehicle, which main target area is Drevlyanka. This route is depicted in figure 31

Figure 31. Kukkovka-Drevlyanka route

This pattern of deliveries should be followed for following areas: Kluchevaya, Kukkovka, Drevlyanka, Perevalka. For the rest 5 areas deliveries should occur as it has been described above, since number of locations in those areas is the exact amount that 7 trucks could deliver.

To operate efficiently and serve points as fast as possible, there is possibility to implement new distribution working pattern. First of all, there is a need to mention that those changes would require acquisition of additional equipment: and roll cage containers. Although equipment might be cost effective for a company now, cost breakdown for new equipment would be precisely described further. At the moment, pallet-based system is implemented and this system has a lot of drawbacks (K.Hartwall, 2016):

1. High employee rotation
2. Tiring for operator (driver)
3. Highly manual operations
4. A lot of time spent for unloading at retail points
5. Maximum of 12 stores per route

Rolla cage container system provides following benefits:

1. Minimized unloading time
2. Amount of stores visited per route is 2,5 times more
3. Cost savings and waste elimination on shrink wrap
4. More products transported meaning less workforce is needed to fulfill demand
5. Advantages for the stores (faster unloading, more time to serve customers)

All of the mentioned advantages could bring benefit to a company in a long run. Besides use of roll cage container is quite attractive since all of retailer point have unloading bay available. Calculation of shifting distribution from pallet system to roll cage container is demonstrated in the following picture:

	Pallet system				Roll cage container system		
	Dimensions (m)	Volume (m3)	Total pallets/day		Dimensions (m)	Volume (m3)	Total containers/day
Width	1	1,7	59	Width	1,1	1,5	66
Height	1,4			Height	0,8		
Length	1,2			Length	1,7		
Comparison of pallet and container			1,12	Pallet is able to accommodate 12% more products			
Containers needed to purchase			66				
Purchasing price			$90				
Purchasing price in local currency			339 897 руб.				

Figure 32. Estimation cost for roll cage containers implementation

Vehicle's cargo compartment space will be utilized as much as possible and service time would be decreased. Thus, instead of 12 retail points visited per day this figure could reach as much as 30.

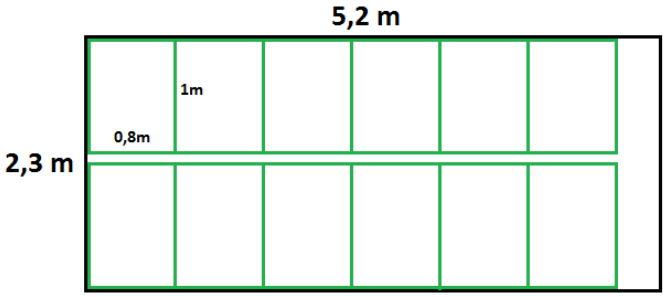

Figure 33. Vehicle loading pattern (roll cage containers)

6 Conclusions

Any logistics company has to outline and deeply research innovations, before implementing them in to supply chain environment. All of the decisions should be based on calculation and bring benefit to company in a long run.

The objective of presented case study was to identify weak links in supply chain management of Slavmo and to find possible optimization solutions. Theoretical background and current operating environment were studied to understand process of both supply chain in general and company's activities. As methodology, both qualitative and quantitative methods were used with major emphasis on quantitative research. Information was gathered through personal company visit, scientific literature review and online browsing of information. During thesis project areas of improvement were identified and improvement have, as a result, following improvement suggestions were proposed:

1. Beverages storage area utilization
2. Beverage segment production rate change
3. Distribution activities optimization

Improvement suggestions encompass different areas of company's supply chain: production, warehousing and distribution. Production and storage are connected in general and in this case study this phenomenon is well illustrated. Partial improvements would be nonsense. First and second optimization options are connected to each other and have to be implemented together only. Distribution routes proposed are meant to maximize fuel economy, however, further cooperation with retailers is required to work delivery schedule through. It should be done in order to find spot in a way, so delivery vehicle would not idle at retailers points awaiting to be unloaded.

Distribution vehicle selection calculation has confirmed that vehicles that are operated now are perfect for city delivery and there is no need to select another competitor vehicle. Thus, it's quite important to use quantitative research and estimate possible hidden costs and potential savings prior to investment.

Furthermore, hidden costs also have to be defined and could be an issue. It might be not that easy to figure them out. To make a right decision concerning potential im-

provement, it has to be considered from different perspectives. For instance, in presented thesis this issue is related to safety stock and basic running inventory. Company would gain benefit by moving production rate to intermittent, however, increased inventory always brings inventory carrying cost. In addition, it would be difficult to control inventory according to FIFO strategy since there would be lots of products, whereas it's not complicated to apply FIFO strategy when inventory is for one day only. Another example of hidden cost from proposed potential solution is roll cage container. Introduction of roll cage containers in distribution activities brings numerous advantages, still to achieve most benefit amount of roll cage containers should be double of amount needed for transportation of products. Most time savings would be achieved only if containers are left at retailer's point and picked up following day. Thus, swap principle should be applied – container with products is left at the store, whereas empty container is taken back to warehouse.

All of the results of improvement suggestions are of recommendation nature. It is up to company whether to implement offered solutions or keep current operating environment, since some of improvements require decent amount of investments which might be an economic burden for enterprise at the moment. However, improvement suggestions, which do not involve financial investment, are highly recommended to introduce since enterprise is going to benefit in a long run perspective and will provide better customer service. Among such suggestions are distribution pattern for Petrozavodsk and beverage production frequency adjustment. All of the improvement results were supported with cost calculations, to prove that suggestions are worth considering and possible costs company has to imply were estimated. This thesis could have significance for a small to medium size food manufacturers with 100% private logistics.

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