Case - OneCom

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The global smartphone industry stands as a testament to human ingenuity and technological advancement, shaping the way we communicate, work, and interact with the world around us. Here, supply chains are complex and globally interconnected. It involves numerous components sourced from different parts of the world, including semiconductors, display panels, batteries, cameras, and other electronic components.

Several key players dominate this supply chain, such as semiconductor manufacturers such as TSMC, Samsung, and Qualcomm, as well as display suppliers like Samsung Display and LG Display. These companies often have intricate relationships with smartphone manufacturers such as Apple, Samsung, Huawei, and Xiaomi.

The smartphone supply chain has faced challenges in recent years. Issues such as the global shortage of semiconductors, geopolitical tensions affecting trade relationships, and disruptions caused by the COVID-19 pandemic have affected production and distribution. These challenges have led to delays in product launches, increased prices for certain components, and manufacturer supply chain reconfigurations to mitigate risks. Hence, it is eminent that companies continually review their supply chain, production, and customer base to maintain their competitive edge. Given the high stakes involved, it is imperative that these decisions are carefully made with the support of robust data and analytics, ensuring well-informed choices.

In this ever-evolving landscape where innovation drives competition, OneCom is a prominent player that specializes in manufacturing high-quality smartphones with advanced features and cutting-edge technology. The company prides itself on innovation, reliability, and commitment to sustainability throughout its operations. OneCom is located in California, USA, where the headquarters also contains the primary R&D department. OneCom has three production facilities in Europe (Magdeburg, Germany), North America (San Diego, USA) and South America (Juarez, Mexico). Furthermore, OneCom owns a set of warehouses and a few strategically located R&D centers. An overview of OneCom's facilities is given in Figure 1.

1 Organization

The organization in OneCom aims at efficiently managing its operations and achieving business objectives. The overall leadership is maintained by the Chief Executive Officer (CEO), Chief Operating Officer (COO), Chief Financial Officer (CFO), Chief Technology Officer (CTO), and Chief Marketing Officer (CMO). Various departments within the organization are responsible for specific functions:

Research and Development (R&D) Responsible for designing and developing new smartphone technologies and features.

Figure 1: Location of OneCom's headquarters (including R&D), production sites, and warehouses.

Product Development Translates R&D innovations into tangible products, coordinating design, engineering, and testing.

Manufacturing and Supply Chain Oversees the production process, including sourcing materials, assembly, and quality control.

Sales and Marketing Manages sales channels, marketing campaigns, and customer engagement efforts.

Customer Service Provides support to customers, addressing inquiries, technical issues, and product returns.

Finance and Accounting Handles financial planning, budgeting, accounting, and reporting functions.

Human Resources Manages recruitment, employee relations, training, and development initiatives.

Legal and Compliance Ensures the company operates within regulatory frameworks and handles legal matters.

Information Technology (IT) Manages the company's technological infrastructure, including networks, systems, and cybersecurity.

The organization may consist of different units including product lines, regional divisions, and cross-functional teams to facilitate specialized functions, geographic operations, and collaborative initiatives.

2 Supply chain network

OneCom's supply chain begins with the sourcing of components required for manufacturing its smartphones. Components includes processors, memory chips, display screens, camera modules, and batteries. The company seeks to establish strategic partnerships with suppliers who prioritize ethical sourcing practices and environmental sustainability. Supply chain parts include

Sourcing OneCom works closely with suppliers globally to ensure a stable and reliable supply of components. For example, it may source lithium-ion batteries from a supplier in South Korea known for its expertise in battery technology and commitment to environmental standards. Similarly, it might procure high-quality camera sensors from a trusted supplier in Japan.

Manufacturing OneCom's production sites assemble the components into finished smartphones. The company maintains state-of-the-art production facilities equipped with advanced machinery and quality control measures to ensure consistency and reliability in its products.

Distribution and Logistics After manufacturing, the smartphones are distributed to retail stores or to its own warehouses. The company partners with logistics providers to manage transportation, warehousing, and inventory management efficiently. For example, it may utilize a combination of air, sea, and land freight to transport its products to different regions, optimizing cost and delivery times.

Sales OneCom collaborates with retail partners to showcase its products and provide customers with hands-on experiences. This includes partnering with telecommunications carriers, electronics retailers, and online marketplaces to reach a broad customer base.

After-Sales Service OneCom places a strong emphasis on customer satisfaction and provides comprehensive after-sales service and support. This includes warranties, repairs, and technical assistance through authorized service centers and online support channels. The company strives to ensure a positive customer experience and build long-term relationships with its users.

Throughout its supply chain, OneCom prioritizes environmental sustainability initiatives. This includes minimizing waste generation, optimizing energy efficiency in manufacturing processes, and promoting recycling and responsible disposal of electronic waste. The company may also explore initiatives such as using recycled materials in its product packaging and reducing carbon emissions from transportation.

OneCom is increasingly emphasizing the importance of leveraging data and analytics to drive more informed decision-making across the organization. The objective is to generate data-driven insights that can enhance efficiency, identify opportunities, and mitigate risks. Currently, OneCom is exploring several key projects, some of which are described in the following.

3 Redesigning the network due to potential merger

Recently, OneCom and Yfon, a major competitor, are in the final stages of merging. The merger between OneCom and Yfon carries significant implications not only for the firms involved but for the entire cell phone ecosystem. It becomes apparent that the stakes are high, and the decisions made will reverberate across markets and continents, shaping the course of the industry for years

Table 1: Global demand (aggregate) and import duties in million of units.

Market	NA	SA	EU	Non-EU	J	AP	A
OneCom demand	10	4	20	3	2	2	1
Yfon demand	12	1	4	8	7	3	1
Import duties (%)	3	20	4	15	4	22	25

Table 2: Plant capacities (millions of units), fixed costs (millions of $) and variable costs ($/unit).

	Plant	Capacity	Fixed Cost/year	Variable cost/unit
OneCom	P1 (Germany)	20	100	6.0
	P2 (USA)	20	100	5.5
	P3 (Mexico)	10	60	5.3
Yfon	P1 (Germany)	20	100	6.0
	P2 (USA)	20	100	5.5
	P3 (China)	10	50	5.0

to come. Therefore, given the high stakes involved, it is imperative that these decisions are carefully made with the support of robust data and analytics, ensuring well-informed choices.

Although the strategic components of the merger have been mostly agreed upon, there are still operational details that need to be finalized before the two firms can reach a final agreement. One key operational aspect currently under scrutiny is the redesign of their facility network. Yfon has three production facilities located in Europe (Bonn, Germany), North America (Austin, USA) and Asia (Shenzhen, China). Both firms cater to the same global market base, encompassing seven key market regions including North America (NA), South America (SA), Europe (EU), Europe (Non-EU), Japan (J), Rest of the Asia-Pacific region (AP), and Africa (A).

Their current aggregate market sizes (demand) are outlined in Table 1. An overview over their production systems are given in Table 2 where the capacity, annual fixed cost, and variable production costs for each plant are as shown. Finally, transportation costs between regions are as shown in Table 3. Duties (see Table 1) are applied on each unit based on the total variable cost, which is the sum of variable production cost and transportation cost. For instance, a unit currently shipped from North America to Africa has a variable production cost of $5.50 and a transportation cost of $2.20. The 25 percent import duty from North America to Africa is thus calculated as 25%

Table 3: Transportation costs between regions ($/unit)

	NA	SA	EU	Non-EU	J	AP	A
NA	1.00	1.50	1.50	1.80	1.70	2.00	2.20
SA	1.50	1.00	1.70	2.00	1.90	2.20	2.20
EU	1.50	1.70	1.00	1.20	1.80	1.70	1.40
Non-EU	1.80	2.00	1.20	1.00	1.80	1.60	1.50
J	1.70	1.90	1.80	1.80	1.00	1.20	1.90
AP	2.00	2.20	1.70	1.60	1.20	1.00	1.80
A	2.20	2.20	1.40	1.50	1.90	1.80	1.00

of (5.50 + 2.20) = $1.925. Note that duty is not applied when the plant and the market are in the same region.

Questions

1. For each company, formulate a suitable decision model to determine the lowest cost achievable for the production and distribution network prior to the merger? Which plants serve which markets?
2. What is the lowest cost achievable for the production and distribution network after the merger? Which plants are used? Which plants serve which markets?
3. Suppose now that it is possible to scale back each 20 million-unit plant to a 10 million-unit plant, and that this will result in a 40% reduction in fixed costs for any scaled back plant. Note that variable costs at a scaled-back plant remain unaffected by this change. In addition, suppose that shutting down a plant – whether it's producing 10 million or 20 million units – leads to a reduction of only 80% in fixed costs (the remaining 20% are not recovered due to expenses such as severance and other associated costs related to a plant shutdown). How should the merged network now be configured?

4 Evaluating and improving the supply chain

OneCom operates a smartphone assembly facility in San Diego, California (see Figure 1). Established in 1988, this facility was originally one of the company's primary manufacturing plants serving international markets. Over time, it has been reconfigured to focus on the assembly and quality control of the OneCom OCean5 smartphone model, now exclusively catering to domestic demand. The products assembled at this facility, using components from suppliers, are distributed to retailers through a distributor, forming a domestic multi-echelon supply chain. This supply chain includes suppliers, the assembly facility, the distributor and retailers. The domestic supply chain is illustrated in Figure 2. The supply chain from upstream to downstream consists of the following levels:

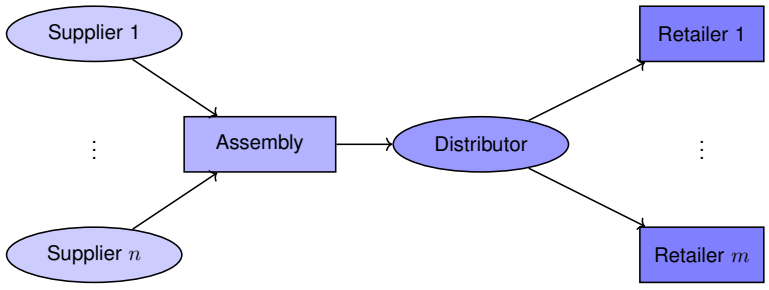

Figure 2: The domestic supply chain. Arrows indicate the flow of goods.

Suppliers Suppliers provide OneCom with all the components required to assemble OCeans5, including frames, batteries, and motherboards. While the supplier of frames and batteries is quite reliable, the supply of motherboards that comes from a partner company in San Francisco may occasionally face delays due to variable operation and transportation times.

Assembly plant The assembly plant is responsible for making the finished product to be sold at retailers to the end customers. Two types of inventories are kept at the assembly plant: one for the finished products and one for the raw material, namely, the components used to make the final product. The orders from the distributor are fulfilled using the finished product inventory kept, or the so-called Output Buffer. When an order is received, one of two scenarios may occur: If the Output Buffer has enough on-hand inventory, the order is sent to the distributor right away. In this case, the lead time is limited to the transportation delay. If the Output Buffer lacks sufficient stock, the order is backordered.

The assembly line processes orders exclusively in batches of prespecified sizes. The assembly operation consists of several steps. When an assembly order is placed, the availability of sub-assemblies is first verified. There are three main sub-assembly components required for production: the motherboard, battery, and frame. Although the supplies of batteries and frames are abundant, reliable, and readily available, the company maintains an inventory of motherboards in an Input Buffer to prevent disruptions in the assembly process. This is a proactive strategy to protect the business against supply shortages.

When an assembly order is made, if all components for the production of the entire order are available, the process starts. The first activity is the case assembly operations, which is about integrating the motherboard into the frame. This process is semi-automated. The case assembly is followed by display and battery installation. The last step is to conduct extensive tests including functional (e.g., boot-up, screen, audio, camera, connectivity), performance (e.g., CPU and GPU, battery, memory), and software (e.g., operating system, apps, security) tests. This step relies largely on manual work. Once the production batch has passed these tests, the output buffer is immediately replenished.

As the assembly plant houses a number of processing resources that may not be easily identified as discrete servers, hence it seems both sensible and practical to think of the processing rate in terms of batches per unit of time and to use a single-server queue to model the operations of the facilities.

Distributor The distributor keeps inventories of final products, including the OCean5 model. The distributor's inventory is replenished by shipments from the assembly plant. When the distributor receives an order from retailers, one of two scenarios may occur:

- Sufficient Inventory: If the distributor has enough inventory on hand, the order is shipped immediately. In this scenario, the lead time is limited to the transportation delay.
- Insufficient inventory: If the distributor lacks sufficient stock, the order incurs additional delays due to both transportation and potential stock-outs upstream of the distribution center. In this case, the retailer's order is backordered and fulfilled as soon as the inventory becomes available.

Retailers There are multiple retailers that collectively generate streams of demand met by the distributor. The interarrival times between successive Orders from retailers, and order sizes are random variables. However, using historical data, the distributor is able to estimate both the arrival process and the order size.

The operations management team at the San Diego assembly plant has become increasingly concerned with the fill rate at the distribution center, which has been affecting their ability to meet

retailer demand. Frequent shortages at the output buffer, coupled with variable lead times, are exacerbating the issue. Given these challenges, the team is eager to conduct a thorough analysis of the supply chain's performance. Their goal is to improve the overall reliability of the supply chain to meet demand more effectively.

Assumptions

- While the supplies of batteries and frames are abundant, reliable, and readily available, the company occasionally experiences delays in the supply of motherboards. These motherboards are manufactured and shipped to the plant in California by a partner company based in San Francisco. As one supplier limits the supply side, the analysis of the supply chain assumes having one supplier.
- Using historical data, the distributor have estimated a joint demand distribution from all retailers. The analysis results show that the order interarrival times are exponentially distributed with a mean of 1.2 days. The demand size is also a random varibale and follows a discrete distributions as follows:

$$D = \begin{cases} 50 & 0.25 \\ 100 & 0.25 \\ 150 & 0.35 \\ 200 & 0.15 \end{cases}$$

- The inventories at the distributor, input buffer, and output buffer are managed using continuous review policies, with parameters provided in Table 4. According to this policy, an order of size Q is placed with the upstream supply chain member when the inventory position falls to or below the reorder level r.

Table 4: Inventory control parameters

	(Q, r)
Distributor	(300,150)
Output Buffer	(500,250)
Input Buffer	(1000,500)

- The transportation times from the distributor to the retailers and from the assembly plant to the distributor warehouse are independently and identically distributed. The mean and standard deviation of transportation times are 0.5 days and 0.2 days, respectively, following a normal distribution.
- Historical data show that in 85% of the cases, the supplier's average delivery time is 1 day. However, in the remaining 15% of cases, the delivery time triples.
- The assembly line process is highly standardized, with assembly times uniformly distributed between 0.75 and 0.85 days.
- Each production batch at the assembly plant consists of 500 units, and production begins only when all components for one batch are available.

Performance measures

The operations manager at OneCom's is interested in the following performance measures:

- The long-run average inventory levels across the entire system,
- The long-run average number of backorders at both the distribution center and the Output Buffer,
- The utilization level of the assembly resources,
- Customer service levels at each echelon.

Assignments.

1. Develop a simulation model to replicate OneCom's local supply chain.
2. Report on the specified performance measures.
3. Use the results from the previous assignment to assess OneCom's inventory policy and operational efficiency.

5 Estimating Global Demand

As an intern in the newly formed data science section at the IT department, you have been asked to estimate the global demand next year (assumed to be 2024). The numbers are needed for an upcoming merger between OneCom and another company Yfon.

A senior data analyst (your mentor) has extracted sales in the last 3 years from OneCom's database systems and sent it to you. The file `sales-src.csv` contains weekly sales by country. Moreover, the senior analyst has also received an Excel file with Yfon's sales numbers (the file name contains the string 'external').

You are keen to analyze the data by producing a reproducible report that presents your findings. Initially, you need to clean the data by creating a unified dataset that includes all the necessary data from both companies. You have determined that the data should be aggregated monthly and that the dataset should include columns: 'Company', 'Month', 'Year', 'Sales', 'Country' and 'Region'. OneCom utilizes specific custom regions (which must be used): North America (NA), South America (South of the USA, SA), Europe (EU), Europe (Non-EU), Japan (J), the rest of the Asia-Pacific region (AP), and Africa (A). After searching the Internet, you managed to download a file `regions-src.csv`, which includes all countries in the world, their regions, etc. according to the ISO standard[1]. Furthermore, you discovered an Excel file `eu-countries-src.xlsx` that contains a list with all EU countries.

1. Tidy the data from both companies (Company 1 and 2) by
   (a) Transforming dates so you can identify the month and year. Hint: you may have a look at the `lubridate` package
   (b) Mapping countries to custom regions. Hint: you may need to do mutating joins.

[1] `https://github.com/lukes/ISO-3166-Countries-with-Regional-Codes/blob/master/all/all.csv`

(c) Merging the data into a single dataset.

(d) Validate your tidy dataset, e.g. have dates been transformed correct, are country names unique for a country, are my regions correct, are there are no missing data in the dataset, are sales okay etc?

Note that it is not good practice to overwrite the source data files. That is, always save your tidy data in a new csv file. Moreover, your data transformation must be reproducible i.e. no manual editing in dataset files.

2. Get an overview over the data by

   (a) Given company and region calculate aggregate sales for each month.

   (b) Plot the sales numbers given month for each year. Make a plot for each company and region and comment on your findings.

   (c) Aggregate the sales numbers to yearly sales for each region and make a new plot showing the yearly sales given year foreach region and company. Have the sales increased over the years?

   (d) Do you expect total sales by region to increase/decrease next year?

You realize that sales do not always equal demand. What if OneCom was not able to satisfy the demand? Hence, you write an e-mail to your mentor, asking him to contact the sales (or should it be another department?) to ask if OneCom have had any stockouts. He replied that in general OneCom does not keep track of stockouts, but he had a talk with the sales department, which estimated that in general OneCom was able to satisfy demand in all regions except for the AP region where demand was exceptional high in the last quarter of 2023. An approximate estimate is that OneCom could have sold 20% more cellphones. It is not possible to get this information from Yfon.

3. Reevaluate your findings. Will this change your conclusion in Question 2d.

4. Make a table similar to Table 1 with the aggregate demand for the companies. Hint: Take a look at the ‘kableExtra‘ package. (your numbers should be similar).