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For more information, contact
MIT Global SCALE Network

Postal Address:
Massachusetts Institute of Technology 77
Massachusetts Avenue, Cambridge, MA 02139 (USA)

Location:
Building E40, Room 267
1 Amherst St.

Access:
Tel: +1 617-253-5320
Fax: +1 617-253-4560

Email: *scale@mit.edu*
Website: *scale.mit.edu*

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Spare Parts Management, Repairs and Logistics – Cost Modeling in the Telecommunications Sector
Iulia Borca and Eduardo Orri Vidal

For Full Thesis Version Please Contact:

Marta Romero
ZLOG Director
Zaragoza Logistics Center (ZLC) Edificio
Náyade 5, C/Bari 55 – PLAZA 50197
Zaragoza, SPAIN
Email: mromero@zlc.edu.es
Telephone: +34 976 077 605

Spare Parts Management, Repairs and Logistics – Cost Modeling in the Telecommunications Sector

By: Iulia Borca and Eduardo Orri Vidal

Thesis Advisors: Prof. David Gonsalvez and Prof. Mustafa Çagri Gürbüz

Summary:
Customer expectations are currently influenced by fast-changing business environments, a variety of highly competitive products and services, and rapid development of technology, especially in the telecommunications sector. A telecom operator needs an efficient spare parts management model in order to have any network failures corrected within promised service time windows. This thesis defines a cost model for spare parts management, repairs, and logistics for an international telecommunications company in order to identify cost trade-offs, to evaluate total landed costs, and to provide a control tool for inventory allocation.

Iulia Borca
- MIT-Zaragoza International Master of Engineering in Logistics and Supply Chain
- MSc in Econometrics and Applied Statistics, Babes-Bolyai University, Romania
- BA in Banking and Finance, Babes-Bolyai University, Romania
- Responsible for International Relations and Public Offerings, Broker SA

Eduardo Orri Vidal
- MIT-Zaragoza International Master of Engineering in Logistics and Supply Chain
- MSc in Industrial Engineering focused on Business organization, Polytechnic University of Valencia, Spain
- Logistics Consultant, Packaging, Transport and Logistics Research Center, ITENE

KEY INSIGHTS

1. By treating each type of spare part with a different policy, savings in transportation and holding cost can be achieved without compromising service level.
2. For slow moving spare parts, inventory should be kept in a central location to reduce the total holding cost and maintain low transportation cost.
3. In the case of spare parts that fail on a constant basis and have low value, the best policy is to keep them closer to the failure sites as the inventory holding cost is not very high and the company can be more responsive.

Introduction

After-sales service is becoming a very important differentiating factor between companies across the world in almost all industries. After purchasing a product or a service, a customer expects a high level of support from the vendor. However, many companies do not see the importance of after-sales service for their business and do not know how to make money out of it.

A telecommunications operator needs an efficient spare parts and repair management process in order to have any network failures corrected within promised service windows. This requires inventory management of spare parts located at strategic sites in the network for unexpected failures. It also requires a near-optimal logistics infrastructure to ensure that necessary spare parts are available.

A cost model characterizing different scenarios can help managers make correct decisions about the approach to use, taking into consideration cost efficiency and the service level that is required. We defined a cost model for Spare Parts Management, Repairs and Logistics (SPMRL) for an international telecom operator, taking into account the level of inventory at each stage within the network, the total relevant cost and the required service level.

We followed the next phases in our approach: identification of cost drivers, description of SPMRL processes for the case company, cost model development and simulation. At the end, a sensitivity and scenario analysis was performed in order to see the impact of changes in input parameters for the SPMRL area of this specific company.

Telecommunications Sector

The telecommunications sector offers services related to television, radio, broadband (fiber optic networks, wireless services) and voice communications. A few years ago, telecom operators were national or regional monopolies that offered services they deemed appropriate for their customers, not necessarily focusing on better solutions and innovations. Recently, the industry has been transformed by rapid deregulation and even faster innovation.

The case company is present in more than 20 countries. It has more than 280,000 employees with recorded revenues of over 60b Euros, reaching more than 280 million customers worldwide in the last financial year.

Future priorities of the telecom operator in the area of business, networks and technology that need good support from its SPMRL networks are:

- differentiating itself from the competition by offering efficiency of service, both in quality and speed;
- becoming a leader in customer satisfaction;
- taking advantage of economies of scale through networks standardization;
- increasing automation in the network;
- incorporating innovative services and technologies through acquisitions.

SPMRL Networks under Study

Our cost model for the case company can be generally applicable for all countries where the company operates, but needs some customization for each country. In our analysis, the model is customized for two different countries, one in South America (Country 1) and one in Europe (Country 2).

The case company holds a large number of spare parts or Stock Keeping Units (SKUs) – over 19,000 in Country 1 and over 3,900 in Country 2 – that can have very different characteristics in terms of heterogeneity, value, criticality, weight, and so on. Such diversity strongly influences the calculations of costs in the SPMRL area (transportation, holding, repair, shortage, and other costs).

The main elements of the network structure for Country 1 are a central warehouse, 9 regional warehouses, and 55 operation centers. The central warehouse is the location from which the replenishment of the downstream network is done. No failure notifications are served directly from it nor from a regional warehouse. An operation center is a location of small dimensions where minimum inventory is kept and from where a customer failure notification is served by a technician.

In the case of Country 2, the SPMRL network is composed of a central warehouse and 53 regional warehouses. From both the central warehouse and all regional warehouses, customer failure notifications are served by technicians.

After gaining insights into the network structure, we continued with an analysis of the real data characterizing the company's network and operations.

Initial Data Analysis

The following main issues needed a clear approach to build the cost model:

- selection of operation centers/warehouses from where a failure is served;
- aggregation of warehouses present in Country 2 because some locations had the same address or were keeping very low-valued inventory (in the end 53 regional warehouses were chosen by aggregating the same addresses and eliminating the locations where no inventory was kept);
- selection of SKUs to be included for analysis in the cost model.

After analyzing the data received from the case company, we decided to take the following approaches in calculating the probability of a failure occurring in a certain location:

- Country 1: based on the size of the population within the area served by each of the network locations;
- Country 2: depending on historical data of failure occurrences throughout the locations served by each warehouse.

In Country 1, 89% of the total number of SKUs only fail once/twice a year. In this case, we considered that the best inventory policy would be to keep a central inventory of 1-3 units. Moreover, the spare parts that fail once or twice a year are the same over time with a percentage above 90%. The inventory levels could be reduced for these spare parts to the recommended level of 3 units within the network and thus minimize the holding cost.

In 2010, for Country 2, only 11% of the inventory was used, only 18% of the different SKUs were used, and all the spare parts needed accounted for only 9% of the value of the total inventory kept. We considered the spare parts that fail only once or twice a year under a separate analysis. The recommendation would be applying the same policy of keeping 1-3 units in inventory to cover the very sporadic demand, at least for the SKUs that show the same failure behavior over time.

These policies of inventory reduction would be applicable for spare parts that are too expensive to keep or that occupy warehouse capacity that could be used for other parts.

Six Groups of Spare Parts

As explained in the previous section, we first decided to apply a different approach for the spare parts that fail once/twice a year. Then the idea was to separate all remaining spare parts into six different categories, and consider the averages as representative SKUs for their categories and extrapolate the results to the whole group. This categorization is illustrated in the following table:

	LOW MTBR	MED MTBR	HIHG MTBR
HIGH COST PART	SKU 1	SKU 2	SKU 3
LOW COST PART	SKU 4	SKU 5	SKU 6

These different scenarios could provide answers about where to allocate particular spare parts that have different failure behavior, and what the tradeoffs between service level and costs are.

After taking out the SKUs that fail once/twice per year, the remaining portfolio of parts was split into three groups, depending on if a spare part failed on average quarterly, monthly, or daily. The next step was to separate each of the three groups into high-value or low-value parts.

In the case of Country 1, the spare parts generally included in the high valued groups represent approximately 13% within their MTBR category and usually account for more than 50% of the value. The six groups and their characteristics are displayed in the following table:

	Value of replacements	Frequency of replacements: Low	Frequency of replacements: Medium	Frequency of replacements: High
	High	Group 1	Group 3	Group 5
No. of different SKUs	High	202	66	26
Average MTBR (days)	High	85	19	3
StDev MTBR (days)	High	2.43	10.47	2.28
Av. repair cost (CU1)	High	3,384.31	2,064.65	1,022.28
	Low	Group 2	Group 4	Group 6
No. of different SKUs	Low	1288	512	176
Average MTBR (days)	Low	90	20	4
StDev MTBR (days)	Low	34.56	7.57	2.04
Av. repair cost (CU1)	Low	322.02	270.06	292.36

For Country 2, the variety between the three MTBR categories (low, medium, high) is quite significant when we looked at value split within each category. The number of high valued spare parts represents 6% in the low MTBR category (Group 1), 23% in the medium MTBR category (Group 2) and 38% in the high MTBR category (Group 3). The six groups and their characteristics are shown in the following table.

	Value of replacements	Frequency of replacements: Low	Frequency of replacements: Medium	Frequency of replacements: High
	High	Group 1	Group 3	Group 5
No. of different SKUs	High	11	22	5
Average MTBR (days)	High	66	22	4
StDev MTBR (days)	High	23.01	11.41	1.70
Av. value inventory (CU2)	High	29,280.15	10,844.79	5,718.64
Av. repair cost (CU2)	High	38,804.74	20,673.28	7,736.37
	Low	Group 2	Group 4	Group 6
No. of different SKUs	Low	163	75	8
Average MTBR (days)	Low	90	25	5
StDev MTBR (days)	Low	28.26	9.73	1.58
Av. value inventory (CU2)	Low	6,937.29	6,876.27	2,594.92
Av. repair cost (CU2)	Low	8,137.49	6,196.97	4,037.84

Simulation Results

The first step was to do an AS-IS analysis of the current situation across the spare parts logistics network of the case company. Then, based on the insights we got from the AS-IS situation, we simulated various scenarios based on these setups:

- sensitivity analysis on how inventory levels influence costs and service levels.
- movement of inventory from downstream network to central warehouse and vice-versa.
- reduction of inventory levels throughout the network.

The policy of centralizing a larger part of the inventory for spare parts with high failure frequency and high value led to a 13% reduction in holding cost that translated into a 1% drop of total relevant cost for Country 1.

Decreasing the inventory level for Country 2 to around 10% brought a reduction of approximately 4% of the total relevant cost for all six groups.

By moving all inventory in the central warehouse in the case of slow moving items, the transportation and holding cost dropped 5% and 12% respectively, leading to an average reduction in the total relevant cost of 3% in the case of Country 1. In the same scenario for Country 2, the results were not so conclusive, as we did not have a clear distinction for holding cost rates between different types of warehouses. In another scenario for Country 2, we did an additional analysis in order to find the difference between the two types of holding cost that would make this policy feasible.

Conclusions

The first insights we got by analyzing the data for both countries could be summarized as follows:

- There is more inventory than needed to serve the failures that happen within a year.
- A high number of SKUs from the portfolio of spare parts need replacements only once or twice per year.
- A large percentage of the spare parts that need to be replaced only once/twice per year maintain this behavior from one year to the next.

Based on the above conclusions, we developed a simulation model to identify how the changes in inventory allocation affect the overall cost, cost tradeoffs, and service level for spare parts that need replacement more than once/twice per year.

Some of the conclusions we arrived at after running various simulations are the following:

- For the SKUs that fail on average quarterly and have a high value, the best policy is to keep them in the central warehouse when there is a clear difference between regional and central holding cost.
- By holding all inventory in the central warehouse, the total relevant cost decreases but the capability to be responsive at any given time is more limited.
- For spare parts that fail on a constant basis and have low value, the best policy would be to keep them closer to the demand points, despite incurring more holding cost, as the company can be more responsive.
- Spare parts that have a low rotation should be kept in the central warehouse. This would maintain the transportation cost low, and at the same time reduce the total holding cost.

Treating each type of spare part with a different policy could impact significantly the final result, improving the benefits for the end customers and for telecommunication companies. We believe that by following this type of approach in reallocating the spare parts in the networks, savings in transportation and holding cost could be achieved without compromising the service level.