**Chapter – 4**

**Overview of operational planning activates**

Every organization must plan its’ activates at several level and operate these as a system. The time dimension is shown as long, intermediate and short range.

**Long-range planning**: is generally done once a year, focusing on a time horizon that is usually greater than a year. The length of the time horizon will vary from industry to industry. For those industries that require many years to plan and construct plants and facilities, and to install specific process (e.g. refiners), the time horizon will vary may be 5 to 10 or more years. For other industries where the ability to expand capacity is shorter (e.g. clothing manufacturing and many service industries), the time horizon may be 2 to 5 years or less.

**Intermediate-range planning**: usually covers the period from 6 to 18 months in the future, with time dimension or “buckets” that are monthly and or quarterly. (the near-term time increments are often monthly, whereas those that the end of the time horizon tend to be quarterly, as these are usually less accurate). Intermediate - range planning is typically re-viewed and updated quarterly.

**Short-range planning:** covers the period from one day to six months, with the time increment usually being weekly as with long-range planning, the length of the time horizon for intermediate and short- range planning will vary from industry to industry.

**Aggregate production planning**

Again, aggrergate production planning is concerned with setting production rates by product group or other broad categories for the intermediate term (6 to 18 months).

The main purpose of the aggregate plan is to specify that combination of production rate, workforce level, and the resulting inventory on hand or backlogs that both minimizes costs (efficiency) and satisfies the forecasted demand (effectiveness).production rate refers to the quantity of product competed per unit of time (such as VCRs per hour or automobiles per day).

**Workforce level** is the number of workers needed for production. When the number of units produced in any given period exceeds demand, the result is an inventory on hand of the product. When demand exceeds production, the result is **a backlog (stockout),** which represents the shortfall. Both inventories and backlogs are carried forward to the next time period, howevr, there can be situations when stockouts are not carried forward because the customer decided to purchase the product elsewhere rather than wait.

**Production planning strategies**

There are essentially three production strategies. These strategies involve tradeoffs among workforce size, work hours, inventory and other backlogs. When there is a need to adjust the workforce on a regular basis, many firms will maintain a nucleus of full-time employees, which is then increased as required with temporary workers, who are often hired through an employment agency. Those temporary workers who performed well then hired on a full- time basis as the need arises.

1. **Chase strategy**: match the production rate to meet the order rate by hiring and laying off employees as the order rate varies. There are obvious motivational issue with this starategy.when order backlogs are low, employees may feel compelled to slow down out of fear of being laid off as soon as existing orders are completed.
2. **Stable workforce** - variable work hours: vary the output by varying the number of hours worked through flexible work schedule or overtime. By varying the number of work hours, production quantities can be matched, with in limits, to existing orders. This strategy provides workforce continuity and avoids many of the emotional and tangible costs of hiring and firing personnel that are associated with that chase.
3. **Level strategy**: maintain a stable workforce working at a constant output rate. Shortages and surplus are absorbed by fluctuating inventory level, order backlogs, and lost sales. Employees benefit from stable work hours, but inventory costs are increased. Another concern is the possibility of inventoried products becoming obsolete.

**Scheduling and sequencing jobs**

**Scheduling is** establishing the timing of the use of equipment, facilities and human activities in an organization. Is a time table for performing activities, utilizing reassure or allocate facilities. Scheduling occur in any organization regardless of the nature of its activities.

E.g. -.manufacturing schedule production, educational institution schedule classroom, instruction students and service provider scheduled appointments.

**Effective scheduling can yield**

* Cost savings
* Increases in productivity
* Jobs completed on time
* Company competitive advantage in terms of customer service.
* In educational institution effective scheduling reduce the need for expansion
* In hospital effective scheduling can save life& improve patient care.

**Goals of scheduling**

* Efficient utilization of staff, equipment and facilities
* Minimization of customer waiting time, inventories and processing time

**Sequencing**

* Sequencing is determining the order in which jobs at a work center will be processed.
* It is concerned with determining job processing order.
* Sequencing determines both the order in which jobs are processed at various work centers and the order in which jobs are processed at individual workstations within the work centers.
* If relatively lengthy jobs are involved, the order of processing can be very important in terms of costs associated with jobs waiting for processing and in terms of idle time at the work centers.
* In using this rules, job processing times and due dates are important pieces of information. Job time usually includes setup and processing times.

**Assumptions of priority rules:**

* The set of jobs is known;
* no new jobs arrive after processing begins
* No jobs canceled.
* Setup time is independent of processing sequence
* There will be no interruption in processing such as machine breakdowns, accidents, or worker illness.
* Job flow time: this is the length of time that a job is at a particular workstation or work center.

 It includes; Actual processing time, Any time waiting to be processed, Transportation times between operations, Any waiting time related to equipment breakdowns, Unavailable parts, and Quality problems and son on.

* Job flow time is the length of time that begins when a job arrives at the shop, workstation, or work center, and ends when it leaves the shop, workstation, or work center,
* The average flow time for a group of jobs is equal to the total flow time for the jobs divided by the number of jobs.
* **Job lateness (job tardiness):** this is the length of time the job completion date is expected to exceed the date that the job was due or promised to a customer.
* It is the difference between the actual completion time and the due date.

Average number of jobs: jobs that are in a shop are considered to be work-in-process inventory. The average work-in-process for a group of jobs can be computed using the following formula. Average number of jobs = total flow time/make span.

**Priority rules for allocating Jobs to machines**

The process of determine which job is started first on a particular machines or work center is known as sequencing or priority sequencing. Priority rules are the criteria by which the sequence of jobs is determined.

These can be very simple, requiring only that jobs be sequenced according to one piece of data, such as processing time, due date, or order of arrivals. Ten of the more common priority rules for sequencing jobs are.

1. **FCFS**: first come, first served. Orders are run in the order that they arrive in the department.
2. **SPT**- shortest processing time. Run the jobs with the shortest completion time first, next shortest second, and so on. This is identical to SOT- shortest operating time.
3. **Due date**- earlest due date first. Run the job with the earliest due date first.
4. **Start date-** due date minus normal lead time. Run the job with earliest start date first.
5. **STR-**slack time remaining; this is calculated as the difference between the time remaining before the due date minus the processing time remaining. Orders with the shortest STR are run first.
6. **STR/OP-** slack time remain per operation. Order with shortest STR/OP are run first, calculated as follows

 **STR/OP =** time remaining before due date – remaining processing time

 Number of remaining operations

1. CR critical ratio: this is calculated as the difference between the due date and the current date divided by the work remaining. Order with the smallest CR is run first.
2. QR queue ratio: this is calculated as the slack time remaining in the schedule divided by the planned remaining queue time. Orders with the smallest QR are first.
3. LCFS, last come, first served: this is rule occurs frequently by default. As orders arrive they are placed on the top of the slack and the operator usually picks up the order on top to run first.
4. Random order-whim: the supervisor or the operator usually select whichever job they feel like running.

**Scheduling in jobs on one machine**

Consider the following examples: Ioannis Kyriakides is the supervisor of legal copy express, which provides copy services for L.A. law firms in the down town Los Angeles area. Five customers submitted their order at the beginning of the week. Specific scheduling data on these orders are as follows.

|  |  |  |
| --- | --- | --- |
| Job(in order of arrival) | Processing time(days) | Due date(days) |
| A | 3 | 5 |
| B | 4 | 6 |
| C | 2 | 7 |
| D | 6 | 9 |
| E | 1 | 2 |

1. **FCFS rule**

|  |  |  |  |
| --- | --- | --- | --- |
| job | Processing time(in day) | Due date(in days) | Flow time(in days) |
| Start job time finish |
| A | 3 | 5 | 0 + 3 = 3 |
| B | 4 | 6 | 3 + 4 = 7 |
| C | 2 | 7 | 7 + 2 = 9 |
| D | 6 | 9 | 9 + 6 = 15 |
| E | 1 | 2 | 15 + 1 = 16 |

**Total flow time = 3+ 7+ 9 + 15 + 16 = 50 days**

**Mean flow time = 50/5 = 10 days**

Comparing the due date of each job with its flow time, we observe that only Job A will be on time. Job B, C, D and E will be late by 1, 2, 6 and 14 days, respectively. On the average a job will be late by (0 + 1 + 2 + 6 + 14)/5 = 4.6 days.

1. **SPT rules**

|  |  |  |  |
| --- | --- | --- | --- |
| job | Processing time | Due date | Flow time |
| E | 1 | 2 | 0 + 1 = 1 |
| C | 2 | 7 | 1 + 2 = 3 |
| A | 3 | 5 | 3 + 3 = 6 |
| B | 4 | 6 | 6 + 4 = 10 |
| D | 6 | 9 | 10 + 6 = 16 |

**Total flow time = 1+3+6+10+16= 36 days**

**Mean flow time + 36/5 = 7.2 days**

SPT results in lower average flow time. In addition Job E and C will be ready before the due date and Job A is late by only one day. On the average a job will be late by (0+0+1+4+7)/5 = 2.4 days

1. **Due date rules**

|  |  |  |  |
| --- | --- | --- | --- |
| **Job**  | **Processing time** | **Due date** | **Flow time** |
| E | 1 | 2 | 0+1=1 |
| A | 3 | 5 | 1 +3=4 |
| B | 4 | 6 | 4+4=8 |
| C | 2 | 7 | 8+2=10 |
| D | 6 | 9 | 10+6=16 |

**Total completion time= 1+4+8+10+16= 39 days**

**Men flow time= 7.8 days**

In this case jobs B, C and D will be late. On average a job will be late by (0+0+2+3+7)/5=2.4 days.

1. **LCFS rules**

|  |  |  |  |
| --- | --- | --- | --- |
| **Job** | **Processing time**  | **Due date**  | **Flow time**  |
| E | 1 | 2 | 0+1=1 |
| D | 6 | 9 | 1+6=7 |
| C | 2 | 7 | 7+2=9 |
| B | 4 | 6 | 9+4=13 |
| A | 3 | 5 | 13+3=16 |

**Total flow time = 46 days**

**Mean flow time= 9.2 days average day late=4 day**

1. **Random schedule**

|  |  |  |  |
| --- | --- | --- | --- |
| **Job** | **Processing time**  | **Due date** | **Flow time** |
| D | 6 | 9 | 0+6=6 |
| C | 2 | 7 | 6+2=8 |
| A | 3 | 5 | 8+3=11 |
| E | 1 | 2 | 11+1=12 |
| B | 4 | 6 | 12+4=16 |

**Total flow time = 53 days**

**Mean flow time = 10.6 days Average day late 5.4 days**

1. **STR schedule**

|  |  |  |  |
| --- | --- | --- | --- |
| **Job** | **Processing time**  | **Due date** | **Flow time** |
| E | 1 | 2 | 0+1=1 |
| A | 3 | 5 | 1+3=4 |
| B | 4 | 6 | 4+4=8 |
| D | 6 | 9 | 8+6=14 |
| C | 2 | 7 | 14+2=16 |

**Total flow time = 43 days**

**Mean flow time = 8.6 days Average day late = 3.2 days.**

**Scheduling n jobs on two machines**

Johnson rule consist of the following steps

1. List the operation time for each job on both machines
2. Select the job with the shortest operation time
3. If the shortest time is for the first machines, do that job first, if the shortest time is for the second machines do the job last.
4. Repeat step 2 and 3 for each remaining job until the schedule is complete.

Example: we can illustrate the application of Johnson rule by scheduling four jobs through two machines.

Step1. List operation time

|  |  |  |
| --- | --- | --- |
| job | Operation time machine 1 | Operation time machine 2 |
| A | 3 | 2 |
| B | 6 | 8 |
| C | 5 | 6 |
| D | 7 | 4 |

**Step 2 and 3: select shortest operation time and assign.**

Job A is shortest on machine 2 and is assigned first and performed last.(job A is now no longer available to be scheduled).

**4. Repeat step 2 and 3 until completion of schedule**

Select the shortest operation time among the remaining jobs. Job D is second shortest on machine 2, thus it is performed second to last (remember job A is last). Now job A and D are not available any more for scheduling. Job C is the shortest on machine 1 among the remaining jobs. Job C is performed first. Now, only job B is left with the shortest operation time on machine 1. Thus according to step 3, it is performed first among the remaining 0r second overall (job C was already scheduled first).

In summary, the solution sequence is C B D A