CSP 587 - Software Quality Management

Team Project #2 - Report

Team Madison

Section 1: Introduction

The project mainly focuses on the risk management for vehicular systems. Basically, it compares autonomous and AI-controlled systems with taking two means of transportation which is Cars and CTA Trains In this project, we are going to explore the differences in safety, cost and other parameters between the two different means of transport i.e., Cars and CTA Trains in both automated systems and human-supported systems. We are going to achieve the answer to the question Which system fully automated or human supported system is safest and more cost effective and efficient way of transportation by analyzing the real time historic data available.

Objectives:

In this project, we are basically aiming to achieve the below objectives from our analysis:

- **Accident Risk Exposure:**

  By thorough analysis of the previous and historic data, we will be identifying the primary safety concerns in human operated and full automated systems which can help us in assessing the risk exposure in both means of transportation.

- **Fully Automated vs. Human Supported:**

  We will be comparing Fully Automated and Human Supported transportation systems to derive insights related to our current study.

- **Cost Benefit Calculations:**

  In this objective, we will be focusing on the financial impacts of both Full Automated and Human Supported Systems in both means of Transportation.

- **Safety Assessment:**

  We will be providing a detailed safety assessment report and determine which approach offer highest level of safety for the passengers.

Section 2: Risk Assessment Plan

Methodology

The main methodology for this project involves a systematic review and assessment of accident risks related to AI-controlled cars and CTA trains. To ensure a comprehensive risk evaluation.

Scope:

- This risk assessment looks at AI-controlled cars (Levels 4 and 5 automation) and automated CTA trains (at GoA3 and GoA4 levels).The evaluation covers key functions like AI decision-making, perception, and control.
- It also takes into account different weather conditions in Chicago like rain, snow, and fog and the interaction between AI systems and pedestrians and other vehicles.
- Cybersecurity risks, especially with AI systems connected to the internet and Human interaction with AI, especially in emergency or takeover scenarios, is considered.

Limitations:

- **Data Availability**:

  There is less real-world data on Level 5 autonomous systems since they are still being tested, making it harder to predict certain failures.

- **Proprietary Restrictions**:

  Access to detailed AI algorithms from manufacturers was not available, limiting deeper analysis.

- **Regulatory Uncertainty**:

  The rules for autonomous vehicles are still being developed, which makes future safety predictions less reliable.

- **Human Factors**:

  It's challenging to account for all possible human errors when interacting with AI in rare or emergency situations.

- **Environmental Factors**:

  Extreme weather conditions beyond typical Chicago weather like unexpected storms and heavy snow may not be fully covered due to limited data.

Data Collection Methods:

Here I have collected some data from the online

Historical Data Analysis:

- I mainly used reports from NHTSA (National Highway Traffic Safety Administration) and the Chicago Transit Authority (CTA) to review accident records.
- California DMV reports on autonomous vehicle collisions provided insights into real-world crashes, noting 674 accidents as of December 2023.
- I compared these reports to understand how autonomous systems perform versus human-driven vehicles. I found that self-driving cars had an accident rate of 9.1 per million miles, while human-driven cars had 4.1 accidents per million miles.

AI Performance Reports:

- Waymo reported 150 crashes between July 2021 and August 2023, but their crash rate was 0.18 per million miles, which is much lower than the 4.2 crashes per million miles for human drivers.
- Tesla's Autopilot Safety Reports helped compare AI driving systems and showed where human drivers might do better, especially in unclear situations.

Case Studies:

- The 2016 Tesla Autopilot crash in Florida showed the limits of AI sensors in telling objects apart in tough conditions.
- The 2018 Uber self-driving car accident highlighted the dangers of weak human-AI teamwork, especially when humans rely too much on AI.

- The 2019 Copenhagen Metro incident, where a train didn’t stop in heavy rain due to sensor failure, showed how bad weather can affect AI systems.

Environmental Data:

- Data from the National Weather Service and Illinois Department of Transportation (IDOT) on Chicago’s weather patterns (rain, snow, fog) provided a brief view into how weather affects AI sensors like LIDAR and radar.

Cybersecurity Threat Intelligence:

- Reports from CISA (Cybersecurity and Infrastructure Security Agency) and bulletins from Auto-ISAC helped me understand cybersecurity risks, particularly the 99% increase in automotive cybersecurity vulnerabilities in 2019.

Public Perception and Industry Reports:

- I have gone through the public opinion surveys, like the 2023 AAA survey, where 68% of respondents expressed fear of self-driving vehicles. This shows that public trust remains a challenge for autonomous technology adoption.

Risk Evaluation:

Failure Modes and Effects Analysis (FMEA) is used to evaluate the chances and effects of risks, helping to prioritize efforts to reduce those risks.

Probability of Occurrence:

- Automated Cars: According to NHTSA, 392 crashes involving Level 2 systems occurred between July 2021 and May 2022. While generally safe, these systems still pose a risk.
- Case Studies: The 2016 Tesla crash in Florida demonstrated sensor limitations in low-visibility conditions. Fully autonomous trains, like the Paris Metro Line 1, have shown improved safety but still face risks.
- Automated Trains: Performance reports show that fully automated systems, such as Copenhagen Metro, can be highly reliable with a 99.2% on-time performance in 2020.

Factors Influencing Incidents:

- System Complexity: More complex AI systems introduce more points of potential failure.

- Environmental Conditions: Bad weather can seriously affect sensor accuracy.
- Cybersecurity: AI systems connected to the internet are vulnerable to cyberattacks.
- Human-AI Interaction: Over-reliance on AI increases risks if human operators fail to intervene in time.
- Infrastructure Readiness: Poor infrastructure increases the likelihood of accidents, requiring well-maintained tracks and signals for safe operation.

Section 3: Current Risk Analysis

A. Cars

1. Accident Risk Exposure

According to the National Highway Traffic Safety Administration (NHTSA), there were 392 crashes involving vehicles with Level 2 advanced driver assistance systems (ADAS) reported between July 2021 and May 2022. This shows that while these systems are generally safe, there is still a chance of accidents happening.

2. Contributing Factors:

- **AI decision-making errors**

  Risk Scenario: An AI-controlled car approaches a crosswalk where a pedestrian is waiting. The pedestrian takes a step forward, hesitates, and then steps back. The AI system, trained to identify clear crossing intentions, incorrectly predicts that the pedestrian will not cross and again he likes to cross the road and proceeds. Here, You can see that the main AI misinterprets the pedestrian’s hesitation as a decision not to cross the road and it accelerates, causing a near-miss or an accident if the pedestrian decides to cross the road.

  Impact: This decision-making error could lead to an accident or put pedestrians in dangerous situations. Human drivers can understand small signals and unexpected actions, but AI doesn't have the ability to make those careful decisions.

- **Sensor malfunctions**

  Risk Scenario: An autonomous car uses LIDAR to spot objects around it so the AI can avoid obstacles. In heavy rain, water droplets interfere with the LIDAR sensor, making it less accurate. The sensor starts to miscalculate the distances, thinking puddles are obstacles or missing real obstacles, like another car, because the water blocks its view.

Impact: The AI might turn sharply or stop suddenly for no reason, which could confuse other drivers, or it might not avoid a real danger, causing an accident.

- **Vulnerability to cybersecurity threats or attacks**

Risk Scenario: Hackers break into an autonomous car’s GPS system. They change the GPS coordinates, making the car think it is on a different street. This wrong GPS data makes the car’s AI change its route, causing it to make unexpected turns, drive into restricted areas, or ignore traffic rules.

Impact: The car could enter unsafe areas (like construction zones), run red lights, or even cause accidents. A hacker could make the car drive into dangerous situations on purpose.

B. CTA Trains

1. Accident Risk Exposure

The CTA train is controlled by AI and is supposed to stop at a station. But the track was recently repaired, and the AI hasn’t been updated about the changes. Because of this, the train tries to stop at the usual spot but doesn't adjust for the new track, causing it to go past the platform or stop too suddenly.

Impact: This AI mistake can make passengers uncomfortable, delay the schedule, or, in serious cases, cause accidents, injuries, or even loss of lives.

2. Contributing Factors

- **Sensor malfunctions**

  Risk Scenario: A CTA train uses radar to find objects on the track, like debris or other vehicles. But in foggy weather, moisture scatters the radar signals, making them less effective. The radar might mistake the fog for an object or miss detecting debris on the track.

  Impact: The train might brake for no reason, causing delays. In the worst case, it might not stop for real debris, which could lead to a derailment or damage to the train.

- **Vulnerability to cybersecurity threats or attacks**

  Risk Scenario: The CTA trains are managed by a central AI system that controls their speed, track switching, and stopping. A hacker finds a weakness in the network and gains access to this system. The hacker could make several trains speed up at the same time, skip scheduled stops, or change tracks randomly, which could lead to crashes.

  Impact: This type of attack could cause major damage to the infrastructure, put passengers in danger, and require a lot of time to fix the system and restore safe operations.

- **Human Interaction Risks: Over-reliance on AI by human operators, leading to delayed intervention**

  Risk Scenario: A CTA train is being controlled by AI. The AI detects a signal failure ahead but misjudges how serious the problem is and keeps the train running at normal speed. The human operator trusts the AI to handle everything, so they don't watch the signal system as closely as they should. They assume the AI will manage any issues.

  Delayed Intervention: By the time the operator notices that the AI isn't responding correctly to the signal failure, it's too late to slow down or change the train's path safely. The train continues on its current route, which could lead to a near-miss or crash.

  Impact: The operator's delayed response, caused by relying too much on AI, could result in serious safety risks or accidents.

- **Poor communication between AI systems and human operators during emergencies**

  Risk Scenario: An autonomous car is driving in heavy rain when its LIDAR sensor fails due to water interference. The AI system recognizes that it's no longer receiving reliable data but continues driving in "manual override mode" without clearly alerting the human driver. The AI system fails to notify the human operator effectively that its sensors are malfunctioning and that the car requires immediate manual control. The human driver, unaware of the malfunction, assumes the AI is still in control. When the car suddenly begins drifting out of its lane, the human operator is caught off-guard. They have no clear understanding of the system's failure and struggle to regain control.

Impact: The delayed human intervention could cause the car to go off course dangerously or collide with another vehicle. This situation became dangerous by the lack of clear communication from the AI system about the nature of the malfunction.

Section 4: AI Controlled System Analysis

A. Cars with AI Control:

1. Potential changes in risk exposure:

- **Reduction of Human Error:**
  Human errors such as distracted driving, reckless driving, and drunk driving are the major causes of car accidents. By making the vehicle autonomous we can eliminate these errors as AI will have full control over vehicle operations and it takes instant decisions to avoid accidents. For example, if a person is in a phone conversation and misses an obstacle on the way, the AI sensors will detect that obstacle and make a split-second decision that prevents the collision.
  According to a study, Autonomous cars are actually safer compared to human driven cars.

- **Improved Adaptation to Environmental Conditions:**
  In extreme weather conditions like heavy snowfall, thick fog and heavy rain, humans find it difficult to drive as the road will not be clearly visible. But because of the sensors, autonomous cars can detect the surrounding vehicles and objects even if they are not visible.
  For example, if there is dense fog, autonomous cars use Radar sensors, to detect the vehicles that are several hundred feet away.

- **Helpful in Long Drives:**
  If we encounter an emergency where we have to drive the car for a very long distance, after some time we might feel tired or sleepy especially at nights. In this situation we can rely on autonomous cars as they can operate continuously without any break. This results in reducing the accidents that happen because of bad judgment by human driver after long hours of driving.
  For example: Autonomous cars like Tesla and Lucid.

- **Reduction of Traffic Laws Violation:**
  Knowingly or unknowingly human drivers frequently violate traffic rules, especially not following speed limits, running red lights, being unable to yield at intersections, etc. These violations can be significantly reduced using autonomous cars as they can be programmed to strictly follow traffic regulations. Also, reduces accidents

caused because of missing important signboards, as we can integrate a maps software which already has all the upcoming signboards information.

2. New Factors to Consider:

- **Cybersecurity Risks:**
  Ensuring high-security measures is very important, as hackers can gain control over the car, to manipulate the sensors, which results in accidents or to steal the user data.

- **Sensor Malfunction:**
  Autonomous cars rely on multiple sensors to know the surroundings and detect the obstacles, failure in any of these sensors could lead to severe accidents.
  So, the car company should vigorously test all sensors in various outdoor situations and various weather conditions.

- **Fails in Ethical Decision making:**
  This is the biggest problem with autonomous cars and requires a major improvement in this area. Let's take a scenario where 5 pedestrians come onto the road suddenly, now the moving car has two options to turn the extreme left or right and collide with the divider or move straight and try to break in a short distance. In this situation a human driver will mostly take an extreme turn, as it results in leaving the driver with injuries. However, because of certain pre-programmed decision-making situations, autonomous cars mostly choose extreme breaking, which might result in killing pedestrians.

- **Legal Challenges:**
  Existing laws should be updated according to autonomous cars, to avoid situations where no one can decide who is responsible for the accident. For example, if a bad decision results in a crash, then it might be difficult to determine who is responsible between car company or software developer or the owner.

B. CTA Trains with AI Control:

1. Potential changes in risk exposure:

- **Reduction in Operator Error:**
  Operations such as breaking, speed control and signalling are controlled by humans, a small error could lead to a severe accident. Let's look at the incident that happened in 2014 at O'Hare International Airport, a CTA Blue line train overran

at the end of the station and collided with the bump, resulting in several injuries. And this happened because the driver fell asleep. This could have been avoided if there was an AI system to detect the station ending, and automatically reduce the train's speed.

- **Real-Time Monitoring:**
  Humans cannot see obstacles on track, which are hundreds of feet away from them. This results in late braking, hence, high chance of collision. A similar incident occurred in 2023, November. A yellow line train traveling at a speed of 26.9 mph collided with a stopped snow removing machine, resulting in injuring 6 people. This happened as the operator couldn't see that machine until very near, so unable to stop the train in time. This can be avoided using AI systems, as they rely on sensors like radar, cameras, etc. They will find the obstacles that are on the track from a distance and apply the brakes, before it's too late.

- **Optimized Train Scheduling and Movements:**
  When trains are moving on tight schedules, manual scheduling might result in delays, signal errors and in the worst case might lead to collisions.
  These problems can be avoided using AI, as it can manage time more accurately and optimize train schedules, thereby reducing delays and risks. In complex junctions where there will be multiple signals, the probability of making an error is higher for humans, whereas AI can handle these complex signalling tasks, reducing the risk of collision due to human error.

- **Warning Devices:**
  There are some limitations for humans, as they cannot check every inch of the train track daily and if no one notices a small breakage on the track it will result in train derailment. The same happened with the Blue Line train in 2001, a track defect resulted in injuring 140 people and in 2006 a defective switch caused the Pink Line train to derail. To avoid these situations from happening again, we need to implement a warning device or system, that will keep track of all the switches and tracks, and immediately give a warning if that system finds an issue.

2. New Factors to consider:

- **Infrastructure Compatibility:**
  Existing infrastructure needs to be updated as this is not compatible with AI systems. Especially tracks and signals must be upgraded to communicate effectively with AI systems, which helps in finding defects before it is too late.

- **Maintenance and System Redundancy**:
  It is going to be necessary to check the AI systems regularly, to ensure that all the sensors and cameras work perfectly without any defect. Also, there should be a backup readily available to take over the operations, if the main AI system fails.

- **Cyber Attacks:**
  Just like autonomous cars, AI-controlled trains are also prone to cyber-attacks by hackers. Which will result in train delays or collisions in the worst cases. Therefore, it is necessary to implement high security systems or a self-destruction switch, which will turn off all the AI systems in this type of situations, so that manual operators can take the situation into their control.

- **Training to the Operators and Staff:**
  The shift from manual to integration with AI needs training to the staff and operators. As they need to learn how to supervise AI operations instead of directly controlling trains.

Section 5: Comparative Analysis: Fully - Automated vs. Human - Supported Systems

A. Assumptions:

1. Fully-Automated Systems:

Fully automated systems are programmed such that they can operate without the involvement of Humans. They will be given a set of instructions which are already programmed and provided previous real-time data. They make their decision based on the data available and the set of instructions programmed. It can be assumed that AI systems can mitigate distractions and poor decision-making made by Humans which can help reduce accidents caused due to these reasons. It also assumed that as AI is given set of instructions programmed into the system it follows all the traffic rules like lane-keeping and track changing and other scenarios.

2. Human Supported Systems:

In the Human Supported Systems where AI is used for giving instructions to the Humans where Humans operate the vehicles or Trains completely, it is Humans who make all the decisions. It also assumed that for some situations Humans decision is needed because in some specific conditions AI can't take correct decisions. There might be some situation where opposite person might take some unexpected turns or something similar to that where humans can act better compared to the current AI systems.

B. Data Used:

We have used data from various real time sources. Some of the sources which we used include National Highway Traffic Safety Administration, Autonomous Vehicle and Train Data from companies like Waymo, Trains operating in Chicago, Paris and Tokyo. The data says that almost 90% of the accidents are caused by Human Errors which says that transforming the transportation system from Human supported to Full automated can show significant results which include passenger safety and other important traffic aspects.

C. Cost-Benefit Calculations:

1. Financial Costs:

The financial costs involved in developing a fully automated system is usually higher because it requires advanced technology which includes development of software's, high quality sensors. Whereas when it comes to Human supported systems, although it requires some cost in developing but when compared to Fully automated systems. When it comes to long run, we can have reduced costs on Fully automated systems because of less accidents and improved efficiency.

2. Benefits:

A study conducted by Nature Communications on autonomous vs human operated vehicles found that fully automated vehicles had a lower risk of exposure to accidents when compared to Human supported vehicles particularly in work zones, heavy traffic areas. It is also evident that autonomous systems do not suffer from ill conditions which humans do. So, it is likely that Fully Automated systems can perform better when compared to Humans in this aspect which ensures passenger safety reducing the cost of recovery in case of accident.

Section 6: Overall Safety Assessment

Quantitative Data Comparison:

Criteria	Fully Automated Cars	Human-Supported AI CTA Trains
Accident Reduction	94% potential reduction in crashes caused by human error (NHTSA)	30% reduction in accidents after partial automation (UIC)
Cost-Effectiveness	$800 billion annual economic benefit in the US (SAFE)	30% reduction in operational costs (UITP)
Public Acceptance	48% of Americans express willingness to ride in self-driving cars (Pew Research)	75% passenger comfort with automated trains with human oversight (Thales)
Technological Feasibility	Level 4 autonomy achieved in controlled environments (Waymo)	GoA3 widely implemented, GoA4 in select systems globally
Environmental Adaptability	23% higher error rate in adverse weather (CARLA simulator study)	99.2% on-time performance in varied conditions (Copenhagen Metro)

Evaluation of the safest approach:

From our above analysis we have provided the following safety approach for the both fully automated Cars and CTA Trains with human and AI support

When evaluating safety, we have to focus on four key criteria: accident reduction, cost-effectiveness, public acceptance, and technological feasibility. These criteria are critical because:

- **Accident Reduction** measures how well each system prevents accidents, directly impacting public safety.
- **Cost-Effectiveness** ensures that implementing these systems brings value without being prohibitively expensive.
- **Cost-Effectiveness** means making sure these systems provide good value and aren't too costly to put in place.
- **Public Acceptance** looks at whether people trust these technologies and are willing to use them, which is key for successful rollout.
- **Technological Feasibility** checks how practical it is to set up the system with the technology and infrastructure we have today.

Cars: Fully-automated Systems

Human error is mainly responsible for 94% of serious crashes, according to the NHTSA. Fully automated systems can greatly reduce these errors as we can see that Waymo's self-driving cars have driven over 20 million miles and only had minor incidents, showing that with maintaining the system we can be safe with automated cars.

Advanced sensors and AI can process information faster than humans, allowing them to make quick decisions to avoid accidents.

- **Accident Reduction:** Fully automated cars could cut accidents by 90%, while human-supported systems might reduce them by 50%. This main difference is important, given that there are about 36,000 deaths and 2.7 million injuries from car accidents every year we can reduce this with AI driven Automated cars
- **Human Error Elimination:** more car accidents happen because of human mistakes, like distracted or Drowsy driving. Fully automated systems can get rid of these issues.
- **Reaction Time:** AI can understand and respond to situations much faster than human drivers, which is crucial in fast-changing road conditions.
- **Consistency:** Different from human drivers, AI systems don't get tired, distracted, or sleepy, which helps them stay focused and perform well for a long time.

- **Cost-Benefit Analysis:** Even though setting up fully automated systems costs more at first (estimated $50 billion compared to $20 billion for human-supported systems), they show much higher benefits over five years (estimated $775 billion vs. $470 billion).
- **Long-term Scalability:** As technology gets better and costs go down, the advantages of fully automated systems are expected to grow even more.

CTA Trains: Human-Supported AI Systems

- **Current Safety Record:**

  CTA trains have a low accident rate, so the benefits of fully automated trains are less noticeable compared to cars.
- **Controlled Environment:**
  Trains run on set tracks, making it easier for humans to oversee operations effectively.
- **Cost-Effectiveness:**
  Human-supported train systems have a smaller negative financial impact (-$1 billion) compared to fully automated systems (-$2.5 billion) over five years.
- **Public Acceptance:**
  About 75% of people are more comfortable with automated trains that have human operators, according to Thales.
- **Flexibility:**
  Human operators can step in during unexpected situations or system failures, adding extra safety.
- **Regulatory Compliance:**
  Current US laws require human operators for emergencies, making human-supported systems easier to put in place.

Additional Considerations:

Transition and Scalability:

Gradually introducing fully automated cars together with human-driven ones allows for an easier transition. And in CTA Trains Human-supported systems can fit better with existing train setups, with the chance to move to higher automation levels later.

Public Education and Training:

Public education campaigns can increase acceptance of automated systems by up to 25% (AAA Foundation study, 2022).In CTA Training programs for operators can focus on system monitoring and emergency response, with an expected 18-month transition period based on the Paris Metro experience.

Ethical and Legal Considerations:

Both systems need to think about ethical decision-making in accidents. Legal frameworks are being created to treat AI systems like "electronic persons" (EU Parliament proposal, 2022).

Continuous Improvement:

Both systems can keep improving AI technology. Human-supported train systems offer a good balance between new technology and current safety standards.

Risk Distribution:

Using fully automated cars and keeping human-supported trains spreads risk across different types of transportation. This approach allows for long-term studies on both systems, helping shape future policies and technologies.

Emergency Management:

Systems like Tesla's Autopilot have driver monitoring and safe stopping features. Automatic Train Operation (ATO) with Automatic Train Protection (ATP) ensures safe stopping and speed control, even in emergencies.

Section 7: Post - Analysis Audit:

A. Evaluation of the Risk Assessment Process:

For both AI-controlled cars and CTA trains we have identified the primary risks associated with them. Key points include:

- **Comprehensive Identification of Risks:**
  Our analysis examined the risks associated with both human operated systems and AI systems. We have taken various categories, like human factors, environmental, and operational defects, for evaluation of major risks.

- **Data Utilization:**
  Past accident data and current technological capabilities were used to measure the severity of the risks, this helped in prioritizing major risks. We also considered hypothetical data, as we have written some scenarios, regarding reducing risks using AI systems implementation.

- **Identified Limitations:**
  This analysis allowed us to identify the limitations like lack of real-world data for AI systems and also lack of ethical information in AI systems, like deciding between two harmful situations. These types of limitations are addressed through hypothetical scenario testing and similar incident data from the past.

B. Was the Analysis Worth It?

Yes, the analysis was definitely worth it. It provided critical insights about safety and how we can effectively implement AI systems to reduce the risks of human errors. Even though implementing these new AI systems would cost very high initially, the long-term gains from these will be worth the cost and time as it leads to saving people's lives. Moreover, this analysis serves as a basement or a template for similar studies. In conclusion despite of the challenges, we gained valuable knowledge about the limitations and risks involved in present transportation. We also learned how AI systems can help solve these issues and how to implement AI in transportation efficiently and effectively. Last but not least this analysis will help us to keep track of future transportation development. Considering all these factors, this analysis was undoubtedly worth conducting.

C. Process improvement Opportunities:

There are several improvement opportunities found from our above risk assessment. The absence of real-world data for AI systems highlights the need of conducting thorough testing in a variety of environments in order to get better and accurate results. Another challenge is making ethical decisions in the use of AI, which requires the creation of systems that can make better decisions and put human safety first. Also, scenario-based testing will help us to test the system in various environments and conditions. By addressing these issues we can make better and reliable AI systems which will help us improve our life in an efficient way.

Section 8: Status Report

We initially started with dividing each section for analysis for each team member. Each team member analyzed Fully – Automated and Human – Supported Systems separately and shared our thoughts in various meetings and completed the project. The below are the contributions of each team member.

Contributions:

1) **Divya Kampalli (A20539479):**
   Section 3: Current Risk Analysis
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   Section 1: Introduction
   Section 5: Comparative Analysis: Fully - Automated vs. Human - Supported Systems
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   Section 6: Overall Safety Assessment