CHAPTER 7

PROCESS SELECTION, DESIGN, AND ANALYSIS

DAVID A. COLLIER
AND
JAMES R. EVANS
LO1 Describe the four types of processes used to produce goods and services.

LO2 Explain the logic and use of the product-process matrix.

LO3 Explain the logic and use of the service-positioning matrix.

LO4 Describe how to apply process and value stream mapping for process design.

LO5 Explain how to improve process designs and analyze process maps.

LO6 Describe how to compute resource utilization and apply Little’s Law.
called to make an airline flight reservation just an hour ago. The telephone rang five times before a recorded voice answered. “Thank you for calling ABC Travel Services,” it said. “To ensure the highest level of customer service, this call may be recorded for future analysis.” Next, I was asked to select from one of the following three choices: “If the trip is related to company business, press 1. Personal business, press 2. Group travel, press 3.” I pressed 1. I was then asked to select from the following four choices: “If this is a trip within the United States, press 1. International, press 2. Scheduled training, press 3. Related to a conference, press 4.” Because I was going to Canada, I pressed 2.

What do you think?
Describe a situation that you have encountered in which a process was either well designed and enhanced your customer experience, or poorly designed and resulted in dissatisfaction.
Three Types of Goods and Services

1. **Custom, or make-to-order, goods and services** are generally produced and delivered as one-of-a-kind or in small quantities, and are designed to meet specific customers’ specifications.

   - Examples include ships, weddings, certain jewelry, estate plans, buildings, and surgery.
Three Types of Goods and Services

2. **Option**, or *assemble-to-order, goods and services* are configurations of standard parts, subassemblies, or services that can be selected by customers from a limited set.

- Examples are Dell computers, Subway sandwiches, machine tools, and travel agent services.
Three Types of Goods and Services

3. \textit{Standard}, or \textit{make-to-stock}, \textit{goods and services} are made according to a fixed design, and the customer has no options from which to choose.

- Examples: appliances, shoes, sporting goods, credit cards, online Web-based courses, and bus service.
Four Types of Processes

1. **Projects** are large-scale, customized initiatives that consist of many smaller tasks and activities that must be coordinated and completed to finish on time and within budget.

   ➢ **Characteristics:** one-of-a-kind, large scale, complex, resources brought to site; wide variation in specs and tasks.

   ➢ **Examples of projects:** legal defense preparation, construction, customer jewelry, consulting, and software development.
Four Types of Processes

2. **Job shop processes** are organized around particular types of general-purpose equipment that are flexible and capable of customizing work for individual customers.

- **Characteristics:** Significant setup and/or changeover time, batching, low to moderate volume, many routes, many different products, high workforce skills, and customized to customer’s specs.

- **Examples:** Many small manufacturing companies are set up as job shops, as are hospitals, legal services, and some restaurants.
Four Types of Processes

3. **Flow shop processes** are organized around a fixed sequence of activities and process steps, such as an assembly line, to produce a limited variety of similar goods or services.

- **Characteristics:** Little or no setup time, dedicated to small range of goods or services that are similar, similar sequence of process steps, moderate to high volume.
Four Types of Processes

3. Flowshops continued

- An **assembly line** is a common example of a flow shop process. Many option-oriented and standard goods and services are produced in flow-shop settings.

- **Examples**: automobiles, appliances, insurance policies, checking account statements, and hospital laboratory work.
Four Types of Processes

4. A continuous flow process creates highly standardized goods or services, usually around the clock in very high volumes.

- **Characteristics:** not made from discrete parts, very high volumes in a fixed processing sequence, high investment in system, 24-hour/7-day continuous operation, automated, dedicated to a small range of goods or services.

- **Examples:** chemical, gasoline, paint, toy, steel factories; electronic funds transfer, credit card authorizations, and automated car wash.
## Exhibit 7.1

### Characteristics of Different Process Types

<table>
<thead>
<tr>
<th>Type of Process</th>
<th>Characteristics</th>
<th>Goods and Services Examples</th>
<th>Type of Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROJECT</td>
<td>One-of-a-kind</td>
<td>Space shuttle, cruise ships</td>
<td>Custom or Make-to-Order</td>
</tr>
<tr>
<td></td>
<td>Large scale, complex</td>
<td>Dams, bridges</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resources brought to the site</td>
<td>Skyscrapers, weddings, consulting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wide variation in specifications or tasks</td>
<td>Custom jewelry, surgery</td>
<td></td>
</tr>
<tr>
<td>JOB SHOP</td>
<td>Significant setup and/or changeover time</td>
<td>Automobile engines</td>
<td>Option or Assemble-to-Order</td>
</tr>
<tr>
<td></td>
<td>Low to moderate volume</td>
<td>Machine tools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Batching (small to large jobs)</td>
<td>Orders from small customers, mortgages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many process routes with some repetitive steps</td>
<td>Slices, hospital care</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Customized design to customer’s specifications</td>
<td>Commercial printing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many different products</td>
<td>Heavy equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High work force skills</td>
<td>Legal services</td>
<td></td>
</tr>
<tr>
<td>FLOW SHOP</td>
<td>Little or no setup or change-over time</td>
<td>Insurance policies</td>
<td>Standardized or Make-to-Stock</td>
</tr>
<tr>
<td></td>
<td>Dedicated to a small range of goods or services that are highly similar</td>
<td>Cafeterias</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Similar sequence of process steps</td>
<td>Refrigerators, stock trades</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate to high volumes</td>
<td>Toys, furniture, lawn mowers</td>
<td></td>
</tr>
<tr>
<td>CONTINUOUS FLOW</td>
<td>Very high volumes in a fixed processing sequence</td>
<td>Gasoline, paint, memory chips, check posting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not made from discrete parts</td>
<td>Grain, chemicals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High investment in equipment and facility</td>
<td>Steel, paper</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dedicated to a small range of goods or services</td>
<td>Automated car wash</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Automated movement of goods or information between process steps</td>
<td>Credit card authorizations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 hour/7 day continuous operation</td>
<td>Steel, electronic funds transfer</td>
<td></td>
</tr>
</tbody>
</table>
Exhibit 7.2

Product-Process Matrix

- **OPERATIONS**
  - Process Choice Decision
  - with Example Process Characteristics
  - One-of-a-kind
  - Large scale
  - Complex
  - Wide variation of tasks
  - Resources to site
  - High setup time
  - Batching
  - Many process routes
  - Customized
  - Many different products
  - General high level skills
  - Low/no setup time
  - Highly similar products
  - Dominant line flow(s)
  - Specialized skills
  - High investment in equipment and facility
  - Not made from discrete parts
  - Automated
  - 24/7 continuous operation

- **MARKETING**
  - Demand (Volume)
  - High
  - Low
  - Type of Good
  - Custom Make-to-Order
  - Options Assemble-to-Order
  - Standardized Make-to-Stock

- **Flow Shops**
  - Off-the-Diagonal Position A

- **Job Shops**
  - Off-the-Diagonal Position B

- **Projects**
  - Continuous Flow
Process Choice in Services

- The product-process matrix does not transfer well to service businesses and processes.

- In the product-process matrix, product volume, the number of products, and the degree of standardization/customization determine the manufacturing process that should be used. This relationship between **volume** and **process** is not found in many service businesses.
For example, to meet increased volume, service businesses such as retail outlets, banks, and hotels have historically added capacity in the form of new stores, branch banks, and hotels (i.e., bricks and mortar) to meet demand, but do not change their processes.

So, new ways to think about services and their processes are needed, such as the Service Positioning Matrix.
Process Choice in Services

• A **pathway** is a unique route through a service system. Pathways can be customer- or provider-driven, depending on the level of control that the service firm wants to ensure.
Service Positioning Matrix

- The *service encounter activity sequence* consists of all the process steps and associated service encounters necessary to complete a service transaction and fulfill customer’s wants and needs.
### The Service Positioning Matrix

<table>
<thead>
<tr>
<th>Number of Pathways Built into the Service System Design by Management</th>
<th>Unique Not Repeatable</th>
<th>Customer’s Service Encounter Activity Sequence</th>
<th>Highly Repeatable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Few</td>
<td>Fulfillment of Customer Wants and Needs</td>
<td>Customer wants a high degree of freedom and decision making power to select a service encounter activity sequence</td>
<td>Customer wants a low degree of freedom and decision making power to select a service encounter activity sequence</td>
</tr>
<tr>
<td></td>
<td>Management Designed Service System Characteristics</td>
<td>Unique never to be repeated service encounter activity sequence</td>
<td>Low to moderately repeatable service encounter activity sequence</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>Many customer pathways</td>
<td>Highly repeatable service encounter activity sequence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Management designs a low degree of control into the service system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate number of customer pathways</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Management designs a moderate degree of control into the service system</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited number of customer pathways</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Management designs a high degree of control into the service system</td>
<td></td>
</tr>
</tbody>
</table>

Service Positioning Matrix

- **Customer-routed services** are those that offer customers broad freedom to select the pathways that are best suited for their immediate needs and wants, from many possible pathways through the service delivery system.

- The customer decides what path to take through the service delivery system with only minimal guidance from management.

- Examples include searching the Internet, museums, health clubs, and amusement parks.
Service Positioning Matrix

- **Provider-routed services** constrain customers to follow a very small number of possible and predefined pathways through the service system.

- A newspaper dispenser is an extreme example of a service system design with only one pathway, thus allowing a single service encounter activity sequence.

- Logging on to your secure online bank account is provider-routed.
Exhibit 7.3

The Service Positioning Matrix

<table>
<thead>
<tr>
<th>Fulfillment of Customer Wants and Needs</th>
<th>Unique Not Repeatable</th>
<th>Customer’s Service Encounter Activity Sequence</th>
<th>Highly Repeatable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management Designed Service System Characteristics</td>
<td>Customer wants a high degree of freedom and decision making power to select a service encounter activity sequence</td>
<td>Customer wants a moderate degree of freedom and decision making power to select a service encounter activity sequence</td>
<td>Customer wants a low degree of freedom and decision making power to select a service encounter activity sequence</td>
</tr>
<tr>
<td>Many</td>
<td>Unique never to be repeated service encounter activity sequence</td>
<td>Low to moderately repeatable service encounter activity sequence</td>
<td>Highly repeatable service encounter activity sequence</td>
</tr>
<tr>
<td>Few</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Service Positioning Matrix

The position along the horizontal axis of the Service-Positioning Matrix is described by the sequence of service encounters. It depends on two things:

1. **The degree of customer discretion, freedom, and decision-making power in selecting their service encounter activity sequence.**

Customers may want the opportunity to design their own unique service encounter activity sequence, in any order they choose.
Service Positioning Matrix

The position along the **horizontal axis** of the *Service Positioning Matrix* is described by the sequence of service encounters. It depends on two things:

2. *The degree of repeatability of the service encounter activity sequence.*

Service encounter repeatability refers to the frequency that a specific service encounter activity sequence is used by customers.
Service Positioning Matrix

The position along the *vertical axis* of the *Service Positioning Matrix* reflects the number of pathways built into the service system design by management. It depends on two things:

1. *The number of unique pathways (routes) that customers can take as they move through the service system during delivery of the service.*

2. *Management’s degree of control designed into the service delivery system.*
**Exhibit 7.3 The Service Positioning Matrix**

<table>
<thead>
<tr>
<th>Management Designed Service System Characteristics</th>
<th>Customer's Service Encounter Activity Sequence</th>
<th>Highly Repeateable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulfillment of Customer Wants and Needs</td>
<td>Customer wants a moderate degree of freedom and decision making power to select a service encounter activity sequence</td>
<td>Customer wants a low degree of freedom and decision making power to select a service encounter activity sequence</td>
</tr>
<tr>
<td>Many</td>
<td>Unique never to be repeated service encounter activity sequence</td>
<td>Highly repeatable service encounter activity sequence</td>
</tr>
<tr>
<td>Few</td>
<td>Unique never to be repeated service encounter activity sequence</td>
<td>Highly repeatable service encounter activity sequence</td>
</tr>
</tbody>
</table>

- Many customer pathways
- Management designs a low degree of control into the service system

- Moderate number of customer pathways
- Management designs a moderate degree of control into the service system

- Limited number of customer pathways
- Management designs a high degree of control into the service system

The hierarchy of work is defined as:

1. Task
2. Activity
3. Process
4. Value Chain

- A **task** is a specific unit of work required to create an output. An example is drilling a hole in a steel part or completing an invoice.

- An **activity** is a group of tasks (sometimes called a workstation) needed to create and deliver an intermediate or final output. Workstations might be a position on an assembly line, a manufacturing cell, or an office cubicle.

- **Value chain** and **process** have been previously defined.
A *process map (flowchart)* describes the sequence of all process activities and tasks necessary to create and deliver a desired output or outcome.

A process map can include the flow of goods, people, information, or other entities, as well as decisions that must be made and tasks that are performed.

Process maps document how work either is, or should be, accomplished, and how the transformation process creates value.

Process maps delineate the boundaries of a process. A *process boundary* is the beginning or end of a process.
• A **process flowchart** is the basis for value stream mapping, service blueprinting, and service maps.

• **Service blueprints** add a “line of visibility” that separates the back and front office (rooms) as shown in Exhibit 7.5.

• Many names are used for the analysis and development of process flowcharts, so don’t let corporate fads and buzzwords confuse you—the basics of process analysis don’t change, just the buzzwords and consultant’s sales pitch!
Automobile Repair
Flowchart

Exhibit 7.5
Value Stream Mapping

- The **value stream** refers to all value-added activities involved in designing, producing, and delivering goods and services to customers.

- A value stream map (VSM) shows the process flows in a manner similar to a traditional process flowchart or service blueprint.

- Traditional flowcharting, service blueprinting, and value stream mapping all try to analyze wait and process times, bottleneck work stations, process throughput, and so on.
Restaurant Order Posting and Fulfillment Process

Exhibit 7.6: Restaurant Order Posting and Fulfillment Process

- **Start**: Waiter places customer meal order on order board—assume zero time
- **Order waiting 5 minutes**
- **Chef picks up order and checks “Is it accurate?” 1 minute**
  - **Yes**: Chef stages raw material—4 minutes
  - **No**: Chef cooks meal 12 minutes
    - Chef stages raw material—4 minutes
    - Ovens—10 minutes

- **Order Arrival Rate**: No—recheck with waiter

- **Chef assembles order—3 minutes**

- **Prepared order waits for pickup—5 minutes**

- **Waiter picks up customer order—assume zero time**

**END**
Value Stream Mapping

• However, the difference between VSM and these other flowcharting and analysis approaches lies in that value stream maps highlight value-added versus non-value-added activities, and include costs associated with work activities for both value- and non-value added activities.

• That is, VSM tries to include the economics of the process on the flowcharts.

• There are many formats for VSM, such as Exhibit 7.7.
Exhibit 7.7

Value Stream Map for Restaurant Order Posting and Fulfillment Process

Value-Added Activities [VA]

Order waits on order board @ [5 minutes per order] *(1 hr/60 min) *[($5 per order) = $0.41

Chef picks up order and checks “Is it accurate?” @ [1 minute per order] *(1 hr/60 min) *[($30 per hour) = $0.50

If order is accurate, chef stages raw materials @ [4 minutes per order] *(1 hr/60 min) *[($30 per hour) = $2.00

Chef cooks meal using ovens @ [12 minutes per order] *(1 hr/60 min) *[($30 per hour) = $6.00 labor cost (10 minutes per order) *(1 hr/60 min) *[($10/hour oven cost) = $1.67 equipment cost Total labor + Oven Cost = $7.67

Chef Assembles order @ [3 minutes per order] *(1 hr/60 minutes) *[($30 per hour) = $1.50

Non-Value Added Activities [NVA]

Prepared order waits for waiter to pick up customer’s order @ [5 minutes per order] *(1 hr/60 min) *[($60 per hour) = $5.00

Total Time = 20 minutes (VA time) + 10 minutes (NVA time) = 30 minutes

Total Cost = $11.67 (VA cost) + $5.417 (NVA cost) = $17.087
Examples of **non-value-added activities** include:

- transferring materials between two nonadjacent workstations
- overproducing
- waiting for service or work to do
- not doing work correctly the first time
- requiring multiple approvals for a low cost electronic transaction

Eliminating non-value-added activities in a process design is one of the most important responsibilities of operations managers (see Chapter 17 on Lean Operating Systems).
1. Define the purpose and objectives of the process.

2. Create a detailed process or value stream map that describes how the process is currently performed.

3. Evaluate alternative process designs. Identify and define appropriate performance measures for the process.

4. Select the appropriate equipment and technology.

5. Develop an implementation plan to introduce the new or revised process design.
Process Analysis and Improvement

Few processes are designed from scratch. Many process design activities involve redesigning an existing process to improve performance. Management strategies to improve process designs usually focus on one or more of the following:

- Increasing revenue by improving process efficiency in creating goods and services and delivery of the customer benefit package.
- Increasing agility by improving flexibility and response to changes in demand and customer expectations.
Process Analysis and Improvement

Management strategies to improve process designs usually focus on one or more of the following (continued from previous slide):

- Increasing product and/or service quality by reducing defects, mistakes, failures, or service upsets.
- Decreasing costs through better technology or elimination of non-value-added activities.
- Decreasing process flow time by reducing waiting time or speeding up movement through the process and value chain.
Reengineering and Creative Destruction

• **Reengineering** has been defined as “the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed.”
Process Design and Resource Utilization

- **Utilization** is the fraction of time a workstation or individual is busy over the long run.

- Understanding resource utilization is an important aspect of process design and improvement.

Utilization \( (U) = \frac{\text{Resources Demanded}}{\text{Resource Availability}} \) \[7.1\]
Process Design and Resource Utilization

\[ U = \text{Demand Rate}/[\text{Service Rate} \times \text{Number of Servers}] \]

\[ U = \text{DR} / [(\text{SR})(\text{NS})] \quad [7.2] \]

• If you know any three of the four variables in Equation 7.2, you can solve for the 4th!
An inspection station for assembling printers receives 40 printers/hour and has two inspectors, each of whom can inspect 30 printers per hour. What is the utilization of the inspectors? What service rate would be required to have a target utilization of 85 percent?

**Solution:**

The labor utilization at this inspection station is calculated to be $40/(2 \times 30) = 67\%$. If the utilization rate is 85\%, we can calculate the target service rate by solving the equation:

\[
85\% = \frac{40}{2 \times SR}
\]

\[
1.7 \times SR = 40
\]

\[
SR = 23.5 \text{ printers/hour}
\]
Exhibit 7.6
Restaurant Order Posting and Fulfillment Process

Start
Order Arrival Rate

Waiter places customer meal order on order board—assume zero time

Order waits 5 minutes

Order waits 5 minutes

Chef picks up order and checks “Is it accurate?” 1 minute

Chef stages raw material—4 minutes

Chef cooks meal 12 minutes

Ovens—10 minutes

No—recheck with waiter

Yes

Chef assembles order—3 minutes

Prepared order waits for pickup—5 minutes

Waiter picks up customer order—assume zero time

END
### Exhibit 7.8

**Utilization Analysis of Restaurant Order Posting and Fulfillment Process**

<table>
<thead>
<tr>
<th>Work Activity #1</th>
<th>Work Activity #2</th>
<th>Work Activity #3</th>
<th>Work Activity #4</th>
<th>Work Activity #5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Chef decides if order is accurate)</strong></td>
<td><strong>(Chef stages raw materials)</strong></td>
<td><strong>(Chef prepares side dishes)</strong></td>
<td><strong>(Oven operation)</strong></td>
<td><strong>(Chef assembles order)</strong></td>
</tr>
<tr>
<td>Order arrival rate (given)</td>
<td>20 orders/hr</td>
<td>20 orders/hr</td>
<td>20 orders/hr</td>
<td>20 orders/hr</td>
</tr>
<tr>
<td>Time per order</td>
<td>1 minute</td>
<td>4 minutes</td>
<td>12 minutes</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Number of resources</td>
<td>1 chef</td>
<td>1 chef</td>
<td>1 chef</td>
<td>2 ovens</td>
</tr>
<tr>
<td>Output per time period</td>
<td>60 orders/hr</td>
<td>15 orders/hr</td>
<td>5 orders/hr</td>
<td>12 orders/hr</td>
</tr>
<tr>
<td>Resource utilization with 1 chef and 2 ovens</td>
<td>33%</td>
<td>133%</td>
<td>400%</td>
<td>167%</td>
</tr>
</tbody>
</table>
• The average number of entities completed per unit time—the output rate—from a process is called **throughput**.

• **Throughput** might be measured as parts per day, transactions per minute, or customers per hour, depending on the context.

• A *bottleneck* is the work activity that effectively limits throughput of the entire process.

• Where's the bottleneck work activity in Exhibits 7.6 and 7.8?
### Exhibit 7.9

Revised Utilization Analysis of Restaurant Order Posting and Fulfillment Process (4 chefs)

<table>
<thead>
<tr>
<th>Work Activity #1 (Chef decides if order is accurate)</th>
<th>Work Activity #2 (Chef stages raw materials)</th>
<th>Work Activity #3 (Chef prepares side dishes)</th>
<th>Work Activity #4 (Oven operation)</th>
<th>Work Activity #5 (Chef assembles order)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource utilization with 4 chefs and 2 ovens</td>
<td>8.33%</td>
<td>33%</td>
<td>100%</td>
<td>167%</td>
</tr>
</tbody>
</table>
### Exhibit 7.10
Revised Utilization Analysis of Restaurant Order Posting and Fulfillment Process (4 ovens)

<table>
<thead>
<tr>
<th>Work Activity #1</th>
<th>Work Activity #2</th>
<th>Work Activity #3</th>
<th>Work Activity #4</th>
<th>Work Activity #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Chef decides</td>
<td>(Chef stages</td>
<td>(Chef prepares</td>
<td>(Oven operation)</td>
<td>(Chef assembles</td>
</tr>
<tr>
<td>if order is</td>
<td>raw materials)</td>
<td>side dishes)</td>
<td></td>
<td>order)</td>
</tr>
<tr>
<td>accurate)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order arrival</td>
<td>20 orders/hr</td>
<td>20 orders/hr</td>
<td>20 orders/hr</td>
<td>20 orders/hr</td>
</tr>
<tr>
<td>rate (given)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time per order</td>
<td>1 minute</td>
<td>4 minutes</td>
<td>12 minutes</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Number of</td>
<td>4 chefs</td>
<td>4 chefs</td>
<td>4 chefs</td>
<td>4 ovens</td>
</tr>
<tr>
<td>resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output per time</td>
<td>240 orders/hr</td>
<td>60 orders/hr</td>
<td>20 orders/hr</td>
<td>24 orders/hr</td>
</tr>
<tr>
<td>period</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource</td>
<td>8.33%</td>
<td>33%</td>
<td>100%</td>
<td>83%</td>
</tr>
<tr>
<td>utilization with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>ovens</td>
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Exhibit 7.11
Simplified Restaurant Fulfillment Process

Work Activity 1 240/hour

Work Activity 2 60/hour

Work Activity 3 20/hour

Work Activity 4 24/hour

Work Activity 5 80/hour
Little’s Law is a simple formula that explains the relationship among flow time ($T$), throughput ($R$) and work-in-process ($WIP$).

**WORK-IN-PROCESS = THROUGHPUT $\times$ FLOW TIME**

or

$$WIP = R \times T \quad [7.3]$$

- **Flow time**, or **cycle time**, is the average time it takes to complete one cycle of a process.
- Little’s Law provides a simple way of evaluating average process performance.
- If we know any two of the three variables, we can compute the third using Little's Law.