Real-World Constraints Definition Guide

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Purpose

Because StudyPilot is a web-based study management system, it must satisfy certain real-world technical, environmental, security, user, and platform constraints independent of its functional requirements.
These constraints establish the mandatory framework that defines the system architecture, performance limits, API usage restrictions, privacy rules, and user-experience expectations.

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1) System Context

Where does the software run?

- Web-based application
- Runs inside a browser (Chrome, Edge, Safari, Firefox)
- No server backend; most data is stored in localStorage

Environment, users, hardware:

- University and high-school students, exam-prep users
- Laptop, tablet, mobile browsers
- Variable connectivity (mobile data / WiFi)

OUTPUT — System Context Definition

StudyPilot is a lightweight web application running on modern browsers, relying on external APIs and client-side data storage. System performance depends on device capacity, screen size, and internet stability.

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2) Deriving Technical Limits from Software Functions

Function → Measurable Technical Constraint:

- "Improve focus via Pomodoro"
  → Timer drift < **100 ms** per 25-minute cycle

- "Play personalized music via Spotify"
  → API calls ≤ **30 requests/min** (Spotify limit)

- "Provide weather-based study suggestions"
  → Weather API refresh interval ≥ **10 minutes** (rate limit)

- "Tasks should load quickly"
  → Dashboard load time ≤ **2 seconds**

- "Analytics should update in real time"
  → Statistics recalculation ≤ **1 time/minute** (CPU protection)

OUTPUT — Performance and Behavior Limits Identified

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3) Domain Constraint Selection (Filled for StudyPilot)

Domain	StudyPilot Constraints
Performance	Dashboard ≤ 2 seconds load time
Reliability	Minimal data loss if localStorage is corrupted
Security & Privacy	User data must remain client-side; no server uploads
Compatibility	Must run on Chrome, Edge, Safari, Firefox
Resource / Platform	Max 1 MB localStorage usage
Network / I/O	Must switch to fallback mode if Spotify/Weather APIs fail
Human Factors (UX)	Key actions ≤ 3 clicks

OUTPUT — Domain → Constraint mapping completed

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4) Standards / Regulation Alignment

StudyPilot must comply with the following:

- **ISO/IEC 25010 — Software Quality Model**
    - Performance Efficiency
    - Usability
    - Reliability
- **GDPR / KVKK — Privacy Rules**
    - Minimal data collection
    - No server-side personal data storage
- **Spotify Web API Policy**
    - Rate limits
    - No credential exposure
- **OpenWeatherMap API Policy**
    - Refresh interval limits

OUTPUT — Constraints are aligned with industry standards

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5) Resource & Hardware Constraints

- User device RAM is limited → app must remain lightweight
- localStorage limit typically 5–10 MB → StudyPilot restricts itself to **max 1 MB**
- CPU usage must stay low → Timer & Analytics must be optimized
- Mobile battery consumption must be minimized

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6) Network and Protocol Constraints

- Offline support = **not available** (intentional constraint)
- If Spotify API fails → switch to **silent mode**
- If Weather API fails → reuse cached values
- Must comply with browser **CORS** policies

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7) Security & Privacy Constraints

- User data **cannot be uploaded** to any server
- All data must remain inside **browser localStorage**
- No login system → no password storage
- API credentials cannot be exposed in client code → use token-less public endpoints or proxy
- Logs must not include personal data

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8) User & UX Constraints

- Responsive UI must support **320px–1600px** widths
- Primary task actions (Add → Edit → Complete) ≤ **3 steps**
- Notification delay ≤ **2 seconds**
- Pomodoro start/stop must be **single-click**
- Color contrast must follow **WCAG 2.1**

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9) Constraint Record (StudyPilot Format)

Constraint ID: SW-C-001

- Description: Dashboard load time ≤ 2 seconds
- Evidence: ISO 25010 — Performance Efficiency
- Impact: Performance
- Test: Browser performance profiling

Constraint ID: SW-C-002

- Description: Spotify API calls ≤ 30 requests/min
- Evidence: Spotify API Rate Limits
- Impact: Network / API
- Test: Rate-limit simulation

Constraint ID: SW-C-003

- Description: Weather API refresh interval ≥ 10 minutes
- Evidence: OpenWeatherMap Policy
- Impact: External API
- Test: API call monitoring

Constraint ID: SW-C-004

- Description: User data must remain in localStorage only
- Evidence: GDPR — Data Minimization
- Impact: Security / Privacy
- Test: Code inspection + privacy review

Constraint ID: SW-C-005

- Description: Timer drift < 100 ms per cycle
- Evidence: UX focus accuracy requirement
- Impact: User Experience
- Test: Timer drift measurement

Constraint ID: SW-C-006

- Description: Interface must scale correctly across 320px–1600px
- Evidence: WCAG 2.1 Responsive Design
- Impact: Human Factors (UX)
- Test: Responsive UI testing

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10) Traceability → Constraint → Requirement → Test → Quality

Each constraint is linked to:

- Corresponding StudyPilot requirement (REQ-UI-01, REQ-STAT-03, REQ-POMO-05…)
- A test case in the QA plan
- An ISO 25010 quality characteristic

OUTPUT — Full lifecycle traceability has been achieved