Optimization Model for Scrum-based Software Development

Sets and Indices

$t \in \mathcal{T}$	Teams
$e \in \mathcal{E}$	Employees
$k \in \mathcal{K}$	Tasks / Sub-Tasks
$s \in \mathcal{S}$	Sprints
$p \in \mathcal{P}$	Projects
$f \in \mathcal{F}$	Features

Decision Variables

$x_t \in \mathbb{Z}_{\geq 1},$	Assigned team size
$y_{e,s} \in \{0,1\},$	Employee e assigned to sprint s
$z_{k,e} \in \{0,1\},$	Task k assigned to employee e
$sp_s \in \mathbb{Z}_{\geq 0},$	Story points assigned to sprint s
$d_s \in \mathbb{Z}_{\geq 7}^{\leq 30},$	Duration of sprint s in days
$r_b \in \mathbb{Z}_{\geq 0}^{\leq 14},$	Resolution time for blocker b
$skl_t \in \mathbb{R}_{\geq 0}^{\leq 5},$	Average skill level in team t
$bu_p \in \mathbb{R}_{\geq 0}^{\leq B_p},$	Budget used for project p
$fp_{rp} \in \mathbb{Z}_{\geq 0},$	Number of features planned in release plan rp
$bl_{pb} \in \mathbb{Z}_{\geq 0},$	Number of backlog entries in product backlog pb

Objective Functions

Multi-objective form (weights w_i)

$$\begin{aligned}\max \quad & w_1 \sum_{p \in \mathcal{P}} \text{CompletionRate}_p - w_2 \sum_{p \in \mathcal{P}} \frac{\text{BudgetOverrun}_p}{B_p} + w_3 \sum_{t \in \mathcal{T}} skl_t + w_4 \sum_{s \in \mathcal{S}} \text{SprintGoalAchieved}_s \\ & - w_5 \sum_{k \in \mathcal{K}} \text{Blockers}_k + w_6 \sum_{st \in \mathcal{ST}} \text{StakeholderSatisfaction}_{st} \\ & - w_7 \text{TaskEffortVariance} + w_8 \sum_{t \in \mathcal{T}} \text{TeamStability}_t + w_9 \sum_{f \in \mathcal{F}} \text{DocumentationQuality}_f\end{aligned}$$

(Where $w_i \geq 0$ are scalar weights reflecting importance.)

Constraints

- **Project deadlines:**
$$\text{FinishDate}_p \leq \text{ProjectEnd}_p, \quad \forall p \in \mathcal{P}$$
- **Team size limit:**
$$x_t \leq \text{MaxTeamSize}, \quad \forall t \in \mathcal{T}$$
- **Employee availability:**
$$y_{e,s} = 0 \quad \text{if employee } e \text{ unavailable during sprint } s$$
- **Skill matching:**
$$z_{k,e} = 0 \quad \text{if employee } e \text{ lacks required skills for task } k$$
- **Sprint duration fixed:**
$$d_s = \text{FixedSprintDuration}, \quad \forall s \in \mathcal{S}$$
- **No overlapping sprint assignments for user stories:**
$$\sum_{s \in \mathcal{S}} y_{e,s} \leq 1, \quad \forall e \text{ assigned to a user story}$$
- **Task effort bounds:**
$$\text{Effort}_k^{min} \leq \text{Effort}_k \leq \text{Effort}_k^{max}, \quad \forall k \in \mathcal{K}$$
- **Blocker resolution time:**
$$r_b \leq \text{MaxResolutionTime}, \quad \forall b \in \mathcal{B}$$
- **Product Owner single backlog:**
$$\sum_{pb} \text{manages}(po, pb) = 1, \quad \forall po \in \mathcal{PO}$$
- **Scrum Master assigned:**
$$\sum_{sm} \text{supports}(t, sm) = 1, \quad \forall t \in \mathcal{T}$$

Additional Definitions

$$\text{CompletionRate}_p = \frac{\text{FeaturesCompleted}_p}{\text{TotalFeatures}_p}$$

$\text{BudgetOverrun}_p = \max(0, bu_p - B_p)$

$\text{SprintGoalAchieved}_s \in \{0, 1\}$ indicator variable for sprint goal success

Blockers_k = number of blockers associated with task k

TaskEffortVariance = variance of efforts across tasks

TeamStability_t = measure of team member retention during project

$\text{DocumentationQuality}_f$ = score based on feature documentation completeness