Ryerson University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

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Lab/Tutorial Report No.	Lab 2

Report Title	Lab 2: Case Study (IT in Transportation)

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Lab 2: Mini Case Study

Option #1: Design a mini-case study of IT project of your choice, examples are varied across different fields, your mini-case study could be designed to cover any of the following areas:

4. **IT in transportation**, e.g., software for autonomous driving, emergency services, etc

- ➔ **Autonomous Emergency Response System (AERS)**
  - ◆ An automated system that detects emergencies like fires or medical incidents and triggers appropriate responses, such as alerting authorities or activating safety protocols, without human intervention. It acts as a reliable safety net, swiftly reacting to critical situations to mitigate risks and ensure timely assistance.

Autonomous Emergency Response System (AERS): Revolutionizing Transportation Safety and Efficiency

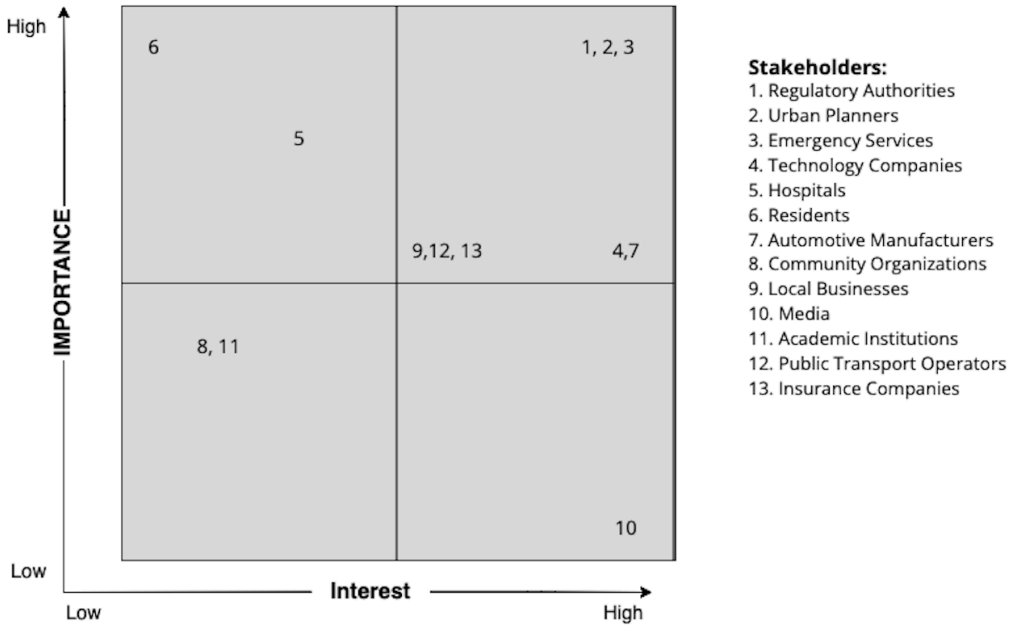
- The Autonomous Emergency Response System (AERS) represents a significant advancement in transportation technology, aiming to improve the efficiency and safety of emergency response services drastically. By integrating autonomous driving technology with real-time data analytics, AERS seeks to address the critical challenges of delayed emergency response times and the high risk of accidents involving emergency vehicles in urban settings. Central to AERS is its ability to navigate emergency units through traffic swiftly and safely, using autonomous vehicles (AVs) equipped with advanced sensors and navigation systems. The system's backbone is a sophisticated platform that processes real-time traffic data, employing machine learning algorithms to devise optimal routes for emergency vehicles. This capability is enhanced by AERS's communication with city infrastructure, orchestrating traffic flow to create clear paths for emergency responders. A unique feature of AERS is the deployment of autonomous drones, dispatched immediately upon emergency calls to deliver first aid and critical care supplies before ambulance arrival. This innovative approach augments the traditional emergency medical response and significantly increases survival rates in urgent situations. The collaborative development of AERS involved stakeholders from the government, healthcare, technology, and urban planning sectors. Their collective input was crucial in ensuring the system met technical and operational standards and aligned with public safety regulations and emergency service protocols. Key stakeholders include government regulators tasked with overseeing legal and safety compliance, urban planners integrating AERS within city infrastructures, and emergency service personnel directly impacted by the new operational dynamics. Public acceptance remains a pivotal factor, underscoring the importance of trust in autonomous technologies for the system's success. AERS promises to transform emergency services by reducing response times, minimizing accident risks, and providing immediate medical interventions. Despite potential challenges like technological integration, regulatory approval, and public skepticism, AERS's benefits highlight the transformative power of IT in enhancing public safety and emergency responsiveness.

Part I: Stakeholder Analysis

1. Stakeholders That Influence The Research Project

Stakeholder Group	Interests in Project	Likely Impact of Project	Priority
Regulatory Authorities	Compliance with laws	High: Ensures project meets legal standards	High
Urban Planners	City infrastructure integration	High: Affects city planning and traffic flow	High
Emergency Services	Faster response times	Very High: Directly benefits from improved speed	High
Technology Companies	Innovation and development	High: Business growth and technology advancement	High
Hospitals	Better emergency care	High: Faster and more efficient patient care	High
Residents	Safety and quick emergency responses	High: Safer and more efficient community	High
Automotive Manufacturers	Building AVs for the system	Medium: New market and product opportunities	Medium
Community Organizations	Representing community interests	Medium: Can influence project acceptance	Medium
Local Businesses	Impact on local traffic and potential disruptions	Medium: Adjustments to operations and customer access	Medium
Media	Reporting on technology and its impacts	Low: Public awareness and perception	Low
Academic Institutions	Research opportunities and partnerships	Low: Gains new knowledge and innovation opportunities	Low
Public Transport Operators	Integration with existing transport systems	Medium: Potential for system enhancements and changes	Medium
Insurance Companies	Risk assessment and insurance policy adjustments	Medium: Changes in risk profiles and policy offerings	Medium

2. Interest / Power Matrix:



High Importance, High Influence:

- Regulatory Authorities: They have the authority to approve or reject project elements and are highly interested in compliance.
- Emergency Services: Direct beneficiaries of the system, significantly influencing how it's used in practice.
- Urban Planners: Key to the system's integration into city infrastructure, highly interested and influential in planning.

High Importance, Medium Influence:

- Hospitals: Reliant on AERS for efficient emergency services, highly interested in its functionality, though their influence on design and implementation is moderate.

High Importance, Low Influence:

- Residents: Greatly affected by the AERS in emergencies, highly interested in its success, but have little influence over its implementation.

Medium Importance, High Influence:

- Technology Companies: They have the expertise and capability to shape the system, with significant influence over its technical aspects, but other market opportunities balance their interest.
- Automotive Manufacturers: They can influence the design and manufacturing of AVs, but their interest is primarily in product development, not specifically in AERS usage.

Medium Importance, Medium Influence:

- Public Transport Operators: AERS will interact with public transport, so these operators have a vested interest and some influence over how their systems integrate.

- Local Businesses: Traffic and emergency response changes affect their operations; they have some interest and influence, primarily through local commerce groups.
- Insurance Companies: Interested in risk management and policy implications that AERS brings, with moderate influence through insurance offerings.

Medium Importance, Low Influence:

- Community Organizations: Interested in how AERS impacts local communities, with some influence through advocacy but limited direct impact on the project.
- Academic Institutions: Their research can contribute to AERS development; they have an interest in advancing knowledge but have limited influence on practical implementation.

Low Importance, High Influence:

- Media: Can sway public opinion about AERS but typically have a broader focus, making their interest in AERS lower compared to other stories they cover.

3. Key Primary and Secondary Stakeholders:

Primary Stakeholders

- **Regulatory Authorities**:
  - Ensure compliance with safety and legal standards.
- **Urban Planners**:
  - Integrate AERS within city infrastructure and planning.
- **Emergency Services**:
  - Direct beneficiaries with critical input on operational needs.
- **Technology Companies**:
  - Develop and provide autonomous driving and data analytics technologies.
- **Hospitals**:
  - Utilize the system for faster emergency response, impacting patient care.
- **Residents**:
  - The general public is affected by the implementation and outcomes of AERS.

Secondary Stakeholders

- **Automotive Manufacturers**:
  - Produce the autonomous vehicles used in the AERS.
- **Community Organizations**:
  - Represent community interests and concerns regarding AERS.
- **Local Businesses**:
  - Impacted by changes in traffic patterns and emergency response protocols.
- **Media**:
  - Influence public perception and awareness of the AERS project.
- **Academic Institutions**:
  - Research and development partners, offering insights and innovations.
- **Public Transport Operators**:
  - Coordinate with AERS for integrated transportation solutions.
- **Insurance Companies**:
  - Adjust policies based on the new risk profiles introduced by AERS.

Part II: Requirement Elicitation using Questionnaire

Regulatory Authorities:

1. What are your primary concerns regarding compliance for AERS?
2. How important are data security and privacy in the AERS from 1 (not important) to 5 (very important)?
3. How likely is it that you would require third-party certification for AERS components?
4. What features are crucial for AERS to gain regulatory approval?

Regulatory Authorities Responses:

Q#	Response 1	Response 2	Response 3	Response 4	Response 5
1	I'm most concerned about adhering to traffic safety	It's non-negotiable that AVs are fully certified	Data protection is at the top of our list	Clear emergency protocols are a must for us	We're keen on ensuring environmental compliance
2	Definitely a 5, data security is key	It's a solid 4 for us	Data security? Absolutely a 5	Data privacy is a major concern, so it's a 5	We'd rate it a 4, quite important
3	Very likely, it's essential for trust	Likely, assuming all standards are met	We'd insist on it for the sake of public safety	I'd say likely, but it needs a thorough review	I'm open to it if certain conditions are met
4	I'd like to see robust traffic management in real-time	Immediate vehicle prioritization is critical	The system must have top-notch data encryption	Seamless integration with city systems is preferred	We'd need to see rigorous testing for reliability

Urban Planners:

1. How should AERS integrate with existing urban infrastructure?
2. Rate the importance of AERS compatibility with smart city initiatives from 1 to 5.
3. How likely is AERS to necessitate changes to current urban infrastructure planning?
4. Which aspects of urban planning require the most consideration for AERS integration?

Urban Planners Responses:

Q#	Response 1	Response 2	Response 3	Response 4	Response 5
1	I'd prefer integration that doesn't upend current traffic	Syncing with our buses and trams is crucial	It has to fit with what we've already built on the roads	Minimal interference with traffic is my priority	Scalability for future growth is key for me
2	I value its importance at a 4	For me, it's a middle-of-the-road 3	It's a 5, no question, looking towards the future	A solid 4 from me	It's a clear 5, thinking long-term
3	I'm open to	With planning,	Significant	Without the	For certain

	changes, so it's a maybe	it's likely	changes? It's very likely then	right funding, it's a no from me	areas, it's a tentative yes
4	Zoning for AV use is my top planning concern	We need to revamp traffic signals first	We can't forget drone flight paths and regulations	Safety for pedestrians is my main focus	Data integration with smart city tech is essential

Emergency Services:

1. What challenges in emergency response should AERS address?
2. On a scale of 1 to 5, how critical is the integration of AERS with your current dispatch systems?
3. How likely are you to incorporate AERS into your current emergency response protocol?
4. Which AERS feature would most improve your service efficiency?

Emergency Services Responses:

Q#	Response 1	Response 2	Response 3	Response 4	Response 5
1	I'd like to see our teams getting to scenes faster	Directing AVs straight to the incident is key	Navigating around traffic is a game-changer for us	The more real-time info we have, the better	Prepping hospitals ahead of time would be amazing
2	Integration is absolutely critical, it's a 5	It's a 5, we need that seamless link	It's important, I'd say a 4	Without a doubt, a 5 for integration	A 5, can't overstate its importance
3	We're very eager to adopt it if it works well	I believe it's likely, with the right training	Reliability is key, so I'm very hopeful	We'd need to trial it first, but I'm optimistic	I'd need more information but I'm somewhat open
4	Medical tools on board would help us a lot	A central dispatch system would make things smoother	Connecting with traffic systems is pretty essential	Fast communication lines would be a major plus	The ability to do more for the patient on arrival is crucial

Part III: Functional and Non-Functional Requirements

Section 1: Functional Requirements

Regulatory Authorities:

1. Compliance enforcement functionality that ensures all operations adhere to traffic and safety regulations.
2. Certification validation system to confirm that all autonomous vehicles (AVs) and drones meet necessary standards.
3. Data protection measures that secure real-time and stored data within the AERS.
4. Emergency override protocols that allow manual intervention in the system when required.

Urban Planners:

1. Infrastructure integration capability that allows AERS to work with existing traffic lights and urban layouts.
2. Smart city compatibility ensures AERS can function with future urban developments and technologies.
3. Zoning and planning tools within AERS for AV corridors and drone operation areas.

Emergency Services:

1. Quick dispatch system to decrease response times for emergency vehicles.
2. Automated routing that circumvents traffic congestion and optimizes the fastest path to incidents.
3. Real-time information update system that provides ongoing data to emergency responders.
4. The centralized control system for emergency dispatch works with both AVs and traditional vehicles.

Section 2: Non-Functional Requirements

Regulatory Authorities:

1. High reliability to ensure AERS operates consistently under various conditions.
2. Scalability to accommodate the expansion of AERS with growing urban environments and emergency services needs.
3. User privacy protection to comply with data protection laws and regulations.

Urban Planners:

1. Minimal impact on current traffic, implying low-latency processing and decision-making to avoid disruptions.
2. System flexibility to allow for urban development changes without significant system overhauls.
3. High interoperability with existing and future city infrastructure for seamless integration.

Emergency Services:

1. System availability to ensure AERS is operational 24/7 with no downtime.
2. It is usable with an intuitive interface for emergency personnel to interact with the system effectively.
3. Maintainability to ensure that updates, upgrades, and repairs can be carried out swiftly and efficiently.

Part IV: Quality Of Requirement

Requirement Description	Completeness	Clarity	Non Duplication	Relevance	Testability	Consistency	Verifiability	Modifiability
Compliance enforcement functionality	High	High	High	High	High	High	High	High
Certification validation system for AVs and drones	High	High	High	High	High	High	High	High
Data protection measures	Medium	Medium	High	High	Medium	High	Medium	High
Emergency override protocols	High	High	High	High	High	High	High	Medium
Infrastructure integration capability	Medium	High	High	High	Medium	High	Medium	Medium
Smart city compatibility	Medium	Medium	High	High	Low	Medium	Low	High
Zoning and planning tools	High	High	High	High	Medium	High	Medium	High
Quick dispatch system	High	High	High	High	High	High	High	High
Automated routing	High	High	High	High	High	High	High	High
Real-time information update system	High	High	High	High	High	High	High	High
Centralized control system	High	High	High	High	High	High	High	Medium
High reliability	Low	Medium	High	High	Medium	High	Medium	High
Scalability	Low	Medium	High	High	Low	High	Low	High
User privacy protection	Medium	Medium	High	High	Medium	High	Medium	High
Minimal impact on current traffic	Medium	High	High	High	Medium	High	Medium	High
System flexibility	Low	Medium	High	High	Low	High	Low	High
High interoperability	Medium	Medium	High	High	Medium	High	Medium	High
System availability	Medium	High	High	High	High	High	High	High
Usability	Low	Medium	High	High	Medium	High	Medium	High
Maintainability	Medium	High	High	High	High	High	High	High

Section 1: Functional Requirements Quality Assessment

Regulatory Authorities:
Compliance Enforcement Functionality:

- Completeness: High. The requirement specifies the need for compliance enforcement.
- Clarity: High. It clearly states the function of enforcing regulations.
- Non-Duplication: High. Unique to regulatory compliance.
- Testability: High. It can be tested by checking against compliance rules.
- Consistency: High. Aligns with known regulatory frameworks.
- Verifiability: High. Enforcement actions are verifiable.
- Modifiability: High. It can be updated to comply with changing regulations.

Certification Validation System:

- Completeness: High. Explicitly requires validation of AV certifications.
- Clarity: High. Clearly describes the need for a validation system.
- Non-Duplication: High. No overlap with other requirements.
- Testability: High. Verifiable through certification checks.
- Consistency: High. Consistent with industry standards for AV certification.
- Verifiability: High. Recognized bodies issue certifications and can be verified.
- Modifiability: High. The system can be updated as certification standards evolve.

Data Protection Measures:

- Completeness: Medium. Needs more detail on the type of data and protection levels.
- Clarity: Medium. 'Data protection' is broad; specifics are needed.
- Non-Duplication: High. Stands alone in data security.
- Testability: Medium. Depends on detailed security protocols to be testable.
- Consistency: High. Must align with data protection laws.
- Verifiability: Medium. Specifics of data protection measures need to be verifiable.
- Modifiability: High. Should adapt to new data protection regulations.

Emergency Override Protocols:

- Completeness: High. Captures the need for manual intervention capabilities.
- Clarity: High. Describes a clear function of the system.
- Non-Duplication: High. No other requirement addresses overrides.
- Testability: High. It can be tested by simulating override scenarios.
- Consistency: High. It should be consistent with emergency response procedures.
- Verifiability: High. Override incidents should be logged and reviewable.
- Modifiability: Medium. Protocols may need updates based on technological advancements or changes in emergency procedures.

Urban Planners:
Infrastructure Integration Capability:

- Completeness: Medium. The types of infrastructure to be integrated should be specified.
- Clarity: High. The integration need is clear.
- Non-Duplication: High. Unique to urban planning needs.
- Testability: Medium. Testability depends on defined infrastructure parameters.
- Consistency: High. Needs to be consistent with existing urban infrastructure.
- Verifiability: Medium. Integration points should be identifiable and verifiable.
- Modifiability: Medium. It may require changes as new infrastructure is developed.

Smart City Compatibility:

- Completeness: Medium. Lacks details on what 'compatibility' entails.
- Clarity: Medium. 'Smart city' is a broad term; specifics would enhance clarity.
- Non-Duplication: High. The only requirement is addressing future tech integration.
- Testability: Low. Needs more defined criteria for smart city technologies to be testable.

- Consistency: High. It should align with smart city standards.
- Verifiability: Low. Compatibility features must be defined to verify them.
- Modifiability: High. Compatibility requirements will evolve as smart city technologies advance.

Zoning and Planning Tools:

- Completeness: High. Implies comprehensive tools for planning.
- Clarity: High. Specific to zoning and planning for AVs and drones.
- Non-Duplication: High. Does not overlap with other functionalities.
- Testability: Medium. Requires specific zoning and planning parameters to test.
- Consistency: High. It must be consistent with urban planning policies.
- Verifiability: Medium. The effectiveness of tools must be demonstrable.
- Modifiability: High. Tools must be adaptable to changes in urban landscapes.

Emergency Services:

Quick Dispatch System:

- Completeness: High. Clearly indicates the need for rapid dispatch.
- Clarity: High. Describes a core function of the AERS.
- Non-Duplication: High. No other requirement addresses dispatch speed.
- Testability: High. Dispatch time can be measured and tested.
- Consistency: High. Dispatch systems must align with emergency service protocols.
- Verifiability: High. Dispatch speeds and times can be verified.
- Modifiability: High. System updates may be needed to improve dispatch times.

Automated Routing:

- Completeness: High. Specifies the goal of circumventing traffic.
- Clarity: High. Clearly articulated as a routing function.
- Non-Duplication: High. Unique to routing efficiency.
- Testability: High. Routing paths and times are measurable.
- Consistency: High. Routing algorithms must be consistent with traffic regulations and patterns.
- Verifiability: High. Routing efficiency and path selection can be verified.
- Modifiability: High. Adjustments may be necessary as traffic patterns and infrastructure change.

Real-time Information Update System:

- Completeness: High. Covers the need for ongoing data updates.
- Clarity: High. Directly states the requirement for real-time updates.
- Non-Duplication: High. No other real-time update requirement is listed.
- Testability: High. Update intervals and accuracy can be tested.
- Consistency: High. Updates must be consistent with the information flow within the emergency services.
- Verifiability: High. The timeliness and relevance of information updates can be verified.
- Modifiability: High. The system should accommodate updates in technology and information dissemination methods.

Centralized Control System:

- Completeness: High. The need for centralized control is well-defined.
- Clarity: High. Clearly mentions control for dispatch.
- Non-Duplication: High. The centralization aspect is unique.
- Testability: High. Control mechanisms can be tested in operational scenarios.
- Consistency: High. Must be consistent with centralized emergency management practices.
- Verifiability: High. Control system functionality and response can be verified.
- Modifiability: Medium. The control system may need to adapt to new technologies or emergency response protocols.

Section 2: Non-Functional Requirements Quality Assessment

Regulatory Authorities:
High Reliability:
- Completeness: Low. Does not specify the required uptime or failure rates.
- Clarity: Medium. The general concept is straightforward but needs more specifics.
- Non-Duplication: High. Distinct in focus on system reliability.
- Testability: Medium. It needs specific metrics to test against.
- Consistency: High. Reliability must be maintained across all system functions.
- Verifiability: Medium. Specific reliability metrics are required for verification.
- Modifiability: High. System architecture must allow for enhancements to improve reliability.

Scalability:
- Completeness: Low. Needs specific metrics for scaling.
- Clarity: Medium. The requirement is understandable but requires specifics.
- Non-Duplication: High. The only requirement is addressing system growth.
- Testability: Low. Without concrete scaling parameters, it's difficult to test.
- Consistency: High. Scaling capabilities must be uniform across the system.
- Verifiability: Low. Scalability needs to be defined in measurable terms for verification.
- Modifiability: High. The system should be designed to scale without significant overhauls.

User Privacy Protection:
- Completeness: Medium. Should detail the standards or regulations to adhere to.
- Clarity: Medium. Privacy is a broad term; specifics are needed for clarity.
- Non-Duplication: High. No other requirement focuses on user privacy.
- Testability: Medium. Testable if specific privacy benchmarks are provided.
- Consistency: High. Privacy measures must be consistent with legal requirements.
- Verifiability: Medium. Privacy protection measures must be verifiable against standards.
- Modifiability: High. Privacy requirements may change with laws and standards.

Urban Planners:
Minimal Impact on Current Traffic:
- Completeness: Medium. It could be improved with details on acceptable impact levels.
- Clarity: High. The requirement is evident in its intent.
- Non-Duplication: High. The only requirement is addressing the current traffic impact.
- Testability: Medium. The effect can be measured if metrics are defined.
- Consistency: High. Traffic impact measures should align with urban traffic policies.
- Verifiability: Medium. Must establish benchmarks for traffic impact to verify.
- Modifiability: High. Impact thresholds may be adjusted based on urban development.

System Flexibility:
- Completeness: Low. Needs to determine what aspects need flexibility.
- Clarity: Medium. The concept is understandable but vague.
- Non-Duplication: High. Unique in addressing adaptability.
- Testability: Low. Flexibility is hard to test without specific criteria.
- Consistency: High. Flexibility should not compromise other system features.
- Verifiability: Low. Requires clear definitions of what must be flexible to verify.
- Modifiability: High. The system should be capable of adapting to changes with minimal effort.

High Interoperability:
- Completeness: Medium. Should specify with what systems and standards AERS must be interoperable.
- Clarity: Medium. A broad term that requires technical specifics.

- Non-Duplication: High. The sole requirement for system integration capability.
- Testability: Medium. Testable if interoperability standards are established.
- Consistency: High. Interoperability must be maintained across various platforms and systems.
- Verifiability: Medium. Specific interoperability criteria are needed to verify compliance.
- Modifiability: High. System design must allow for future integration with new platforms and systems.

Emergency Services:

System Availability:

- Completeness: Medium. Should specify desired uptime percentage.
- Clarity: High. The intent for a highly available system is clear.
- Non-Duplication: High. Distinct focus on system uptime.
- Testability: High. Availability can be measured against a set benchmark.
- Consistency: High. Consistent availability is crucial for emergency services.
- Verifiability: High. System uptime can be monitored and verified.
- Modifiability: High. The system should support updates that improve availability without significant downtime.

Usability:

- Completeness: Low. Needs to specify user groups and usability criteria.
- Clarity: Medium. Usability is a broad term; details would help.
- Non-Duplication: High. The only requirement addressing the user interface.
- Testability: Medium. Usability tests can be conducted if criteria are defined.
- Consistency: High. User interface must be consistently intuitive across different user roles.
- Verifiability: Medium. Usability can be assessed through user testing and feedback.
- Modifiability: High. Interface should be designed for easy updates and improvements.

Maintainability:

- Completeness: Medium. Should provide details on maintenance windows or service levels.
- Clarity: High. Clear that the system should be easy to maintain.
- Non-Duplication: High. No other requirement addresses maintainability.
- Testability: High. Maintenance processes can be tested and measured.
- Consistency: High. Maintenance activities should not significantly disrupt the system's operation.
- Verifiability: High. Maintenance and service records can verify adherence to the maintainability requirement.
- Modifiability: High. System architecture should allow for efficient updates and maintenance.