Garment Production System

Functional Requirements Specification

Garment Production Tracking System is a single-user web application designed to digitize and streamline the existing Excel-based workflow for garment operation planning and analysis. The system allows the user to log in securely and manage all key production planning components — including **Operation Breakdown (OB)**, **Thread Consumption Report (TCR)**, and **Method Analysis (GSD)** — within a unified, structured interface. Every formula, lookup, and rule from the current Excel sheets is faithfully replicated to ensure accuracy and consistency in calculations such as **SMV**, **Target/hour**, **Operators Required**, and **Thread Consumption**.

Executive Summary

Build a minimal Garment Production tool that replicates, one-for-one, the logic and flows present in the Excel workbooks:

- **Operation Breakdown (OB):** per-operation SMV, machine selection from a fixed list, Plan Efficiency, Working Hours, Targets per hour/day, Operators Required.
- **Thread Consumption (TCR):** per operation consumption using machine factors and % distributions from reference tables.
- **Method Analysis:** GSD elemental breakdown that rolls up to SMV and needle/machine time percentages.
- **Masters:** Machines, Operations, Styles, and GSD/Thread factor libraries referenced by OB/TCR/Method sheets.

This spec defines only the **functional rules, validations, workflows, and data model (logical)** to mirror Excel. It excludes analytics, dashboards, exports, and any non-Excel features.

Scope & Non-Goals

In Scope:

1. Masters: **Machine Types**, **Operation Catalog**, **GSD Elements**, **Thread Factors**, **Styles**.
2. **OB Entry** with computed Targets (hour/day) and Operators Required using Plan Efficiency and Working Hours.
3. **TCR Entry** with machine-driven factor lookup and % split; per-operation consumption totals.

4. **Method Analysis** entry that sums GSD elements to SMV; display machine/needle time indicators.
5. Read-only summaries that match totals shown in the Excel sheets.

Non-Goals (not in R1):

- WIP, Bundles, Production Hourly, QA/DHU tracking, dispatch.
- Dashboards, exports, pivots, advanced planning, line balancing.
- Any costing beyond thread consumption arithmetic in TCR.

Glossary

- **Style:** Garment design record referenced by OB/TCR/Method.
- **Operation:** A sewing/assembly step with SMV.
- **SMV/SAM:** Standard Minutes per unit.
- **Plan Efficiency:** OB scalar applied to theoretical output.
- **Working Hours:** Shift length used for daily target.
- **Machine Type:** Sewing/finishing machine categories.
- **Thread Factor (/cm):** Machine-specific factor for thread per cm.
- **TCR:** Thread Consumption Report per operation.
- **GSD Element:** Motion element with standard time used to compute SMV.

User Roles & Permissions (minimal)

Role	Masters (Machines/Operations/GSD/Thread/Styles)	OB	TCR	Method Analysis	Approvals
IE	R/W	R/W	R/W	R/W	Submit/Approve OB, TCR, Method

Planner	R	R	R	R	—
Admin	R/W	R/W	R/W	R/W	Override/Approve

(R/W = create, edit, archive; Approvals are single-step "Approved" flags to lock versions)

Current Excel Logic → Business Rules Map

A) Operation Breakdown (OB)

Inputs (header):

- **Working Hours** (e.g., 8)
- **Target @100** (daily target at 100% efficiency)
- **Plan Efficiency** (0–1 scalar)

Per-row fields:

- Seq (int), Operation Name (text), Machine Type (from list), SMV (min) (number)

Derived (read-only, per row):

- **Target/Hr** = (60 / SMV) × PlanEfficiency
- **Target/Day** = Target/Hr × WorkingHours
- **Operators Required** = Target@100 / (Target/Hr × WorkingHours)

Validations:

- SMV > 0
- PlanEfficiency ∈ (0,1]
- WorkingHours ∈ [6..12]
- Machine Type ∈ Machine master list

Effects:

- OB totals show sums of Target/Day (info only).
- OB has a **Status**: Draft → Approved (locks edit).

B) Thread Consumption Report (TCR)

Inputs per row:

- Operation (reference)
- Machine Type (from list)
- Rows (int > 0)
- Seam Length (cm) (number > 0)

Lookups from Thread Factors (by Machine Type):

- FactorPerCm
- % Needle, % Bobbin, % Looper
- NeedleCount, LooperCount (if present)
- Optional allowances: Backtack (cm), End Waste (cm)

Derived (read-only, per row):

- **Consumption / Operation (cm)** = Rows × SeamLenCm × FactorPerCm
- Split by path (if present):
  Needle_cm = Total_cm × %Needle
  Bobbin_cm = Total_cm × %Bobbin
  Looper_cm = Total_cm × %Looper
- If allowances are present and Excel applies them:
  AdjSeamLen = SeamLenCm + Backtack + EndWaste → use AdjSeamLen in place of SeamLenCm.

Validations:

- Machine Type in master list.
- Rows ≥ 1, SeamLenCm > 0, FactorPerCm > 0.
- % splits must sum to ≤ 1.0 (warn if <1.0; allow if some paths unused).

Effects:

- Row totals and overall totals mirror Excel TCR.

C) Method Analysis

Header fields:

- Operation (reference), Product, Fabric, Stitch Length, SPI, Speed, Layers, Machine Type

Elements table rows:

- GSD Element (from library), Count (int ≥ 1), Time (sec) (numeric), Allowance (sec) (optional)

Derived (read-only):

- **SMV (min)** = Σ(Time + Allowance) / 60
- **Machine Time (sec)** (if present in Excel) and **Needle Time %** displayed as in sheet; if Excel computes NeedleTime% = MachineTime / TotalTime, follow same.

Validations:

- All elements must exist in **GSD Elements** library.
- Numeric fields ≥ 0; SPI, Speed, Layers positive where relevant.

Effects:

- When Method SMV present, show comparison to OB SMV (delta = OB.SMV − Method.SMV) without enforcing replacement (Excel parity).

D) Masters (as referenced in sheets)

- **Machine Types:** Code, Name; must cover list used in OB/TCR.
- **Operation Catalog:** Optional code, name, category; used to populate OB rows.
- **GSD Elements:** Code, Category, Description, Standard times and conditional variants (5/15/30); selectable in Method Analysis.
- **Thread Factors:** For each Machine Type: FactorPerCm, counts, % splits, and any allowance constants used in TCR.
- **Styles:** Identifier, description fields referenced in OB/TCR/Method headers.

Domain Entities & Logical Data Model

(Logical only; implementation-agnostic)

Style(style_id, code, description, product, fabric, spi, stitch_len)
OperationCatalog(operation_id, code, name, category, default_machine_type)

MachineType(machine_type_id, code, name, active)
ThreadFactor(thread_factor_id, machine_type_id → MachineType, factor_per_cm, needle_count, looper_count, pct_needle, pct_bobbin, pct_looper, backtack_cm, end_waste_cm, active)
OB(ob_id, style_id → Style, plan_efficiency, working_hours, target_at_100, status=[Draft|Approved])
OBItem(ob_item_id, ob_id → OB, seq, operation_id → OperationCatalog, machine_type_id → MachineType, smv_min)
TCR(tcr_id, style_id → Style, status=[Draft|Approved])
TCRItem(tcr_item_id, tcr_id → TCR, operation_id → OperationCatalog, machine_type_id → MachineType, rows, seam_len_cm, factor_per_cm (resolved), pct_needle, pct_bobbin, pct_looper, total_cm, needle_cm, bobbin_cm, looper_cm)
Method(method_id, ob_item_id → OBItem, product, fabric, stitch_len, spi, speed, layers, machine_time_sec, needle_time_pct, status=[Draft|Approved])
MethodElement(method_elem_id, method_id → Method, element_id → GSDElement, count, time_sec, allowance_sec)
GSDElement(element_id, code, category, description, std_time_sec, cond_len_5_sec, cond_len_15_sec, cond_len_30_sec, active)

Key relationships:

- Style 1-N OB; OB 1-N OBItem
- Style 1-N TCR; TCR 1-N TCRItem
- OBItem 1-1 Method; Method 1-N MethodElement; MethodElement N-1 GSDElement
- ThreadFactor N-1 MachineType; OBItem N-1 MachineType; TCRItem N-1 MachineType

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Process & Workflow

1) OB Creation & Approval

1. Select **Style** (or create minimal record).
2. Enter **Working Hours**, **Target@100**, **Plan Efficiency**.
3. Add **OB rows**: Seq, Operation, Machine Type, SMV.
4. System displays computed read-only: Target/Hr, Target/Day, Operators Required.
5. Save Draft → **Approve** (locks OB and its items).

2) TCR Creation & Approval

1. Select **Style**.
2. Add **TCR rows**: Operation, Machine Type, Rows, Seam Length (cm).
3. System auto-loads **Factor** and `% splits** from Thread Factors by Machine Type.
4. System computes **Consumption/op** and path splits; shows totals.
5. Save Draft → **Approve** (locks TCR and its items).

3) Method Analysis (per OB Item)

1. From OB row, open **Method**.
2. Fill header (Product/Fabric/etc.) and add **GSD elements** with counts and times.
3. System computes **SMV** and indicators (Machine/Needle time %), shows **delta vs OB SMV**.
4. Save Draft → **Approve** (locks Method and its elements).

4) Master Data Maintenance

- **Machine Types:** Maintain list used by validations.
- **Thread Factors:** Maintain machine mapping and constants; warn if editing a type referenced by approved TCRs (edits apply only to new drafts).
- **GSD Elements:** Maintain codebook for Method Analysis.
- **Operations:** Maintain list for OB/TCR row selection.

Computations & Formulas

OB

- TargetPerHour = (60 / SMV_min) × PlanEfficiency
- TargetPerDay = TargetPerHour × WorkingHours
- OperatorsRequired = TargetAt100 / (TargetPerHour × WorkingHours)
- *Constraints:* SMV_min > 0; PlanEfficiency ∈ (0,1]; WorkingHours ∈ [6..12]

Worked example:
SMV=0.60 min, PlanEff=0.70, WorkingHours=8, Target@100=870

Target/hr = (60/0.60)×0.70 = 70 pcs/hr
Target/day = 70×8 = 560 pcs/day
Operators = 870 / (70×8) = 1.553 → display 1.55 (calculated); if Excel rounds up for planning, also show **Rounded Operators = ceil(1.553) = 2**.

TCR

- Total_cm = Rows × SeamLen_cm × FactorPerCm(machine)
- Optionally: AdjSeamLen_cm = SeamLen_cm + Backtack_cm + EndWaste_cm
- Needle_cm = Total_cm × pct_needle
- Bobbin_cm = Total_cm × pct_bobbin
- Looper_cm = Total_cm × pct_looper
- *Constraints:* Rows ≥ 1; SeamLen_cm > 0; FactorPerCm > 0; % splits ≥ 0 and sum ≤ 1.0

Method Analysis

- SMV_min = (Σ(time_sec + allowance_sec) / 60)
- NeedleTime% = MachineTime_sec / Σ(time_sec), if present in Excel
- *Constraints:* each count ≥ 1; times ≥ 0.

Field-Level Validations & Error Messages

- **Machine Type:** must exist → “Select a Machine Type from the list.”
- **SMV (min):** numeric > 0 → “SMV must be greater than 0.”
- **Plan Efficiency:** 0 < value ≤ 1 → “Plan Efficiency must be between 0 and 1.”
- **Working Hours:** integer [6..12] → “Working Hours must be between 6 and 12.”
- **Rows (TCR):** integer ≥ 1 → “Rows must be 1 or more.”
- **Seam Length (cm):** numeric > 0 → “Seam Length must be greater than 0.”
- **Thread Factor (% splits):** each ≥ 0, sum ≤ 1.0 → “Path % split cannot exceed 100%.”
- **GSD Element:** must exist → “Choose a valid GSD Element.”
- **Method Times:** numeric ≥ 0 → “Time values cannot be negative.”

Step-by-Step Operation Summary

0) Sign-in & Session

1. **User opens app → Login screen.**
    - Inputs: Email/Username, Password.
    - Validation: both required.
2. **On success → Home (Minimal Menu).**
    - Menu: **Styles**, **Operation Breakdown (OB)**, **Thread Consumption (TCR)**, **Method Analysis**, **Masters**, **Imports**, **Profile**.
3. **Time & Locale:** All timestamps stored in UTC, displayed in IST (Asia/Kolkata).

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1) First-Time Setup (one-time or occasional)

1.1 Masters → Machine Types

- **Action:** Add machine codes used in Excel (e.g., SNLS, 3-TH O/L, 5-TH F/L).
- **Fields:** Code (required, unique), Name (required).
- **Validation:** Cannot delete a machine if referenced in an Approved OB/TCR.

1.2 Masters → Thread Factors

- **Action:** Add factors from “DO NOT DELETE” sheets.
- **Fields per machine type:**
    - Factor per cm (required, >0)
    - Needle Count, Looper Count (≥0)
    - % Needle, % Bobbin, % Looper (each ≥0; sum ≤ 1.0)
    - Backtack (cm), End Waste (cm) (≥0, optional)
- **System:** Warn if % sum > 1.0 (block save).

- **Effect:** TCR will auto-pull these by Machine Type.

1.3 Masters → Operation Catalog

- **Action:** Add operation names used in OB/TCR/Method.
- **Fields:** Code (optional, unique), Name (required), Category (optional), Default Machine Type (optional).
- **Validation:** Name required; cannot delete if referenced.

1.4 Masters → GSD Elements (for Method Analysis)

- **Action:** Populate from GSD CODES.xlsx.
- **Fields:** Code (required, unique), Category, Description, Std Time (sec), Conditional stds (5/15/30 sec).
- **Validation:** Times ≥ 0.
- **Note:** These are selectable rows in Method Analysis elements.

1.5 Masters → Styles

- **Action:** Add minimal style header used across OB/TCR/Method.
- **Fields:** Style Code (required, unique), Description, Product, Fabric, SPI, Stitch Length.
- **Validation:** Style Code required & unique.

1.6 Imports (optional)

- **Action:** Import Excel data to prefill Masters/OB/TCR/Method.
- **Process:** Upload → Preview grid with row-level errors → Confirm Import.
- **Validation example:** "Machine Type '5-TH F/L' not found. Add it in Masters → Machine Types."

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2) Daily/Regular Use—Typical Sequence

Goal: Create/Update OB → Approve; Create/Update TCR → Approve; Add Method Analysis per OB row → Approve.

2.1 Create or Open a Style

- **User:** Styles → New (or pick existing).
- **System:** Style record created/selected.

2.2 Operation Breakdown (OB) for the Style

1. **Open:** OB → "New OB for Style [X]" (or open existing Draft).
2. **Header Inputs (required):**
    - **Working Hours** (int, 6–12)
    - **Target @100** (int ≥ 0)
    - **Plan Efficiency** (0 < value ≤ 1)
3. **Add OB Rows:** one per operation in sequence order.
    - **Seq** (int)
    - **Operation** (picker from Operation Catalog)
    - **Machine Type** (picker from Machine Types)
    - **SMV (min)** (numeric > 0)
4. **Auto-Calculations (read-only per row):**
    - **Target/Hr** = (60 / SMV) × PlanEfficiency
    - **Target/Day** = Target/Hr × WorkingHours
    - **Operators Required (fractional)** = Target@100 / (Target/Hr × WorkingHours)
    - **Rounded Operators (planning)** = ceil(Operators Required)
5. **Live Validation:**

- SMV > 0, Machine Type exists, Plan Efficiency in (0,1], Working Hours in [6..12].
- Error messages show inline; save blocked if invalid.

6. **Save Draft** (can come back later).
7. **Approve OB:**
    - System recalculates all derived fields server-side; if OK → Status = **Approved**; OB becomes read-only.
    - **Rule:** Any future changes require "Create New OB Revision" (previous stays read-only).

2.3 Thread Consumption Report (TCR) for the Style

1. **Open:** TCR → "New TCR for Style [X]" (or open Draft).
2. **Add TCR Rows (per operation or seam):**
    - **Operation** (picker; not strictly required to match OB, but recommended)
    - **Machine Type** (picker)
    - **Rows** (int ≥ 1)
    - **Seam Length (cm)** (numeric > 0)
3. **Auto-Lookups from Thread Factors by Machine Type:**
    - **Factor per cm**
    - **% Needle**, **% Bobbin**, **% Looper**
    - Needle/Looper counts (informational)
    - Optional: Backtack/End Waste (cm)
4. **Auto-Calculations (read-only per row):**
    - If allowances used: **Adj Seam Len** = Seam Len + Backtack + End Waste

- **Consumption / Operation (cm)** = Rows × (Adj)Seam Len × Factor per cm
- **Needle_cm** = Total_cm × %Needle
- **Bobbin_cm** = Total_cm × %Bobbin
- **Looper_cm** = Total_cm × %Looper

5. **Totals Footer:** Sums of columns (mirrors Excel behavior).
6. **Save Draft** → **Approve TCR** (locks it).
    - **Rule:** Edits after approval require new TCR version for the Style.

2.4 Method Analysis for Each OB Row (Optional but Available)

1. **Open:** Method Analysis from a specific **OB row**.
2. **Header (copied or entered):** Product, Fabric, Stitch Length, SPI, Speed, Layers, Machine Type.
3. **Add Elements:**
    - **GSD Element** (picker)
    - **Count** (int ≥ 1)
    - **Time (sec)** (≥ 0)
    - **Allowance (sec)** (≥ 0, optional)
4. **Auto-Calculations:**
    - **Total Time (sec)** = Σ(Time + Allowance)
    - **SMV (min)** = Total Time / 60
    - **Needle Time %** (if applicable) = MachineTime_sec / TotalTime_sec
    - **Delta vs OB SMV** displayed (no auto-overwrite of OB SMV).
5. **Save Draft** → **Approve Method** (locks it).

- **Rule:** Updating GSD elements after approval requires cloning Method (new version).

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3) Editing & Versioning

3.1 Draft vs Approved

- **Draft:** Fully editable; calculated fields live-update.
- **Approved:** Read-only; becomes the reference snapshot aligned with Excel parity.

3.2 Revising an Approved Record

- **Action:** “Create New Revision” (OB/TCR/Method).
- **System:** Copies header + rows to a new Draft version.
- **Note:** All calculations re-run; you Approve again when ready.

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4) Integrity & Validations (Everywhere)

1. **Required Fields:** Marked with *; save blocked with clear message (e.g., “SMV must be greater than 0”).
2. **Lookups:** Machine Type, Operation, GSD Element must exist; otherwise show “Pick from list” errors.
3. **Numeric Bounds:**
    - Plan Efficiency (0,1]
    - Working Hours [6..12]
    - SMV > 0
    - Rows ≥ 1
    - Seam Length > 0

- Thread % splits ≥ 0 and sum ≤ 1.0

4. **Derived Recompute:** Server recomputes all read-only fields on save and on approve.
5. **Delete Rules:** Cannot delete any master referenced by an **Approved** OB/TCR/Method.
6. **Audit (minimal):** Created By/On, Updated By/On, Approved By/On displayed per record.

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5) Minimal Navigation Map (User's View)

- **Home**
  - Quick links to last edited Drafts.
- **Styles**
  - Add/Edit Style; open related OB/TCR/Method tabs.
- **OB**
  - List: drafts & approved (by Style).
  - Detail: Header + Rows grid; computed columns; Save/Approve.
- **TCR**
  - List: drafts & approved (by Style).
  - Detail: Rows grid; lookups; totals; Save/Approve.
- **Method Analysis**
  - List by Style & OB row.
  - Detail: Header + Elements grid; SMV calc; Save/Approve.
- **Masters**
  - Machine Types, Thread Factors, Operations, GSD Elements, Styles.

- **Imports**
    - Excel → Preview → Commit with row-level validation feedback.
- **Profile**
    - Change password; sign-out.

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6) Typical "Day in the Life" Flow (Concrete Example)

1. **Login** → **Styles** → Create Style SS26-KD-1J-DRS-00028.
2. **OB:**
    - Header: Working Hours=8, Target@100=870, Plan Efficiency=0.70.
    - Add Rows:
        - Seq 10 — Operation "Join Side Seam", Machine "5-TH O/L", SMV=0.60
        - Seq 20 — Operation "Hem", Machine "Flatlock", SMV=0.45
    - System shows per row: Target/Hr, Target/Day, Operators Required & Rounded.
    - **Approve OB.**
3. **TCR:**
    - Add row for "Join Side Seam": Machine "5-TH O/L", Rows=2, SeamLen=45 cm.
    - System pulls Factor & % splits → computes Total_cm and Needle/Bobbin/Looper splits.
    - **Approve TCR.**
4. **Method Analysis** (for Seq 10):
    - Add elements: PICK_UP × 2 (2.5 sec), LINE_UP × 1 (3.2 sec), STITCH × 1 (28.0 sec), THREAD_TRIM × 1 (2.0 sec).

    - System shows SMV = (2.5+3.2+28+2)/60 = 0.59 min; Delta vs OB SMV = −0.01.
    - **Approve Method.**
5. **Done.** All three artifacts stored, approved, and ready for reference.

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7) Error & Edge-Case Handling

- **Changing Machine Type on a TCR row:** Re-pull factors and recompute consumption; warn user before overwriting previously resolved factor values in Drafts.
- **Editing Thread Factors (Masters):**
    - Affects only **new Drafts** created after the change.
    - Approved TCRs keep their resolved (historical) values.
- **% Splits don't sum to 1.0:**
    - Allowed if < 1.0 (e.g., no bobbin).
    - Blocked if > 1.0 with message: "Path % split cannot exceed 100%."
- **Rounding:**
    - Operators Required shows both fractional and Rounded (ceil).
    - Targets show 2-decimal precision visually; backend maintains full precision.

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8) Non-Functional (Minimal)

- **Single User:** No concurrent editing needed; however, prevent double submits (disable Save while processing).
- **Performance:** Formulas recompute under 300 ms (perceived).
- **Reliability:** Unsaved changes prompt before navigation.

- **Security:** Password complexity (min length 8); lockout on brute force; session timeout (e.g., 30 mins idle).
- **Data Integrity:** Server is source of truth for all derived fields; UI values are previews only.
- **Retention:** Keep all Approved versions; Drafts can be deleted by the user.
- **Time Zone:** Display IST; store UTC.
