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Management of Supply Networks for Products and Services: Concepts, Design, and Delivery

Key Takeaways Document – Part IV

Matching Supply & Demand¹

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- Agenda and intended purpose of these notes
 - These present the key takeaways and messages from each session / lecture.
 - Internalize the key learning from each lecture.
 - Understand the link between class readings and the core messages from each lecture.
 - These notes are not intended as a substitute for the class readings or lecture slides.
 - They also provide a look back at the ground we have covered so far in the class.

¹ Version created on Thursday, August 05, 2004

² Based on Assigned Readings and Lectures.

Why Matching Supply & Demand of Services is a challenge:

(Summarizing from Lecture and Bitran and Mondschein, 1997)³

- Once again recall the distinctive attributes of services:
 - The **simultaneity, perishability and intangibility** properties of services mean that they cannot be inventoried, unlike manufacturing goods facing variable demand. In services this leads to idle resources and staff during periods of low demand, and in periods of high or peak demand this leads to the formation of queues of people or work.
 - The **heterogeneity** property implies, as a result of inconsistencies, that it is hard to estimate work and capacity requirements even for standard work.
- Successfully **managing demand fluctuations**, and **managing capacity differently in high and low demand periods**, are therefore the two mechanisms available to service firms to match supply and demand.
- From a broader perspective, matching supply and demand is the fundamental operational objective within supply chains. Therefore performing the **core operational tasks** efficiently is the key to the viability and profitability of supply chains. Recall the following examples we had provided in class to illustrate the central nature of matching supply & demand to:
 - The airline industry (this industry provides a good case study for learning about various mechanisms)
 - The semiconductor fabrication facility
 - The trucking company example
 - The catalog industry
 - The barber shop
- Even when we operate in a **deterministic environment** (where we can predict accurately the arrival sequence of customer orders, and where we can predict accurately the work required for each customer), the **matching of supply and demand to maximize profits is not a trivial activity**. Firms often have to employ **advanced optimization techniques** to manage even under simplifying deterministic assumptions.
- **Uncertainty** is a fact of life, and therefore inevitably **compounds the problem of matching supply demand** to the extent that managers often have limited control of their system, without expensive strategies such as **endemic over-capacity**, or while living with a **dominant fraction of unsatisfied customers**.
- However, a prevalent myth is that uncertainty cannot be classified and dealt with effectively. Our objective here is to classify and formalize the different sources of uncertainty in services, with the aim of developing specific operational mechanisms to manage each source of uncertainty.

³ Bitran, G.R. and Mondschein, S. (1997), "Managing the Tug-of-War Between Supply and Demand in Service Industries," European Management Journal, Vol. 15, No. 5; pp. 524-534.

Sources of Uncertainty in Supply Chains

- On the Demand Side

- Inherent demand variability and uncertainty: for example for new products, adoption dynamics are hard to predict.
- Seasonality of demand: although predictable, inadequate management of highly variable capacity may result in problems.
- Competitor actions: such as predatory pricing and next generation of products.
- Regulations: when new controls are introduced their impact is not known, and consequently are a source of uncertainty
- Ordering anomalies: we saw earlier in the beer game how variability propagates through the supply chain as a result of the behavior of individual links in the chain.
- Lot sizes: large or variable lot sizes or order quantities, even when overall demand is predictable are also a source of uncertainty
- Lack of communication between marketing / sales and operations (especially in services) leads to poorly understood demand patterns.
- Poorly well-designed contracts.

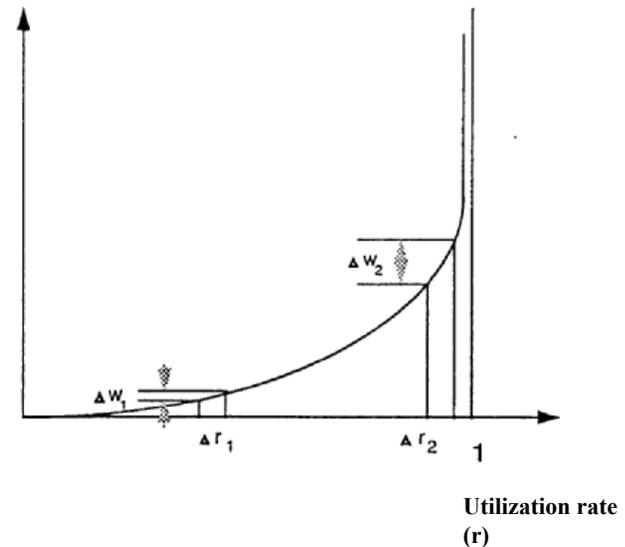
- On the Supply Side

- Shipping and logistics considerations: for example, for economies of scale, multiple products have to be shipped together, whereas these products may have fundamentally different service requirements. Further shipping schedules may be poorly defined or opaque (unlike Fedex) causing uncertainty.
- Allocation schemes where distribution managers allocate product / production quantity to different customer locations (for example to Wal-mart and Costco) may be ill-defined causing uncertainty to both customers.
- Production facilities / factories that have to manage multiple products, but where the group of products for a facility are mismatched
- As a direct consequence, set-up during production can cause disruptions and high supply variability
- Technological uncertainty in the process or product (for example a new product or process)
- Staffing schedules for facilities: may not be synchronized with demand patterns
- Varying skill levels of employees can result in a wide distribution of quality in products and services
- Breakdown of key equipment.
- Variable yield / quality of products

Fundamental Consequences of uncertainty

- Supply may exceed demand for long periods resulting in loss of profitability
- Demand may exceed supply for long periods of time even when average demand is lower than average supply.
- In fact in the Barilla case, we will see that both situations can co-exist.
- Key customers may be unsatisfied and we may lose their revenues as a result of their switching to other products
- Recall the relationship between service quality and firm profitability. One of the consequences of uncertainty is that firms are less profitable for maintaining the same levels of service quality.
- Recall the fundamental curve explaining the relationship between utilization and uncertainty⁴.
- As utilization increased, however, the impact of uncertainty increases dramatically.
- As consequences of uncertainty become more dramatic, they exclude managers from the pro-active decision-making process.
- In complex systems, managers remain reactive, rather than proactive.
- The solution is not usually to increase capacity, but rather to address root causes and reduce uncertainty to the extent possible.
- As a solution, managers typically tend to increase capacity, or hold excess inventory buffers, that in turn lead to increased operating costs
- However, for long term profitability and growth, we need to address root causes of uncertainty and mitigate / eliminate them to the extent possible.
- Often, manager underestimate the extent to which they can mitigate the uncertainty in their operations.
- The consequences of uncertainty on various performance measures of interest to managers is highly non-linear.
- This is one of the reasons why system managers need analytical tools to estimate as well as manage the consequences of uncertainty.

Waiting Time /
Unsatisfied
customers /
Operating costs



⁴ We also have a law that holds well for operational systems (called Little's Law):
Amount of work still in the System = System Throughput (Work per unit time) X Processing Time.

A fundamental characterization of Just-In-Time operations

- In fact by **lowering uncertainty**, the system can progressively become **stable** at even high levels of utilization.
- When we eliminate all forms of uncertainty from the firm's operations, we attain a state where utilization levels cease to have an impact on the performance measures mentioned in the figure above (previous page).
- Operations in this state are then commonly known as **Just-in-Time** operations.
- However, it is important to recognize that Just-in-Time operations are a **limit state** that is a useful goal rather than an attainable state in practice.
- In order to implement Just-in-time operations, firms typically also possess a **Just-in-Case** reserve of inventory buffer, capacity options, etc. This is not to be perceived as their shortcoming; rather we need to understand that in reality for high levels of **customer satisfaction and productivity** in operations, we need in reality to balance the two needs.
- Further one of the pitfalls of Just-in-Time operations is that firms do not realize that this requires a high level of stability in the basic processes and technology of the firm.
- We provide an informal definition as follows: "*JIT is the limit state of a dynamic system after we have removed all sources of uncertainty in the firm's operations*".

Key Points on Inventory Management

- By now it should be clear why managing inventories is a critical activity in supply chains.
- The relation between **inventories** and **service quality** is not so easy to see. Higher levels of customer satisfaction may require correspondingly greater amounts of inventory; however the more important question is **where** to place the inventory in supply chains. By placing and inventory in **strategic locations** and **redistributing inventory** if necessary, it is possible to both reduce overall inventory costs, and improve service levels.
- Many years ago, managers often overstocked inventory to mask internal problems in their operations as well as to address problems with suppliers. This led to corruption of accurate data on true capacity, the real short-comings in operations, and also the critical sources of uncertainty.
- Therefore the first couple of generations of inventory management techniques included lot-sizing formulae that were required to justify inventory levels that could be substantially lower. However these techniques were based on simplistic assumptions on demand distribution, and on technological feasibility, but they still proved very effective.
- Today the assumptions used by some of these techniques have to be challenged, given that information channels have been changed, ordering costs have progressively decreased, and setup times between product changeovers are also being decreased.
- A few decades ago, scheduling of supply chains was done based on the “**Push**” approach, where the scheduling of supply chains was done **based on market forecasts and planned lead times**.
- But with customers getting ever closer to our operations (example of Dell stands out), some in the industry wanted to change their approach completely to that of a “**Pull**” system, where it took a **customer order to trigger production** in factories.
- However, firms that failed to understand the fundamental characterization of JIT (as outlined in the previous note), the need for inventory buffers, and flexibility in capacity, found it difficult to transition to this mode of operations successfully.
- The Simchi-Levi book recommends a new approach called a “**Push-Pull**” approach to operations in such firms. Here a balance is recommended where inventory buffers are located at strategic locations in the supply chain, but where certain units in the supply chain can still operate on a “Pull” framework.
- Some of the critical objectives or of inventory management include:
 - Risk pooling
 - Service differentiation based on customer segmentation
 - Managing complexities arising from multiple products
 - Reducing variability for upstream and downstream facilities
 - Delayed product differentiation

Mechanisms for Matching Supply and Demand

	Supply Management	Demand Management
Tactical Level	<ul style="list-style-type: none"> • Location • Sharing Capacity • Standardization • Automation • Information systems • Modular facility design • Part-time Employees • Preprocessing • Cross Training • Extended Business Hours • Preventive Maintenance • Cooperation with Competitors • Complementary Services 	<ul style="list-style-type: none"> • Reservations • Direct Marketing • Price differentiation • Promotion and Sales • Complimentary service • Information to customers Preventive maintenance of users' equipment
Operational Level	<ul style="list-style-type: none"> • Downgrading of products • Overbooking • Service length • Scheduling • Engaging Customers • Batching the Service 	<ul style="list-style-type: none"> • Pricing • Daily Specials