



Optimizing Manpower Planning for Efficient Resource Allocation

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Introduction



Background

Importance

Background

Manpower planning is a strategic process that involves forecasting and managing an organization's workforce to meet its objectives.

It involves analyzing current and future labor needs, determining the required skills and competencies, and developing strategies to acquire, develop, and retain the right talent.

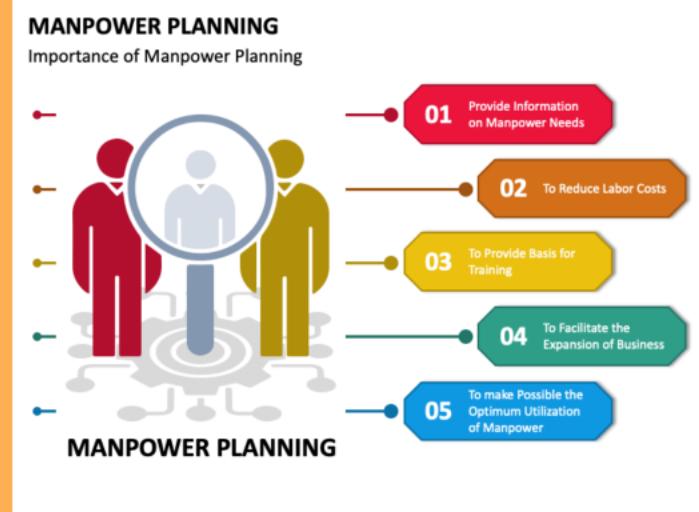
Manpower planning considers factors such as industry trends, technological advancements, economic conditions, and changing customer demands.

It aims to ensure that the organization has the right number of employees with the necessary skills, at the right time and place, to achieve its goals.



Importance

- Rapid technological advancements
- Changing market dynamics
- Cost optimization
- Workforce diversity and inclusion
- Talent retention and development
- Strategic decision-making
- Future readiness



Problem Description

Business Transformation:

The company is undergoing a significant change in how it operates its business and is expected to purchase new machinery.

Analysis of the situation:

- Shift from unskilled labor to skilled and semi-skilled labor.
- Economic slowdown will further reduce labor requirements.
- Adaptation and upskilling of the workforce will be essential.

Forecast

Objectives

Forecast

Labor

	Unskilled	Semi-skilled	Skilled
Current Strength	2000	1500	1000
Year 1	1000	1400	1000
Year 2	500	2000	1500
Year 3	0	2500	2000

Recruitment

Unskilled	Semi-skilled	Skilled
500	800	500

Lay-off

Unskilled	Semi-Skilled	Skilled
\$200	\$500	\$500

Attrition Rates

	Unskilled (%)	Semi-skilled (%)	Skilled (%)
< 1 year of service	25	20	10
≥ 1 year of service	10	5	5

Retraining

Unskilled to Semi-Skilled	Semi-skilled to skilled	Cost
200		\$400
	Max 25% of current skilled force	\$500

Downgrading Skill

50% of downgraded workers will leave

Excess Employees (max 150 overall)

Unskilled	Semi-skilled	Skilled
\$1500	\$2000	\$3000

Part-Time Workers (max 50 each)

Unskilled	Semi-skilled	Skilled
\$500	\$400	\$400

Objectives

Minimize layoffs:

Determine the plan that minimizes the number of employees being laid off.

Minimize costs:

Determine the plan that minimizes the costs.

Model Formulation

Workforce Planning



Parameters

Decision
Variables

Objectives

Constraints

Parameters

rookie_attrition [0,1]: Percentage of workers who leave within the first year of service.

veteran_attrition [0,1]: Percentage of workers who leave after the first year of service.

demoted_attrition [0,1]: Percentage of workers who leave the company after a demotion.

parttime_cap [0,1]: Productivity of part-time workers with respect to full-time workers.

max_train_unskilled: Maximum number of unskilled workers that can be trained on any given year.

max_train_semiskilled[0,1]: Maximum proportion of semi-skilled workers (w.r.t. skilled ones) that can be trained on any given year.

max_parttime: Maximum number of part-time workers of each skill at any given year.

max_overmanning: Maximum number of overmanned workers at any given year.

max_hiring: Maximum number of workers of skill that can be hired any given year.

training_cost: Cost for training a worker of skill to the next level.

layoff_cost: Cost for laying off a worker of skill

parttime_cost: Cost for assigning a worker of skill to part-time work.

overmanning_cost: Yearly cost for having excess manpower of skill

curr_workforce: Current manpower of skill at the beginning of the planning horizon.

demand: Required manpower of skill in year

Decision Variables

hire [0,max_hiring]: Number of workers of skill s to hire in year t.

part_time [0,max_parttime]: Number of part-time workers of skill s working in year t .

workforce: Number of workers of skill s that are available in year t .

layoff: Number of workers of skill s that are laid off in year t .

excess: Number of workers of skill s that are overmanned in year t .

train: Number of workers of skill s to retrain to skill s' in year .

Objectives

Integer Linear Programming

- **Layoffs:** Minimize the total layoffs during the planning horizon.

$$\text{Minimize } Z = \sum_{t \in \text{Years}} \sum_{s \in \text{Skills}} \text{layoff}_{t,s}$$

- **Cost:** Minimize the total cost (in USD) incurred by training, overmanning, part-time workers, and layoffs in the planning horizon.

$$\begin{aligned} \text{Minimize } W = & \sum_{t \in \text{Years}} \{ \text{training_cost}_{s_1} * \text{train}_{t,s1,s2} + \text{training_cost}_{s_2} * \text{train}_{t,s2,s3} \} \\ & + \sum_{t \in \text{Years}} \sum_{s \in \text{Skills}} \{ \text{parttime_cost} * \text{part_time}_{t,s} + \text{layoff_cost}_s * \text{layoff}_{t,s} + \text{overmanning_cost}_s * \text{excess}_{t,s} \} \end{aligned}$$

Constraints

- **Unskilled Training:** Unskilled workers trained in year t cannot exceed the maximum allowance. Unskilled workers cannot be immediately transformed into skilled workers.

$$\text{train}_{t,s_1,s_2} \leq 200 \quad \forall t \in \text{Years}$$

$$\text{train}_{t,s_1,s_3} = 0 \quad \forall t \in \text{Years}$$

- **Semi-skilled Training:** Semi-skilled workers trained in year t cannot exceed the maximum allowance.

$$\text{train}_{t,s_2,s_3} \leq 0.25 * \text{available}_{t,s_3} \quad \forall t \in \text{Years}$$

- **Overmanning:** Excess workers in year t cannot exceed the maximum allowance.

$$\sum_{s \in \text{Skills}} \text{excess}_{t,s} \leq \text{max_overmanning} \quad \forall t \in \text{Years}$$

- **Demand:** Workforce s available in year t equals the required number of workers plus the excess workers and the part-time workers.

$$\text{available}_{t,s} = \text{demand}_{t,s} + \text{excess}_{t,s} + \text{parttime_cap} * \text{part_time}_{t,s} \quad \forall (t, s) \in \text{Years} \times \text{Skills}$$

Continuation

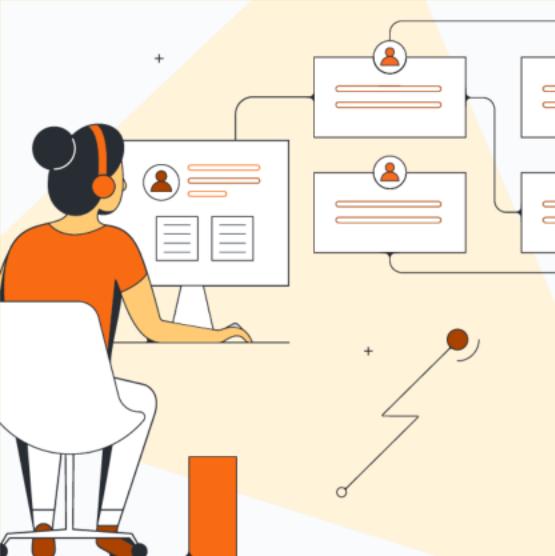
- **Initial Balance:** Workforce s available in year $t = 1$ is equal to the workforce of the previous year, recent hires, promoted and demoted workers (after accounting for attrition), minus layoffs and transferred workers.

$$\begin{aligned} \text{workforce}_{1,s} &= (1 - \text{veteran_attrition}_s) * \text{curr_workforce} + (1 - \text{rookie_attrition}_s) * \text{hire}_{1,s} \\ &\quad + \sum_{s' \in \text{Skills} | s' < s} \{(1 - \text{veteran_attrition}) * \text{train}_{1,s',s} - \text{train}_{1,s,s'}\} \\ &\quad + \sum_{s' \in \text{Skills} | s' > s} \{(1 - \text{demoted_attrition}) * \text{train}_{1,s',s} - \text{train}_{1,s,s'}\} - \text{layoff}_{1,s} \quad \forall s \in \text{Skills} \end{aligned}$$

- **Balance:** Workforce s available in year $t > 1$ is equal to the workforce of the previous year, recent hires, promoted and demoted workers (after accounting for attrition), minus layoffs and transferred workers.

$$\begin{aligned} \text{workforce}_{t,s} &= (1 - \text{veteran_attrition}_s) * \text{workforce}_{t-1,s} + (1 - \text{rookie_attrition}_s) * \text{hire}_{t,s} \\ &\quad + \sum_{s' \in \text{Skills} | s' < s} \{(1 - \text{veteran_attrition}) * \text{train}_{t,s',s} - \text{train}_{t,s,s'}\} \\ &\quad + \sum_{s' \in \text{Skills} | s' > s} \{(1 - \text{demotion_attrition}) * \text{train}_{t,s',s} - \text{train}_{t,s,s'}\} - \text{layoff}_{t,s} \quad \forall (t > 1, s) \in \text{Years} \times \text{Skills} \end{aligned}$$

Results



Minimizing
Layoffs

Minimizing
Cost

Minimizing Layoffs

Minimum No of Layoff: 843

Hiring Plan

	s1	s2	s3
1	0.0	0.0	2.0
2	0.0	654.0	495.0
3	0.0	690.0	500.0

Training and Demotions Plan

	s1 to s2	s1 to s3	s2 to s1	s2 to s3	s3 to s1	s3 to s2
1	200.0	0.0	0.0	256.0	0.0	170.0
2	200.0	0.0	0.0	85.0	0.0	0.0
3	200.0	0.0	1.0	140.0	0.0	0.0

Layoffs Plan

	s1	s2	s3
1	450.0	0.0	0.0
2	160.0	0.0	0.0
3	233.0	0.0	0.0

Part-time Plan

	s1	s2	s3
1	46.0	50.0	50.0
2	50.0	0.0	0.0
3	50.0	2.0	16.0

Overmanning Plan

	s1	s2	s3
1	127.0	19.0	0.0
2	150.0	0.0	0.0
3	150.0	0.0	0.0

Total cost: \$1,447,800

Minimizing Cost

No of Layoff: 1413

Hiring Plan

	s1	s2	s3
1	0.0	0.0	60.0
2	0.0	798.0	495.0
3	0.0	799.0	500.0

Training and Demotions Plan

	s1 to s2	s1 to s3	s2 to s1	s2 to s3	s3 to s1	s3 to s2
1	0.0	0.0	25.0	0.0	3.0	0.0
2	148.0	0.0	0.0	109.0	0.0	0.0
3	104.0	0.0	2.0	140.0	0.0	8.0

Layoffs Plan

	s1	s2	s3
1	814.0	0.0	0.0
2	252.0	0.0	0.0
3	347.0	0.0	0.0

Part-time Plan

	s1	s2	s3
1	0.0	0.0	2.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0

Overmanning Plan

	s1	s2	s3
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0

Total cost: \$508,700

Conclusion

Comparing the two objectives

	Objective		Difference	to minimize layoff
	Minimize Layoff	Minimize Cost		
Total Cost	1,447,800	508,700	939,100	to minimize layoff
Employees laid off	843	1413	570	to minimize cost
939,100/570=		1647.54386	cost per employee to retain them	



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