Aalto University
School of Science

PROJECT PLAN

Posti Group Oyj: Integrated cost optimization of Parcel and eCommerce supply chain

MS-E2177 SEMINAR ON CASE STUDIES IN OPERATIONS RESEARCH

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posti

Background

Posti Group is the leading postal and logistics service company in Finland, in terms of total net sales, with a history spanning over centuries. The total net sales of Posti Group in 2019 exceeded 1564 million euros with an operating profit of 39 M€. Posti Group is owned by the state of Finland and employs approximately 22 000 staff members.

Posti's business consists of delivery services for letter, publication and parcel products, e-commerce services, supply chain solutions as well as a range of transport services for different businesses and organizations. Posti Group maintains a daily supply chain that services approximately 2,8 million households by delivering an average volume of 8 million shipments each day. Posti operates in 10 countries focusing on operations in Finland, Russia and the Baltics. [1]

Since the beginning of the year 2019, Posti Group has been divided in four business segments: Postal Services, Parcel and eCommerce, Logistics Solutions and Itella Russia, each with different areas of responsibility.

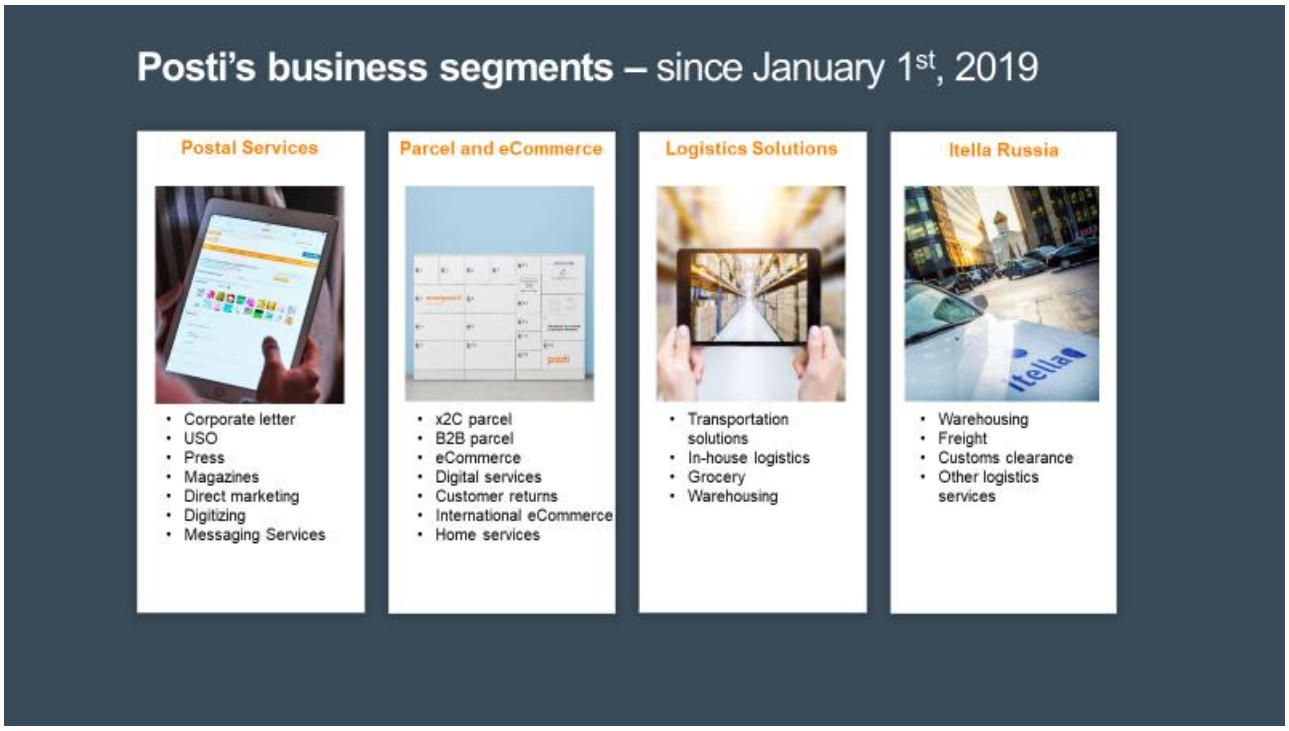

Figure 1. Posti Group business segments. Source: Posti Group Oyj.

According to the reports provided by Statista, eCommerce activities are growing at an exponential rate both globally and in Finland. Global online sales are forecast to reach 4.5 trillion U.S. dollars in 2021 based on data collected from eMarketer [2]. While Finland is still behind in growth when compared to for example Sweden the rate of growth is still very high. The growth in eCommerce volume in Finland is estimated to be between 7% and 10% each year [3]. The popularity of online shopping seems to stem from the ease and comfort that it offers, prompting more and more people to cut down on shop visits and purchase online instead [4].

Figure 2. The number of eCommerce customers in Finland. Source: https://learning.eshopworld.com/ecommerce-blog/finland-ecommerce-insights-2017/

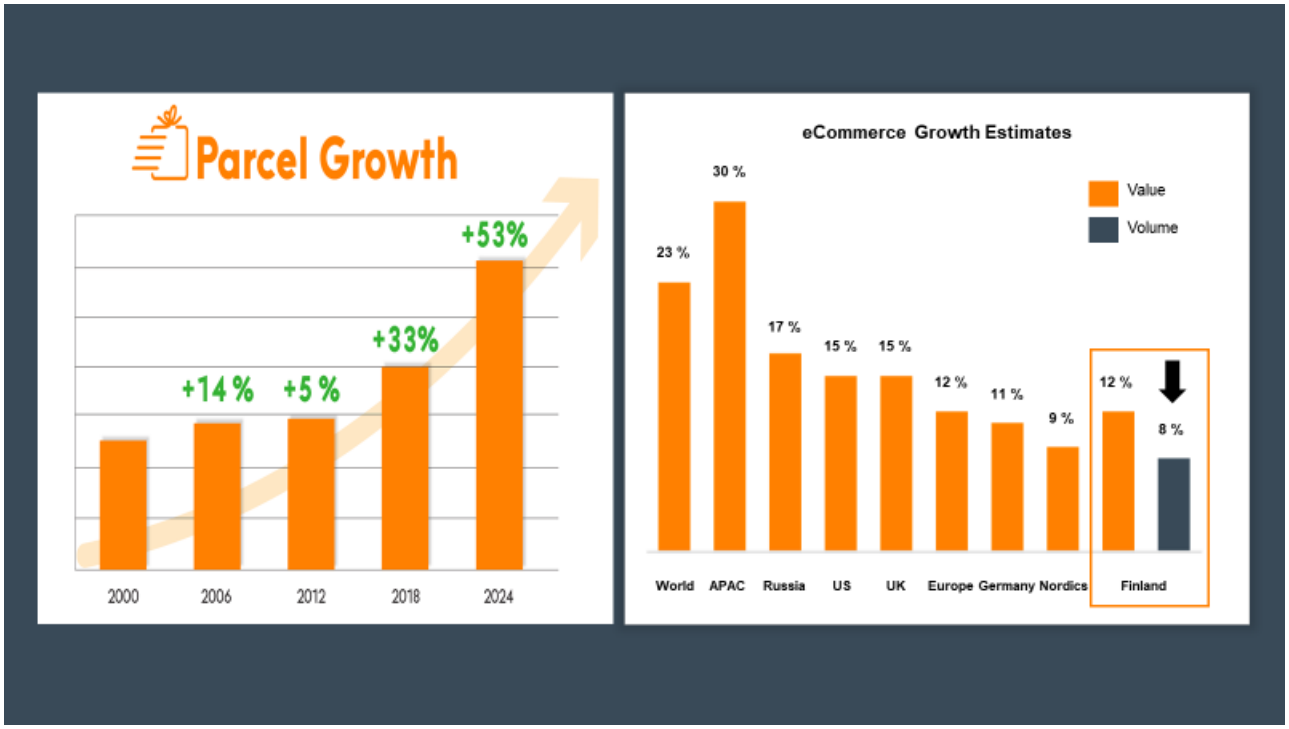

Figure 3. Growth estimates for parcel and eCommerce volumes. Source: Posti Group Oyj.

In their press release, Posti stated that

> *"… [it] is currently undergoing the greatest transformation in its history: consumer behavior has changed, digitalization is increasing, the volumes of paper mail are decreasing at a growing rate. In response, Posti is looking for significant growth opportunities in parcels, e-commerce and logistics services."*[5]

Posti Group forecasts that with the continuing trend of decline in volumes of traditional postal services and with a continuous increase in volume of parcel shipments and continuing growth of international and domestic eCommerce business, the Parcel and eCommerce business segment will be key in the future years. Thus, a timely and cost-effective supply chain for parcel and eCommerce items is of great importance for Posti Group.

Objectives

Main objective of the project is to develop a routing and scheduling planning tool that integrates the associated transportation and sorting costs of the planning period.

The Posti parcel supply chain is heavily time constrained as shipments need to be delivered to the customers within a timeframe of 24h and the supply network covers the whole of Finland. Furthermore, the network is entirely location based. This means that the locations of distribution hubs and distances between all network locations are fixed. These properties require that the tool being developed integrates both the routing of transport units and the scheduling of sorting facilities and transportation.

Each parcel enters Posti's supply chain at a pickup **terminal.** Parcels are collected into **transport units** (TU) that have a fixed capacity. Transport units deliver parcels from terminals to their nearest **distribution center**. Each distribution center has an **outbound sorting center** responsible for dividing the incoming flow of parcels to the other distribution centers. Each parcel entering the outbound sorting center is thus sorted to a TU that delivers it to a distribution center close to the parcel's final destination. Parcels arriving at this destination distribution center are again sorted but this time at the **inbound sorting center**. Inbound sorting is responsible for assigning parcels to TUs that deliver them to the respective final destination terminals. Thus, each distribution center contains two sorting centers: one for outbound and for inbound flow of parcels. There are a total of 6 distribution centers (each containing an outbound and an inbound sorting center) and 33 terminals in the network. Each distribution center contains a terminal, thus, 27 out of 33 terminals are scattered outside of the distribution centers.

Each sorting center has a maximum standard (automated) sorting capacity with a fixed cost. This capacity may be temporarily increased at an increased cost by assigning additional (manual) sorting resources to the sorting center. Once parcels have been sorted according to their destinations, they are entered in the transportation queue. The parcels in the transportation queue are then loaded into TUs that deliver them to the final destination. TUs can be used to their maximum capacity or any fraction of it, but each TU delivery from one location to another will incur a cost depending only on travel time. In addition, TUs are allowed to travel routes via several distribution centers where they may either drop off or pick up parcels for as long as their maximum capacity is not exceeded.

Thus, the optimization objective becomes one of scheduling the departure times and routes of transport units starting from the outbound distribution centers, allocating the number of parcels to be transported in each TU and allocating the (manual) sorting resources to each sorting center. The allocation of resources and scheduling of transports is optimized such that the transportation and sorting costs are minimized and (close to) all parcels are delivered to their destination within a time window of 24 hours.

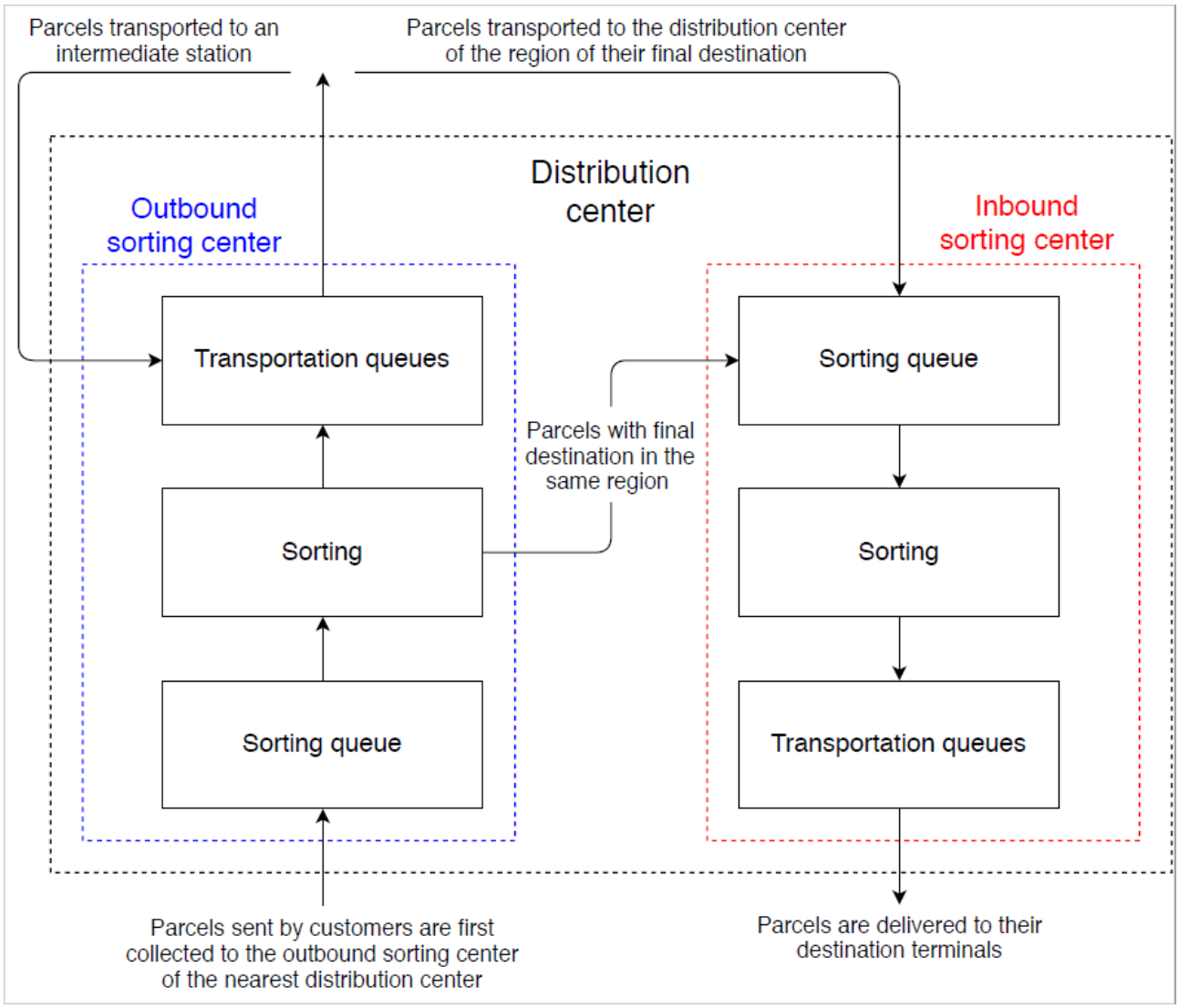

Figure 4. Simplified model of the parcel flows in the network.

Tasks

The project is divided into 6 key tasks and each of these tasks is further divided into subtasks. The tasks are

1. Literature review
    - Identify existing papers describing similar problems
    - Explore existing models and their solutions
    - Identify solution methods that are best suited for own optimization problem
    - Identify relevant theoretical approaches
2. Building the model
    - Agree on the scope and assumptions of the model
    - Define the decision variables
    - Define the objective function
    - Define constraints
    - Determine or estimate parameters
3. Algorithm decision and implementation
    - Decide or design the solution algorithm
    - Implement the model in Julia and JuMP

- Implement the algorithm or use an existing solver if possible in Julia and JuMP

4. Model and algorithm validation and refinement
    - Examine the results of the optimization
    - Compare routing plans and scheduling plans with historical realization data
    - Perform sensitivity and feasibility analysis on the solution
    - Refine the model and/or implementation
5. Implementation of the final tool
    - Finalize the implementation and verify that it complies with requirements
    - Hand over – take over with Posti
6. Reporting
    - Write and submit the project plan and respective presentation material
    - Write and submit the interim report and respective presentation material
    - Write and submit the project report and respective presentation material

Schedule

	Week	10	11	12	13	14	15	16	17	18	19	20	21
1.	Literature review												
	Identify existing papers describing similar problems												
	Explore existing models and their solutions												
	Identify solution methods that are best suited for own optimization problem												
	Identify relevant theoretical approaches												
2.	Building the model		DL 13.3.										
	Agree on the scope and assumptions of the model												
	Define the decision variables												
	Define the objective function												
	Define constraints												
	Determine or estimate parameters												
3.	Algorithm decision and implementation												
	Decide or design the solution algorithm												
	Implement the first iteration model in Julia and JuMP				DL 27.3.								
	Implement the algorithm or use an existing solver if possible in Julia and JuMP					DL 1.4.							
4.	Model and algorithm validation and refinement												
	Examine the results of the optimization												
	Compare routing plans and scheduling plans with historical realization data								DL 24.4.				
	Perform sensitivity and feasibility analysis on the solution								DL 24.4.				
	Refine the model and/or implementation									DL 1.5.			
5.	Implementation of the final tool												
	Finalize the implementation and verify that it complies with requirements										DL 8.5.		
	Hand over – take over with Posti										DL 8.5.		
6.	Reporting												
	Write and submit the project plan and respective presentation material	DL 4.3.											
	Write and submit the interim report and respective presentation material							DL 15.4.					
	Write and submit the project report and respective presentation material												DL 20.5.

Figure 5. Tentative Schedule for the project

Resources

In addition to the project team itself, Posti Group has assigned their own experts in support of the project completion which is a significant asset. For coordination purposes a periodical steering meeting between Posti and the project team is being held. These steering meetings also serve as workshops where Posti and the project team advance the project together and agree on the steps to be completed before the next steering meeting. The project manager adjusts the project schedule, if required, based on progress and the steering meeting decisions.

Posti provides the project with network data of the physical network properties together with data on relevant costs and capacities of transportation units and sorting centers. Furthermore, Posti provides the team with data based estimates of the parcel traffic volume. Implementation of the tool will be conducted using Julia Pro programming and JuMP without a requirement for a separate user interface. This has been agreed on with Posti Group.

Risks

Risk	Likelyhood	Severity	Impact	Mitigation strategies
Team member inactivity or dropout	Low	Low to medium	Other team members workload increases possibly causing delays.	Clear scheduled tasks, remote work, periodical working meetings, standardized information flow between team members
Workload becomes too high	Medium	Medium	Model and/or implementation needs to be simplified, objectives are not achieved, working hours exceed the budgeted amount	Periodical review of progress together with Posti, adjustment of project objectives if required
Inability to formulate a meaningful mathematical model	Low	Medium	Revision of objectives and/or modelling constraints and assumptions, reduction in available time due to “starting over”	Using existing literature, iterating the model together with Posti at regular intervals
Inability to implement the model	Medium	High	Model must be adjusted or changed or the programming language changed	Using existing literature and existing algorithms, implementing model features iteratively one at a time, use programming language familiar to all team members
The implementation does not provide feasible results	Medium	Medium	Model must be adjusted or changed entirely. Worst case severity is starting over.	Iterative model implementation using validation data, using existing literature and algorithms, use programming language familiar to all team members
The final model does not satisfy customer requirements	Low	High	The project objective is not reached and the work effort has been wasted.	Constant communication with Posti and presentation of intermediate steps and results at steering meetings

Literature under review

- Ghiani, Gianpaolo, et al. *Introduction to logistics systems management*. John Wiley & Sons, 2013.
- Barbosa-Póvoa, Ana Paula, et al. *Optimization and decision support systems for supply chains*. Springer, 2017.
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References

[1] https://www.posti.com/en/group-information/posti-in-brief/
[2] https://www.emarketer.com/forecasts
[3] https://www.statista.com/outlook/243/135/ecommerce/finland
[4] https://financesonline.com/ecommerce-trends/
[5] https://www.posti.com/en/media/media-news/2019/posti-to-boost-its-growth-by-increasing-the-number-of-parcel-lockers/