Scrum-Based Software Development: Optimization Model

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Contents

1 Introduction

This document formalizes the optimization model for a software development company using SCRUM, based on the provided domain model.

2 Sets (Entities)

- $\mathcal{P}$: Set of Projects
- $\mathcal{T}$: Set of Teams
- $\mathcal{W}$: Set of Workers
- $\mathcal{F}$: Set of Features
- $\mathcal{S}$: Set of Skills
- $\mathcal{R}$: Set of Roles
- $\mathcal{PO}$: Set of Product Owners

- $\mathcal{SM}$: Set of Scrum Masters
- $\mathcal{PB}$: Set of Product Backlogs
- $\mathcal{SP}$: Set of Sprints
- $\mathcal{SPP}$: Set of Sprint Plannings
- $\mathcal{DS}$: Set of Daily Scrums
- $\mathcal{SR}$: Set of Sprint Reviews
- $\mathcal{SRE}$: Set of Sprint Retrospectives
- $\mathcal{SBL}$: Set of Sprint Backlogs
- $\mathcal{SG}$: Set of Sprint Goals
- $\mathcal{E}$: Set of Epics
- $\mathcal{US}$: Set of User Stories
- $\mathcal{TSK}$: Set of Tasks
- $\mathcal{DEV}$: Set of Development Snapshots
- $\mathcal{BL}$: Set of Blockers
- $\mathcal{SH}$: Set of Stakeholders
- $\mathcal{VEL}$: Set of Velocities
- $\mathcal{REP}$: Set of Release Plans
- $\mathcal{RM}$: Set of Roadmaps
- $\mathcal{SCB}$: Set of Scrum Boards
- $\mathcal{FED}$: Set of Feature Documentations

3 Indices

- $p \in \mathcal{P}$
- $t \in \mathcal{T}$
- $w \in \mathcal{W}$
- $f \in \mathcal{F}$
- $s \in \mathcal{S}$
- $r \in \mathcal{R}$

- $po \in \mathcal{PO}$
- $sm \in \mathcal{SM}$
- $pb \in \mathcal{PB}$
- $sp \in \mathcal{SP}$
- $spp \in \mathcal{SPP}$
- $ds \in \mathcal{DS}$
- $sr \in \mathcal{SR}$
- $sre \in \mathcal{SRE}$
- $sbl \in \mathcal{SBL}$
- $sg \in \mathcal{SG}$
- $e \in \mathcal{E}$
- $us \in \mathcal{US}$
- $tsk \in \mathcal{TSK}$
- $dev \in \mathcal{DEV}$
- $bl \in \mathcal{BL}$
- $sh \in \mathcal{SH}$
- $vel \in \mathcal{VEL}$
- $rep \in \mathcal{REP}$
- $rm \in \mathcal{RM}$
- $scb \in \mathcal{SCB}$
- $fed \in \mathcal{FED}$

4 Goals

- **G0: maximize_team_velocity**

$$\text{Maximize} \sum_{t \in \mathcal{T}} \sum_{vel \in \mathcal{VEL}} vel_{avg\_story\_points} \cdot x_{t,vel}$$

- **G1: maximize_project_budget_utilization**

$$\text{Maximize} \sum_{p \in \mathcal{P}} \sum_{f \in \mathcal{F}} budget_{p,f} \cdot y_{p,f}$$

- **G2: maximize_sprint_goal_achievement**

$$\text{Maximize} \sum_{sp \in \mathcal{SP}} \sum_{sg \in \mathcal{SG}} achievement_{sg} \cdot z_{sp,sg}$$

- **G3: minimize_blocker_severity**

$$\text{Minimize} \sum_{bl \in \mathcal{BL}} severity_{bl} \cdot v_{bl}$$

- **G4: maximize_stakeholder_satisfaction**

$$\text{Maximize} \sum_{sh \in \mathcal{SH}} satisfaction_{sh} \cdot u_{sh}$$

- **G5: maximize_feature_completion**

$$\text{Maximize} \sum_{f \in \mathcal{F}} completion_f \cdot w_f$$

- **G6: minimize_sprint_overrun**

$$\text{Minimize} \sum_{sp \in \mathcal{SP}} overrun_{sp} \cdot x_{sp}$$

- **G7: maximize_worker_availability**

$$\text{Maximize} \sum_{w \in \mathcal{W}} availability_w \cdot y_w$$

- **G8: maximize_user_story_completion**

$$\text{Maximize} \sum_{us \in \mathcal{US}} completion_{us} \cdot z_{us}$$

- **G9: minimize_task_effort_overrun**

$$\text{Minimize} \sum_{tsk \in \mathcal{TSK}} overrun_{tsk} \cdot v_{tsk}$$

- **G10: maximize_epic_priority_completion**

$$\text{Maximize} \sum_{e \in \mathcal{E}} priority_e \cdot w_e$$

- **G11: maximize_velocity_trend**

$$\text{Maximize} \sum_{vel \in \mathcal{VEL}} trend_{vel} \cdot x_{vel}$$

5 Conditions

- **C0: team_size_limit**

$$\sum_{w \in \mathcal{W}} assign_{w,t} \leq 9 \quad \forall t \in \mathcal{T}$$

- **C1: project_budget_limit**

$$\sum_{f \in \mathcal{F}} budget_{p,f} \cdot y_{p,f} \leq budget_p \quad \forall p \in \mathcal{P}$$

- **C2: sprint_duration_fixed**

$$end_{sp} - start_{sp} = 14 \quad \forall sp \in \mathcal{SP}$$

- **C3: worker_skill_requirement**

$$\sum_{s \in \mathcal{S}} has_{w,s} \geq required_{tsk} \cdot assign_{w,tsk} \quad \forall w \in \mathcal{W}, tsk \in \mathcal{TSK}$$

- **C4: blocker_resolution_time**

$$resolved_{bl} - detected_{bl} \leq 2 \quad \forall bl \in \mathcal{BL}$$

- **C5: feature_documentation_required**

$$\sum_{fed \in \mathcal{FED}} documents_{fed,f} \geq 1 \quad \forall f \in \mathcal{F}$$

- **C6: scrum_master_experience**

$$experience_{sm} \geq 2 \quad \forall sm \in \mathcal{SM}$$

- **C7: user_story_priority**

$$priority_{us} \geq 3 \cdot select_{us,sbl} \quad \forall us \in \mathcal{US}, sbl \in \mathcal{SBL}$$

- **C8: release_plan_feature_limit**

$$\sum_{f \in \mathcal{F}} includes_{rep,f} \leq 5 \quad \forall rep \in \mathcal{REP}$$

- **C9: velocity_calculation**

$$number_{vel} = 3 \quad \forall vel \in \mathcal{VEL}$$

- **C10: roadmap_milestone_limit**

$$\sum_{m \in milestones_{rm}} 1 \geq 3 \quad \forall rm \in \mathcal{RM}$$

6 Decision Variables

- $x_{t,vel} \in \{0,1\}$: Assign velocity to team
- $y_{p,f} \in [0,1]$: Allocate budget to feature
- $z_{sp,sg} \in \{0,1\}$: Achieve sprint goal
- $v_{bl} \in \{0,1\}$: Blocker severity
- $u_{sh} \in \{1,2,3,4,5\}$: Stakeholder satisfaction
- $w_f \in \{0,1\}$: Feature completion
- $x_{sp} \in \{0,1\}$: Sprint overrun
- $y_w \in \{0,1\}$: Worker availability
- $z_{us} \in \{0,1\}$: User story completion
- $v_{tsk} \in \{0,1\}$: Task effort overrun
- $w_e \in \{0,1\}$: Epic priority completion
- $x_{vel} \in \{-1,0,1\}$: Velocity trend