

ROOT-LEVEL PROJECT DIRECTIVE

Aşağıdaki proje tanımı **tartışmaya kapalıdır**.

Hiçbir dosya boş bırakılmayacak, hiçbir fonksiyon TODO olmayacak, hiçbir API eksik olmayacağından emin olun.

Tüm çıktı **tamamen çalışan, temiz, tutarlı, çakışmasız, derlenebilir, test edilebilir, script'leri düzgün, dosya yapısı kararlı** olmalıdır.

Bu prompt uygulanırken **AI, kendi yorumunu katmayacak**, sadece aşağıdaki kuralları birebir, sıfırsız uygulayacaktır.

Kodda veya yapıda riskli görülen bir yer varsa: AI sessizce düzeltir.

Çöp dosya, gereksiz script, unutulmuş migration, çakışan import, yarılmış fonksiyon, fazlalık → **tamamen yasaktır**.

PROJECT NAME

BAKIRDEF LITE – FULL DIGITAL MANUFACTURING SUITE (OFFLINE SIMULATED)

PROJECT OVERVIEW (MANDATORY)

Bu proje:

- Savunma sanayi üretim hattı için **tamamen offline**,
- **simüle edilen IIoT verileriyle** çalışan,
- Operatör + Kalite + Yönetim modülleri içeren,
- CNC – CMM – Furnace – Tool Life – OEE – Health – Predictive Maintenance simülasyonlarını barındıran,
- Çok ekranlı, çok modüllü bir üretim takip sistemidir.

Tamamen yerel çalışır:

- Backend: Express + SQLite
 - Frontend: React + Vite + Tailwind
 - Simülasyonlar: Deterministic (seed = 42)
-

ABSOLUTE FILE STRUCTURE REQUIREMENTS

Aşağıdaki dosya ağacının **bir harfi bile farklı olmayacak** şekilde birebir oluşturulması zorunludur.

BAKIRDEF/

```
|── backend/
|   ├── package.json
|   ├── tsconfig.json
|   ├── src/
|       ├── server.ts
|       ├── routes/
|           ├── work_orders.routes.ts
|           ├── revision_control.routes.ts
|           ├── fai_control.routes.ts
|           ├── skill_matrix.routes.ts
|           ├── calibration_control.routes.ts
|           ├── tool_life.routes.ts
|           ├── furnace.routes.ts
|           ├── cmm.routes.ts
|           ├── genealogy.routes.ts
|           ├── audit_readiness.routes.ts
|           ├── cnc.routes.ts
|           ├── production.routes.ts    ← YENİ
|           └── sim.routes.ts        ← YENİ
|       ├── controllers/
|           ├── work_orders.controller.ts
|           ├── revision_control.controller.ts
```

```
| | |   |-- fai.controller.ts
| | |   |-- skill_matrix.controller.ts
| | |   |-- calibration.controller.ts
| | |   |-- tool_life.controller.ts
| | |   |-- furnace.controller.ts
| | |   |-- cmm.controller.ts
| | |   |-- genealogy.controller.ts
| | |   |-- audit.controller.ts
| | |   |-- cnc.controller.ts
| | |   \_ production.controller.ts ← YENİ
| | |   |-- simulations/
| | |   |   |-- cnc.sim.ts
| | |   |   |-- furnace.sim.ts
| | |   |   |-- cmm.sim.ts
| | |   |   |-- tool.sim.ts
| | |   |   |-- oee.sim.ts
| | |   |   |-- health.sim.ts
| | |   |   \_ predictive.sim.ts
| | |   |-- database/
| | |   |   |-- connection.ts
| | |   |   |-- schema.sql
| | |   |   |-- seed.ts
| | |   |   \_ migrate.ts
| | |   |-- middlewares/
| | |   |   \_ validation.ts
```

```
| | └─ utils/
| |   └─ rng.ts
| └─ database/
|   └─ bakirdef.db
└─ frontend/
  ├─ index.html
  ├─ package.json
  ├─ tsconfig.json
  ├─ vite.config.ts
  └─ src/
    ├─ main.tsx
    ├─ App.tsx
    ├─ api/
    |   └─ axios.ts
    └─ pages/
      ├─ OperatorPanel.tsx
      ├─ QualityPanel.tsx
      ├─ ManagerPanel.tsx
      ├─ GenealogyPage.tsx
      ├─ AuditReadinessPage.tsx
      ├─ ProductionFloorDashboard.tsx ← YENİ
      └─ WorkOrderDetailsPage.tsx
    ├─ components/
    |   ├─ Sidebar.tsx
    |   └─ TopBar.tsx
```

```
|   |   └── PanelCard.tsx  
|   |   └── LoadingSpinner.tsx  
|   |   └── StatusBadge.tsx  
|   |   └── operator/  
|   |       └── OperatorActions.tsx  
|   |       └── WorkOrderCard.tsx  
|   |       └── ToolLifeCard.tsx  
|   |   └── dashboard/  
|   |       └── MachineCard.tsx  
|   |       └── HealthIndicator.tsx  
|   |       └── OEETable.tsx  
|   |   └── genealogy/  
|   |       └── TreeChart.tsx  
└── styles/  
    └── globals.css
```

MANDATORY DATABASE SCHEMA (FINAL & FIXED)

Aşağıdaki tablolar birebir oluşturulacaktır:

✓ Core Manufacturing Tables

- operators
- skill_matrix
- materials
- material_lots
- revisions
- work_orders

- tools

✓ Machine & Simulation Tables (MIDTERM COMPLETE)

- machines
- cnc_cycles
- furnace_cycles
- cmm_measurements
- tool_usage_logs
- oee_logs
- machine_health_logs
- machine_maintenance_logs

Her tablo UNIQUE, NOT NULL, FK'ler doğru, index'ler mantıklı olacak.

SIMULATION MODULES – ABSOLUTE REQUIREMENTS

Her simülasyon deterministic olacak. RNG → /utils/rng.ts üzerinden seed = 42 ile çalışacak.

CNC SIMULATION

- cycle time
- load %
- feed
- rpm
- idle/active ratio
- state machine
- wear injection

FURNACE SIM

- heat curve
- soak
- cooling

- over/under temp
- drift
- noise

CMM SIM

- dimensional scatter
- Cp/Cpk
- tolerance bands
- OOT injection

TOOL LIFE SIM

- wear curve
- predicted break
- usage heatmap
- remaining %

OEE SIM

- Availability
- Performance
- Quality
- combined OEE

HEALTH SIM

- vibration
- temperature drift
- bearing degradation

PREDICTIVE MAINTENANCE SIM

- MTBF
- MTTR
- RUL estimator

PRODUCTION FLOOR DASHBOARD (NEW — MANDATORY)

Bu ekran **zorunludur** ve eksiksiz yapılacaktır.

Ekranda şu hesaplamalar yapılacak:

elapsed = now - lastInspection

remaining = maintenanceInterval - elapsed

predictedMaintenance = lastInspection + maintenanceInterval

healthScore = weighted(vibration,temp_drift,wear_rate)

oee = availability * performance * quality

Makine kartında gösterilecek:

- Makine adı
- Durum (Running / Idle / Error)
- Geçen süre
- Kalan süre
- Tahmini bakım tarihi
- Sağlık %
- OEE %
- Renk kodları (green/yellow/red)

BACKEND API – FULL REQUIRED LIST

Production APIs

GET /api/v1/production/machines

GET /api/v1/production/machines/:id

POST /api/v1/production/machines/run-sim

Sim APIs

POST /api/v1/sim/cnc/:id

POST /api/v1/sim/furnace/:id

POST /api/v1/sim/cmm/:id

POST /api/v1/sim/tool/:id

POST /api/v1/sim/oee/:id

POST /api/v1/sim/health/:id

POST /api/v1/sim/predictive/:id

Work Orders

GET /api/v1/work-orders

GET /api/v1/work-orders/:id

POST /api/v1/work-orders/:id/start

POST /api/v1/work-orders/:id/complete

FAI / Revision / Audit / Genealogy

Tam listeler eksiksiz uygulanacak.

■ FRONTEND UI REQUIREMENTS

- Tailwind
 - Dark mode default
 - No animations except 100ms fade
 - Minimal UI
 - Only functional screens
 - No presentation layer
-

■ BEHAVIOR REQUIREMENTS FOR JULES

Bu prompt uygulanırken:

✗ JULES'in yapması yasak olanlar:

- Hiçbir TODO bırakmak

- “Later implement” yazmak
- Test edilmemiş fonksiyon yazmak
- Schema’yi eksik bırakmak
- Random isimli dosya açmak
- Scriptleri eksik yazmak
- Local type tanımını unutarak build error üretmek
- Migration/seed çakışması yaratmak
- Gereksiz paket eklemek

✓ JULES'in yapmak zorunda oldukları:

- Her dosyayı %100 çalışır şekilde yazmak
- API rotalarını teker teker bağlamak
- Simülasyonların hepsini eksiksiz eklemek
- Tüm tablolara seed eklemek
- Tüm endpoint'leri test edilebilir kılmak
- Hiçbir dosya boş kalmayacak şekilde üretmek
- Gereksiz tüm dosyaları kaldırmak
- Tip hatası bırakmamak

THE FINAL DIRECTIVE

Aşağıdaki çıktıyı üret:

“BAKIRDEF LITE” projesini

backend + frontend + simulations + ui + db + api

tamamen sıfırdan

tek seferde,

çalışır,

dosya ağacı birebir,

kod hatasız,

boş satır yok,

tutarlı,
temiz,
derlenebilir şekilde oluştur.

BAKIRDEF: Gerçek Zamanlı Üretim Takip ve IIoT Uygulama Raporu

1. Özет ve Uygulama Vizyonu

BAKIRDEF sistemi, geleneksel ERP yazılımlarının aksine, Savunma ve Havacılık KOBİ'lerinin operasyonel süreçlerini sadece kaydetmek yerine, **Endüstriyel Nesnelerin İnterneti (IIoT)** mimarisinden **gerçek zamanlı olarak yöneten ve kilitleyen** (govern and interlock) özel bir çözümüdür.

Vizyonumuz, firmaların **AS9100/AQAP** standartlarına uyum yükünü, manuel dokümantasyon (Excel/Kağıt) risklerinden arındırarak, "**Hata Önleyici (Poka-Yoke)**" bir yazılım mimarisine taşımaktır. Bu, **tam dijital şecere (genealogy)** ile denetim (audit) sürelerini saniyelere indirmeyi hedefler.

2. Üretim Akışı Simülasyonu: Titanyum Bağlantı Braketi

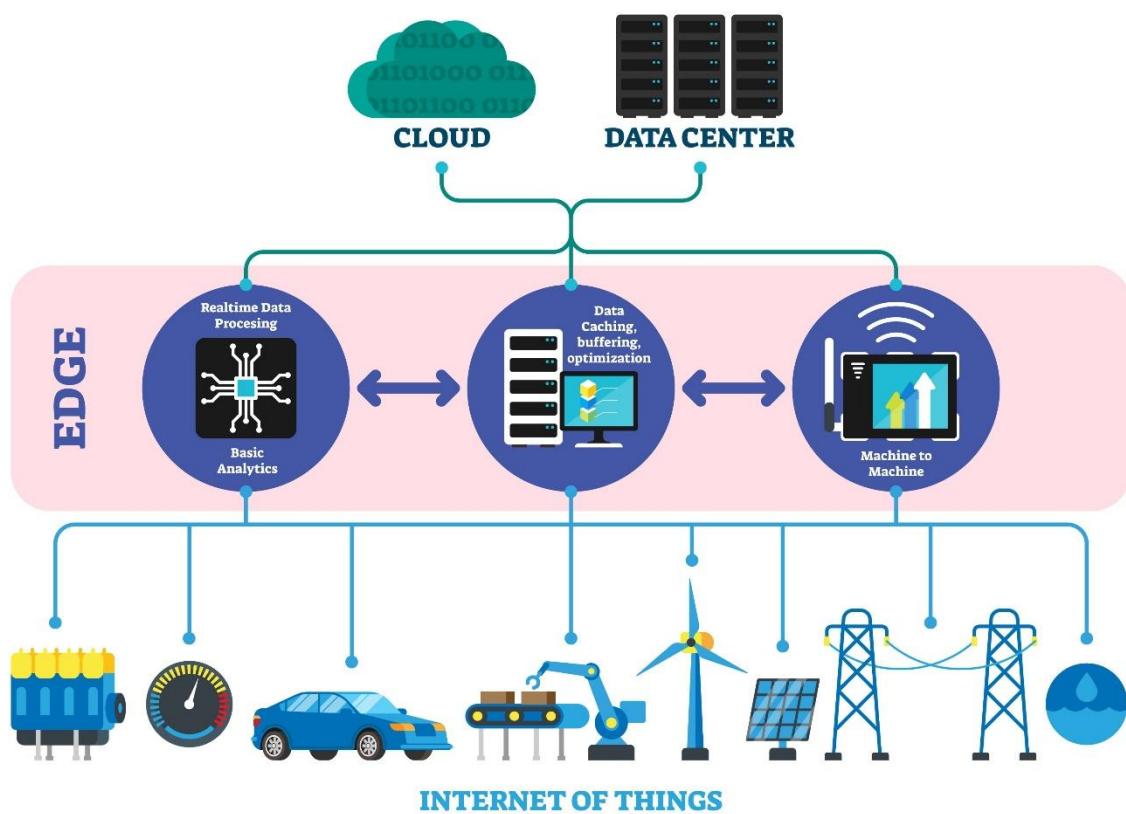
Projenin uygulanabilirliğini göstermek için, savunma sanayinde kritik bir parça olan **Yüksek Dayanımlı Titanyum Bağlantı Braketi**'nin üretim sürecini ele alıyoruz.

Aşama No.	İşlem Adı	Tezgah/İstasyon	Kritik Kontrol Amacı
1	Hammadde Kabul & Partileme	Stok Alanı	Malzeme İzlenebilirliği (Lot/Parti No)
2	Hassas Frezeleme (5 Eksen)	CNC İşleme Merkezi	Takım Ömrü, Revizyon Kontrolü, Proses Verisi
3	Isıl İşlem (Gerilim Giderme)	Vakum Fırını	Kritik Proses Parametrelerinin Kaydı
4	Boyutsal Kontrol	CMM Cihazı	Kalibrasyon Kilidi, İlk Parça Onayı (FAI)
5	Paketleme ve Sevkiyat	Sevkiyat İstasyonu	Operatör Yetkinlik ve İhracat Kontrolü

3. 🖥️ IIoT Mimarisi ve Gerçek Zamanlı Veri Toplama (Sensör Detayları)

BAKIRDEF, veri toplama ve süreç kontrolünü sağlamak için tezgah bazlı, hibrit bir IIoT altyapısı kullanır.

Edge Computing



Shutterstock

Keşfet

A. Aşama 2: CNC İşleme Merkezi Entegrasyonu

Bu istasyondan toplanan veriler, **Takım Ömrü Yönetimi (Tool Life Management)** ve **Dinamik Revizyon Kiliti** senaryolarını hayata geçirir.

Veri Tipi	Donanım/Protokol	Rolü	Gerçek Zamanlı BAKIRDEF Kontrolü
Makine Durumu ve Süre	MTConnect / OPC UA Adaptörü	Modern CNC kontrol ünitelerinden (Fanuc, Siemens, Heidenhain) Çevrim Süresi, Aktif T-Kodu (Takım) ve Makine Çalışma Durumu verilerini çeker.	Takım Ömrü: Toplanan T-Kodu ile Takım Veri Tabanını karşılaştırarak gerçek kesme süresini izler ve ömrü dolduğunda tezgâha kilitleme emri gönderir.
Hata Önleme (Revizyon)	Endüstriyel Tablet & Barkod Okuyucu	Operatörün iş emrini tezgâh başında okuttuğu terminal.	Operatör okutulan iş emri için yeni bir teknik resim Revizyon B'nin yayındığındı görene kadar tezgâhin (yazılımsal olarak) iş başlatmasını engeller.

B. Aşama 3: Isıl İşlem Vakum Fırını Entegrasyonu

Isıl işlem kritik bir prodestir. Proses verilerinin sapması, malzemenin nihai dayanımını tehlikeye atar.

Veri Tipi	Donanım/Protokol	Rolü	Gerçek Zamanlı BAKIRDEF Kontrolü
Sıcaklık ve Süre	Tip R Termokupllar (Endüstriyel Sınıf) & PLC/SCADA Entegrasyonu	Fırın içindeki sıcaklık, süre ve basınç profillerini anlık olarak kaydeder.	Prosesin belirlenen kabul edilebilir limitler ($\$T \pm \Delta$) içinde kaldığını doğrular ve herhangi bir sapmayı anında alarm olarak yönetime iletir. Tüm proses verileri parçanın Dijital Şecere kaydına işlenir.
Durum Okuyucu	Akim Trafosu (CT Sensor)	Fırının güç tüketimini izleyerek çalışma döngüsünün	Fırın döngüsünün, planlanan süreye uygunluğunu doğrular.

Veri Tipi	Donanım/Protokol	Rolü	Gerçek Zamanlı BAKIRDEF Kontrolü
		başlangıç ve bitişini tespit eder.	

C. Aşama 4: CMM Cihazı Entegrasyonu

Veri Tipi	Donanım/Protokol	Rolü	Gerçek Zamanlı BAKIRDEF Kontrolü
Kalibrasyon Durumu	RFID Etiketleri (Ölçüm Aletleri üzerinde)	Her ölçüm aletine benzersiz bir kimlik sağlar ve kalibrasyon sertifikası ile eşleştirir.	Kalite Operatörü, ölçümden önce aleti taradığında, BAKIRDEF Arayüzü, aletin kalibrasyonu geçersizse ölçüm verisi girişini bloke eder (Calibration Lock).
Ölçüm Verisi	CMM Yazılımı API Entegrasyonu	CMM'den alınan ölçüm sonuçlarını (boyutlar, tolerans sapmaları) otomatik olarak sisteme aktarır.	İlk Parça Kontrolü (FAI Kilidi: İlk parça ölçüm sonuçları sisteme girilinceye ve Kalite Onayı verilinceye kadar, CNC'nin toplu üretmeye geçmesi engellenir.

4. Sonuç: Dijital Şecere ve Audit-Readiness Dashboard

Tüm bu toplanan IIoT verileri, BAKIRDEF'in merkezi modülünde birleştirilerek denetim (audit) ve yönetim amaçlı kullanılır:

- Dijital Şecere Arayüzü:** Bir denetçi, üretilen Titanyum Braketinin Seri Numarasını sisteme girer. BAKIRDEF anında aşağıdaki tam şecereyi oluşturur:
 - Hammadde Kaynağı ve Parti Numarası.**
 - İşleme Tarihleri ve Kullanılan Takımın Kalan Ömrü (IIoT Verisi).**
 - Isıl İşlem Sırasındaki Sıcaklık ve Basınç Eğrileri (Kritik Proses Verisi).**
 - Son Kontrolü Yapan Operatörün Sertifika Geçerliliği ve Kullanılan Aletin Kalibrasyon Durumu.**

- **Audit-Readiness (Denetime Hazırlık) Metriği:** Sistemin tüm süreç kilitlerinin aktif olduğu, geçmişte hiçbir kilit ihlali yaşanmadığı ve tüm kayıtların tam olduğu teyit edilerek firmanın denetime hazırlık seviyesi anlık olarak gösterilir.

Bu mimari, BAKIRDEF'i basit bir envanter takip yazılımından, **savunma sanayii standartlarını süreçlerin içine zorla kodlayan (hard-coded)** bir operasyonel yönetim motoruna dönüştürür.



BAKIRDEF: The Defense Compliance Engine for SMEs

MIS Project Report

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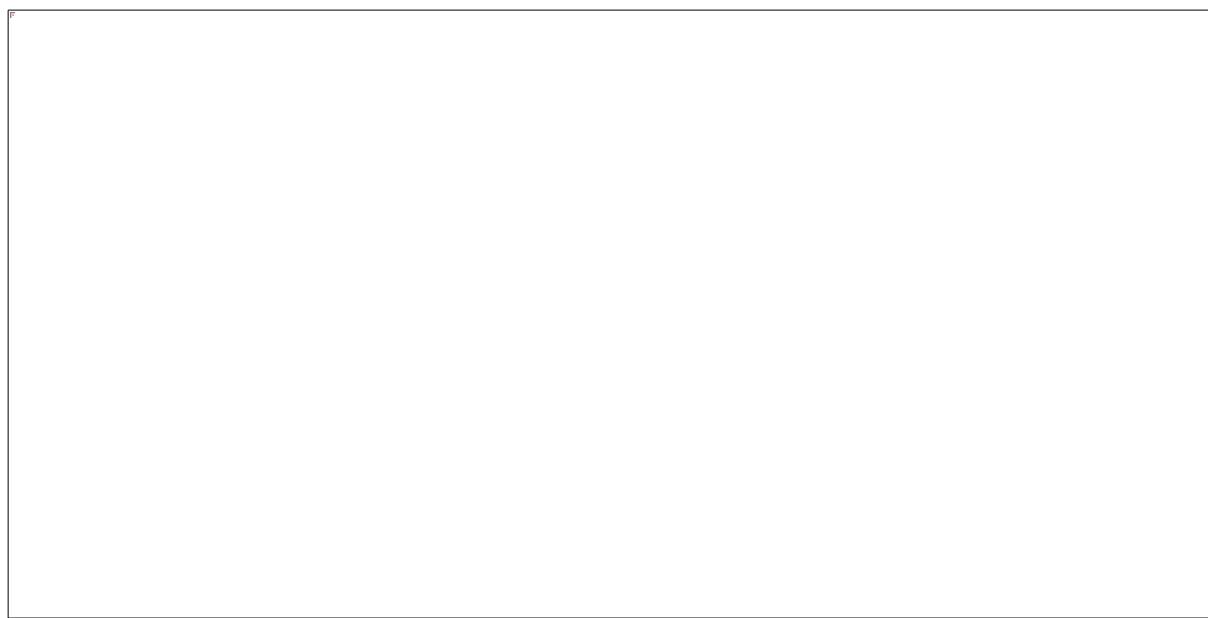
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Market Size And Key Players

In Türkiye, defense and aerospace SMEs are primarily concentrated in industrial clusters that serve as hubs for collaboration, resource sharing, and supplier networks. SAHA İstanbul is the country's largest cluster, encompassing over a thousand companies involved in aerospace, defense, and space technologies. OSTİM Defense and Aerospace Cluster (OSSA) in Ankara specializes in precision machining, mechatronics, cable manufacturing, and other industrial subcomponents. Technopark İstanbul's Defense Industry Cluster (TSSK) hosts high-tech startups and system suppliers, focusing on innovation and advanced technology development. Eskişehir Aviation Cluster (ESAC) is another specialized ecosystem, emphasizing aircraft engines and aviation-related components. Each cluster maintains publicly available member directories, which allow researchers to identify SMEs by sector, capability, and certifications such as AS9100.



Large Turkish defense contractors, including ASELSAN, TAI (TUSAŞ), ROKETSAN, HAVELSAN, BMC, and FNSS, maintain approved supplier lists or strategic partner announcements, which are rich sources of SMEs. These suppliers typically specialize in precision machining, composite parts, cable harness production, electronic subsystems, and defense software. From a technology perspective, many of these SMEs rely on enterprise resource planning (ERP) systems to manage production, inventory, and procurement processes. **SAP ERP solutions** are among the most common, particularly SAP S/4HANA, SAP Business One, and SAP Business ByDesign, as they offer robust modules for manufacturing, compliance, and supply chain management.

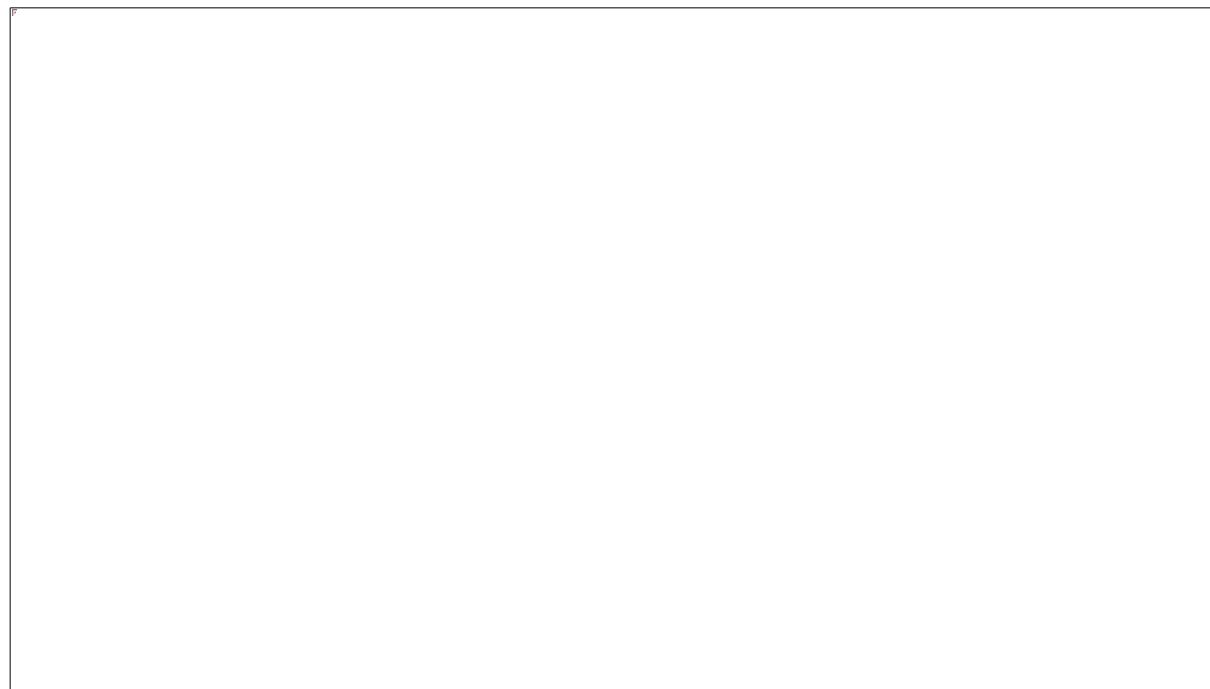
Competing ERP platforms include **Oracle NetSuite**, **Microsoft Dynamics 365**, **IFS Applications**, and **Infor CloudSuite Industrial**, which are also widely used in mid-sized defense manufacturers to streamline operations, ensure quality control, and maintain regulatory compliance. Understanding which platforms are deployed by target SMEs can help position complementary software, analytics tools, or cloud solutions effectively.

Global SME Market Landscape

Globally, defense and aerospace SMEs are similarly clustered in networks and supported by industry associations. France's Aerospace Valley hosts hundreds of SMEs engaged with major manufacturers such as Airbus and Dassault, while Germany and the UK maintain extensive SME supply chains focusing on machining, electronics, and system integration. The European Defence Agency provides databases of SMEs active in defense projects, facilitating cross-border collaboration. Globally, SAP ERP competes with Oracle NetSuite, Microsoft Dynamics, IFS Applications, and Infor CloudSuite Industrial, with adoption often reflecting company size, complexity of production, and integration needs across defense programs.

Finding

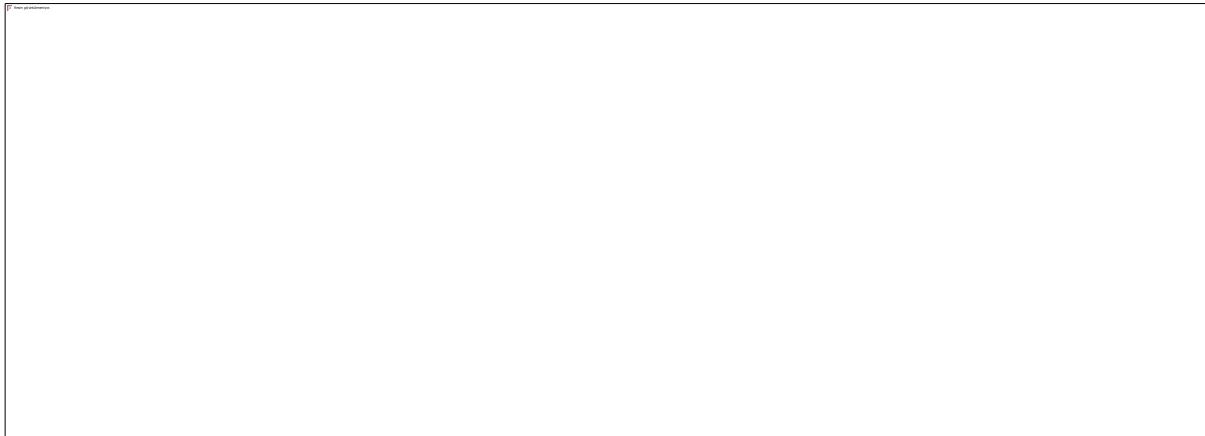
Information we gathered provides clear evidence of structured and active market. From our point of view there is a huge potential in SME's who are lacking consultation and ERP adoption due to the lack competition in the local market which causes SME's to be skeptical to new practices due to high cost.



Need Analysis

The first step involves reviewing the websites of the SMEs identified earlier, particularly the sections labeled "About Us," "Quality," or "Certifications." Companies that hold

AS9100 certification, which is the international standard for quality management in aerospace and defense, indicate a high level of process maturity. Understanding the requirements of AS9100 is critical, as it imposes strict obligations on traceability, configuration management, and quality record-keeping.



Traceability ensures that every raw material can be tracked through the production chain, including which machine processed it, which operator handled it, and the exact date of processing. Configuration management requires that any design change is documented and traceable, showing exactly which product batches are affected. Quality records, such as Non-Conformance Reports (NCRs) and Corrective/Preventive Actions (CAPA), are essential to meet compliance standards.

SMEs typically present their capabilities in a section often titled “Our Capabilities” or “Capabilities.” These sections provide insight into the technical competencies of the company. For example, machining-focused SMEs often list capabilities such as 5-axis CNC machining, precision metalworking, and surface treatments. Electronics SMEs often highlight printed circuit board (PCB) design, cable harness assembly, and automated testing capabilities.

By examining processes, machining SMEs typically follow a workflow that begins with raw material acceptance, followed by cutting, CNC processing, coating, heat treatment, quality control through coordinate measuring machines (CMM), and final shipment. Electronics SMEs usually handle component acceptance, surface-mount technology (SMT) assembly, automated testing (ATE), and shipment. These processes are highly structured and regulated, reflecting the rigorous standards required by aerospace and defense clients.

Competition Analysis(Global & Local)

A. Global Giants (SAP, Oracle, IFS): "Unattainable Excellence"

At the top of the market, global Tier-1 providers dominate, with **IFS** being particularly strong in the defense sector, alongside **SAP** and **Oracle**.

- **Strengths:** These platforms are designed to fully meet rigorous **AS9100** and **AQAP** standards. They offer flawless capabilities in **Traceability, Configuration Management (CM)**, and **PLM integration**. They are robust solutions built for complex, large-scale operations.
- **The Barrier for SMEs:** The primary disadvantage is **cost**. Licensing, implementation, and consulting fees often reach millions of dollars. For a typical SME, these systems are technically desirable but **financially inaccessible**.

B. Local Solutions (Logo, Netsis, Canias): "Insufficient Fit"

On the other end of the spectrum are domestic ERP solutions like **Logo**, **Netsis**, **Uyumsoft**, and **Canias**, which hold approximately 90% of the Turkish SME market.

- **Strengths:** These systems are excellent for general Accounting, Finance, and basic Inventory management. They are highly affordable, widely supported, and fully compliant with local tax regulations.
- **The Barrier for SMEs:** Designed for "general commerce," they lack "**Engineering Depth**." Critical defense requirements such as **Serial Number-Based Genealogy**, **Engineering Change Management (Rev A/B)**, and **Project-Based Costing** are either entirely absent or severely limited.

C. The "De Facto" Competitor: Excel & Paper (The Hidden Risk)

Caught between local ERPs (which lack capability) and global ERPs (which are too expensive), most SMEs resort to managing their critical defense processes using **Microsoft Excel** and **paper forms**. This creates "data islands," breaks data integrity, and poses a massive risk during quality audits.

The Bakirdef Difference

BAKIRDEF is not merely a passive database; it is an active **Operational Management System** designed to physically control production processes and prevent "**Leakage, Errors, and Risks**" in the Defense Industry environment.

While our competitors (Standard Local ERPs) **"record"** the process history, BAKIRDEF **"governs and interlocks"** the process in real-time. The following 8 critical scenarios demonstrate this fundamental difference:

1. Scenario: Dynamic Engineering Revision Lock

- **The Critical Issue:** A Prime contractor (e.g., TAI) updates a technical drawing (Rev A is cancelled, Rev B is released). However, the old work order remains open in the standard ERP. The operator continues manufacturing based on the old drawing, resulting in thousands of dollars in scrap.

- **The BAKIRDEF Solution:** The moment an Engineering Change Order (ECO) is entered, BAKIRDEF **locks all shop-floor tablets**. The operator cannot start the machine until they acknowledge the prompt: "New Revision B Released."
- **Value:** *Error-Proofing (Poka-Yoke) Software Architecture.*

2. Scenario: Raw Material Traceability & Digital Genealogy

- **The Critical Issue:** An aircraft part fails during testing. The client asks: "Which steel batch was this produced from?" In the current system, the quality manager hunts through physical archives for hours. If the document is lost, the supplier is blacklisted.
- **The BAKIRDEF Solution:** At the machine level, the operator must scan the raw material barcode before loading. The system validates: "Is this steel certified?" If yes, it records the link. During an audit, we generate the **Digital Genealogy** with one click: "*This part was machined by Operator Ahmet on 12.05.2024 using Steel Batch #8493 from Ereğli Steel.*"
- **Value:** *100% Full Traceability and Audit-Readiness.*

3. Scenario: First Article Inspection (FAI) Interlock

- **The Critical Issue:** An operator sets up the CNC and starts mass production without quality approval. If the setup is wrong, 100 parts become scrap.
- **The BAKIRDEF Solution: "Process Interlock."** When the operator produces the 1st part, the system physically stops the workflow. The operator must enter measurement values into the tablet. The system will not allow the 2nd part (or barcode generation) until the Quality Department gives digital approval.
- **Value:** *Scrap Prevention via Digital FAI Management.*

4. Scenario: Government Furnished Equipment (GFE) Management

- **The Critical Issue:** Contractors (like ASELSAN) often ship raw materials to the SME for processing ("Take this titanium, machine it, send it back"). This material is not an asset of the SME; it is "Consignment/Trust." Standard ERPs treat this as "Inventory Asset," inflating the financial balance sheet and creating tax issues.
- **The BAKIRDEF Solution: "Shadow Inventory."** The system tags these materials as "Customer Property." It tracks usage and scrap rates in production but completely isolates them from the company's financial ledger.
- **Value:** *Financial & Legal Compliance for GFE.*

5. Scenario: Operator Competency Control (Skill Matrix)

- **The Critical Issue:** A critical aerospace weld is performed by personnel whose certification expired 3 days ago. Even if the part is perfect, it is marked as "Non-Conformance" (NCR) during an audit because the cert was invalid.
- **The BAKIRDEF Solution:** When an operator scans their ID card to start a job, the system runs a background check on the "**Skill Matrix**." It triggers an alert: "*Warning! Welder Certificate Expired*" and prevents the job from starting.
- **Value:** *Dynamic Skill Management and Risk Mitigation.*

6. Scenario: Tool Life Management

- **The Critical Issue:** An operator continues machining with a worn-out (dull) cutting tool, degrading the surface quality of expensive titanium parts.
- **The BAKIRDEF Solution:** The system tracks the actual cutting time of every CNC insert. It sends a "Prepare Replacement" alert to the warehouse when tool life hits 95% and locks the process at 100% life.
- **Value:** *Cost Reduction in Cutting Tools and Quality Assurance.*

7. Scenario: Calibration Lock

- **The Critical Issue:** A part is measured using a caliper with an expired calibration date. The measurement is legally invalid.
- **The BAKIRDEF Solution:** The operator must scan the measurement tool before data entry. If the system does not return a "Calibration Valid" status, it blocks data entry from that specific tool.
- **Value:** *Audit-Readiness and Zero-Defect Culture.*

8. Scenario: Export Control (ITAR / Compliance)

- **The Critical Issue:** A restricted defense component (e.g., NATO Secret) is accidentally shipped to an unauthorized receiver or country.
- **The BAKIRDEF Solution:** "Export Shield." If the product card has an "Export Restriction" flag and the shipping address conflicts with the authorized list, the system automatically blocks the generation of the delivery note.
- **Value:** *International Legal Compliance and Embargo Protection.*

Visionary Feature: AI-Based Smart Bidding

- **The BAKIRDEF Difference:** By analyzing historical data (actual machining times vs. planned times, scrap rates, and tool usage), the system provides a "**Data-Driven Cost Prediction**" for new tenders. This prevents the SME from underbidding (losing money) or overbidding (losing the contract).

CONCLUSION: BAKIRDEF'S MARKET POSITIONING

Our competitors (Standard Local ERPs) are designed to manage a company's "**Wallet**" (Accounting & Finance).

BAKIRDEF, however, is a specialized system designed to manage the "**Engineering Brain**" and "**Production Muscles**" of a Defense SME, with AS9100 and AQAP standards hard-coded into its DNA.

We offer SMEs a unique proposition: "**Acquire million-dollar defense capabilities without abandoning your existing ERP infrastructure.**"