Project Charter

# Project Name

Manhole Cover Defect Intelligent Recognition System

# Project Stakeholders

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1. Project Description

## Background

With the rapid development of infrastructure construction, various underground pipeline facilities such as communication, electricity, and drainage are increasing day by day. Handling hidden dangers of manhole covers is an important task in the periodic maintenance of transmission routes. The quality of maintenance work in the transmission network not only affects the robustness of the network but also affects customer experience. Manhole covers in the existing network are widely distributed and fragmented, often in complex outdoor environments, exposed to wind and rain, prone to damage or displacement, posing significant risks to vehicles, pedestrians, optical cable facilities, etc. Due to the large number and wide distribution of manhole covers, and the inability to actively report their status, it is essential to rectify hidden dangers related to manhole covers. The traditional management method relying on manual verification is time-consuming and labor-intensive, with low maintenance capabilities. There is an urgent need to introduce AI capabilities to achieve intelligent recognition of manhole cover status, replacing traditional manual operations, to reduce costs, increase efficiency, improve quality inspection efficiency and quality, and achieve comprehensive coverage.

## Description of the Challenge or Opportunity

Challenges:

1. Poor Image Quality: Due to the outdoor placement of manhole covers, they are susceptible to factors such as lighting, shadows, and dirt, which can result in poor image quality, thereby affecting the performance of recognition algorithms.

2. Diversity and Complexity: Manhole covers vary in shape, material, color, etc., and the surrounding environment can be highly diverse and complex, adding to the complexity of recognition algorithms.

3. Hazard Classification: Identifying whether manhole covers have hazards and categorizing them poses a challenge. Different types of defects may require different recognition methods and algorithms.

4. Difficulty in Data Annotation: Acquiring a large volume of well-annotated training data can be challenging, especially for complex manhole cover defects.

5. Real-Time Requirements: In outdoor inspection scenarios along transmission routes, there is a need for real-time recognition of manhole cover status to promptly address any issues that arise.

6. Performance Requirements: Recognition algorithms need to be efficient and accurate to handle large-scale data and complex scenarios effectively.

7. Security Considerations: While recognizing manhole cover status, it's essential to ensure the security of the system to prevent unauthorized access or malicious attacks.

Opportunities:

1. Safety Enhancement: By identifying the status of manhole covers, potential safety hazards can be promptly detected, reducing the likelihood of accidents and enhancing the safety of urban traffic and pedestrians.

2. Cost Savings: An automated manhole cover recognition system can reduce the need for manual inspections, lowering maintenance costs and improving efficiency. This can assist city management departments in saving manpower and financial resources.

3. Data-Driven Decision-Making: By collecting and analyzing a large amount of data on manhole cover status, valuable information can be provided for the maintenance and planning of urban infrastructure. Based on this data, decision-makers can formulate more effective city management strategies.

4. Technological Innovation: The manhole cover recognition project promotes the application of computer vision and artificial intelligence technologies in the field of urban infrastructure management. This technological innovation helps drive industry development and may lead to innovative applications in other related fields.

5. Market Demand: With the continuous expansion and updating of urban infrastructure construction, the demand for manhole cover recognition technology is increasing. Providing efficient and reliable solutions can meet the market's demand for safety and efficiency.

## Overview of the Desired Impact

1. Enhanced Safety: By accurately identifying the status of manhole covers, the project aims to significantly reduce the risk of accidents caused by damaged or missing manhole covers. This will enhance the safety of both vehicular traffic and pedestrians in urban areas.

2. Cost Efficiency: Implementing an automated manhole cover recognition system will lead to reduced labor costs associated with manual inspections. This cost-saving measure will enable city management departments to allocate resources more efficiently and effectively.

3. Data-Driven Decision Making: Through the collection and analysis of data on manhole cover conditions, the project seeks to provide valuable insights for urban infrastructure maintenance and planning. Decision-makers will be empowered to make informed decisions to optimize resource allocation and improve overall infrastructure management strategies.

4. Technological Advancement: The adoption of computer vision and artificial intelligence technologies in the field of urban infrastructure management will represent a significant technological advancement. This project will contribute to the ongoing innovation and development of smart city solutions.

5. Market Leadership: By providing a reliable and efficient manhole cover recognition solution, the project aims to establish itself as a leader in addressing the growing market demand for safety and efficiency in urban infrastructure management. This will position the project team as key contributors to the advancement of smart city initiatives.

# Measurable Organisational Value

## 4.1 Project Goal

Develop an intelligent system capable of automatically identifying manhole cover hazards, including cracks, damages, missing covers, tilts, and other types of defects. Improve urban road safety by reducing traffic accidents and personal injuries caused by manhole cover hazards. Reduce labor costs by replacing traditional manual inspection methods with an automated recognition system, thus enhancing efficiency and accuracy. Achieve a recognition accuracy rate of over 95% to ensure high precision in identifying manhole.

## 4.2 Commercial Value

Cost Savings: An automated manhole cover hazard recognition system can reduce labor costs, decrease reliance on human resources, and improve recognition efficiency and accuracy. This helps to save maintenance costs, enhance efficiency, and thus bring significant economic benefits to city management departments and businesses.

Market Demand Fulfillment: With the continuous expansion and updating of urban infrastructure construction, the demand for manhole cover hazard recognition technology is increasing. Providing efficient and reliable solutions can meet the urgent market demand for safety and efficiency, thus bringing continuous business opportunities and growth space for enterprises.

# Project Scope

## 1. System Development: Develop an automated system capable of accurately identifying various types of manhole cover hazards, such as cracks, damages, missing covers, tilts, etc.

## 2. Data Collection and Processing: Gather relevant data on manhole covers, including images and metadata, and preprocess the data to ensure quality and compatibility with the recognition system.

## 3. Algorithm Development: Design and implement computer vision and machine learning algorithms to analyze the collected data and recognize manhole cover hazards with high accuracy and efficiency.

## 4. Integration and Testing: Integrate the developed system with existing infrastructure and conduct thorough testing to ensure its functionality, reliability, and performance under various conditions.

## 5. Deployment and Implementation: Deploy the system in real-world environments, such as urban streets and road networks, and ensure proper implementation to support ongoing operations and maintenance.

## 6. Training and Support: Provide training sessions for end-users and stakeholders on how to use the system effectively. Additionally, offer ongoing technical support and maintenance to address any issues that may arise post-deployment.

## 7. Documentation and Reporting: Prepare comprehensive documentation detailing system specifications, user manuals, and maintenance procedures. Also, generate regular reports on system performance and effectiveness for stakeholders and management review.

## 8. Scalability and Future Enhancements: Design the system with scalability in mind to accommodate future expansion and upgrades. Explore opportunities for enhancing system capabilities and integrating new technologies to meet evolving needs and requirements.

# 6 Project Schedule Summary

## 6.1 Project Start Date and End Date

Start date：2024.3.20

End date：2024.6.1

## 6.2 Timeline of Project Phases and Milestones

1. Requirements analysis phase（1 week)

• Define project objectives and service content.

• Conduct data collection to gain in-depth understanding of the market demand for this service.

• Write requirements specification document.

2. Relevant Technical Learning（2 weeks)

• Study algorithms related to image recognition, as well as how to use these algorithms to train models.

3. Model Training（2 weeks）

• Collect images of manhole covers with various damage conditions and classify them to construct a dataset.

• Train the model using the dataset combined with the YOLOv8 algorithm, and obtain the trained model.

4. System Development（3 weeks）

• Utilize the trained model to build a system for detecting damaged manhole covers.

• Create an aesthetically pleasing user interface for interaction.

5. Integration test(2 weeks)

• Test the system comprehensively to evaluate the accuracy of manhole cover detection and ensure that the system meets the specified performance and functionality requirements.

• Conduct assessments based on the initial requirements to evaluate the system's performance and effectiveness.

6. Iterative Optimization （2 weeks）

• Continuously optimize the system based on its shortcomings to enhance performance and user experience.

## 6.3 Project Reviews

## The project team will hold periodic meetings to discuss project progress, address existing issues, and plan for future development to ensure that the project development stays on track according to the original schedule.

Content of the meeting review：

• Completion status and quality of tasks assigned to individual team members

• Overall project completion status and progress

• Identification of any team members facing challenges and providing assistance for resolution

• Fairness in task assignments across the team

# Project Budget Summary

## Total Project Budget

This project, which involves the development of a YOLO V8-based manhole cover recognition system, has a total budget of RMB 100,000. This budget will cover all expenses required at various stages, including project planning, design, development, testing, launch, and subsequent operation and promotion. We will establish a rigorous budget management system to monitor and adjust all expenses in real-time to ensure smooth project execution within the allocated budget.

## Budget Broken Down by Phase

1. Planning and planning phase

The budget for this phase will primarily cover market research, demand analysis, plan formulation, team building, and initial research into manhole cover recognition algorithms. The estimated cost is RMB 6,000, accounting for 6% of the total budget.

1. Design and development phase

The budget allocated to this phase will mainly be used for website design, content creation, technology development, manhole cover dataset collection and annotation, and model training. The estimated cost is RMB 30,000, representing 30% of the total budget.

1. Test and Launch phase

Funds for this phase will primarily cover system testing, optimization of the manhole cover recognition algorithm, domain name registration, server hosting, and pre-launch promotion preparation. The estimated cost is RMB 20,000, accounting for 20% of the total budget.

1. Operation and promotion phase

During this phase, the budget will be allocated for the daily operation of the website, content updates, marketing promotions, and ongoing collection and updating of manhole cover data. The estimated cost is RMB 30,000, representing 30% of the total budget..

1. Optimization and iteration phase

Funds allocated to this phase will mainly support optimization and iteration of the manhole cover recognition algorithm based on user feedback and data analysis, as well as potential expansion and upgrades in the later stages. The estimated cost is RMB 10,000, accounting for 10% of the total budget.

# Quality Issues

The quality concerns of our manhole cover recognition system primarily involve aspects such as user experience, recognition accuracy, system stability, and security.

1. User Experience:

Interface Friendliness: Ensure a user-friendly interface design that is intuitive and easy to navigate.

Response Speed: Guarantee fast system response times, allowing users to quickly upload images or videos for recognition.

Ease of Operation: Provide a straightforward user workflow, allowing users to easily upload, view recognition results, and perform necessary actions.

Result Display: Clearly present recognition results, including manhole cover locations, conditions, and potential hazards, aiding users in quickly understanding recognition information.

1. Recognition Accuracy

Model Training: Ensure the use of high-quality datasets for model training, improving manhole cover recognition accuracy and stability.

Algorithm Optimization: Continuously optimize recognition algorithms to enhance adaptability to different scenarios, lighting conditions, and manhole cover states, reducing instances of misidentification and omission.

1. System Stability

Operational Stability: Ensure the system can operate continuously and stably, avoiding interruptions in recognition services due to system crashes or slowdowns.

Exception Handling: Establish robust exception handling mechanisms to promptly detect and address abnormal conditions during system operation, safeguarding the stability and reliability of recognition services.

1. Security

Data Security: Strengthen the security of user data, including encryption measures during data transmission and protection of user data privacy.

System Security: Ensure the system is well-protected against unauthorized access or malicious attacks, safeguarding the stable and secure operation of the recognition system

By continuously optimizing user experience, improving recognition accuracy, ensuring system stability, and enhancing security measures, our manhole cover recognition system will better meet user needs, provide reliable recognition services, and contribute to urban management and traffic safety

# Resources Required

Our manhole cover recognition system relies on comprehensive resource support for its operation.

## Human Resources

* Technical Team: Responsible for system development, maintenance, and updates. They need to possess strong technical skills to promptly address various technical issues within the system and continuously optimize and upgrade the system according to market demands.
* Data Annotation Personnel: Responsible for annotating training data to support model training and optimization. They need to have good data understanding and annotation accuracy to ensure the quality and effectiveness of the training data.
* Customer Service Team: Providing user inquiries and technical support. They need to have excellent communication and problem-solving skills to promptly respond to user inquiries and feedback, assisting in resolving issues encountered during user usage.
* Administrators: Responsible for reviewing course refund requests, checking instructor qualifications, and reviewing reported content.

## Technology

Hardware Equipment: Including high-performance servers, image processing devices, etc., to support system operation and execution of image recognition algorithms.

Development Tools and Frameworks: Choosing appropriate development tools and deep learning frameworks, such as TensorFlow, PyTorch, etc., to support system development and model training.

Database System: Establishing a reliable database system for storing and managing the data required by the system, including image data, model parameters, user information, etc.

## Financial Resources

* Development and Maintenance Costs: Including salaries for the technical team, procurement, and maintenance costs of hardware equipment, etc.
* Data Collection and Annotation Costs: Used to pay wages and related expenses for data collection and annotation personnel.
* Customer Service Costs: Used to establish the customer service team and provide good after-sales service.

## Other

* Marketing and Promotion Expenses: Used to promote the system and attract more users and partners.
* Training Expenses: Used to train the technical team and customer service team to improve their technical skills and service capabilities.

By fully utilizing various resources, our manhole cover recognition system will be able to operate stably and provide efficient and accurate recognition services, thereby providing strong support for urban management and traffic safety.

# Assumptions and Risks

## Assumptions

1. Image Quality: The system assumes that the images of the manhole covers provided for analysis are of high quality, with minimal blurring and optimal lighting conditions to ensure accurate defect recognition.
2. Coverage of Defect Types: It is assumed that the system has access to a comprehensive database of known types of manhole cover defects which are representative of real-world scenarios.
3. Hardware Capabilities: The assumption is that the hardware on which the system operates has sufficient processing power and memory to handle the computation-intensive tasks of image processing and data analysis without significant delays. Regulatory environments remain favorable or manageable for e-commerce and online education.
4. User Training: There is an assumption that users of the system, likely municipal workers or contractors, will receive proper training on how to use the system effectively and safely. Partnerships for content and technology will be established without significant hurdles.
5. Regulatory Compliance: The project assumes that all operations comply with local laws and regulations regarding data privacy and public safety.

## Risks

1. Image Variability: The system might encounter variability in image quality due to different weather conditions, lighting, or angles of capture, which can affect the accuracy of defect recognition. Technological Challenges: Medium probability; could result in increased costs and project delays.
2. Technological Limitations: There is a risk that the machine learning models may not sufficiently learn from the available data, leading to lower than expected accuracy in defect identification.
3. Data Privacy and Security: Managing and protecting the data collected by the system poses a risk, especially personal or sensitive data that could be captured inadvertently in public spaces. Customer Acquisition Costs: High probability; might be higher than anticipated, affecting profitability.
4. Adoption by Users: Resistance from potential users, due to reliance on traditional methods or skepticism about the technology's effectiveness, might limit the system’s implementation.
5. Maintenance and Updates: The system requires continuous updates and maintenance to accommodate new types of defects and improvements in technology, posing a risk if not regularly managed.
6. Dependence on Specific Technologies: The project's success is highly dependent on specific software and hardware technologies, which may become obsolete, suffer from lack of support, or experience disruptions in supply chains.

# Project Administration

## Communications Plan

Objective: Ensure timely and effective communication among all project stakeholders.

* Tools: Use emails, project management software, and regular team meetings.
* Frequency: Weekly updates via email, monthly project review meetings, and as-needed urgent communications.
* Stakeholders: Project team, municipal authorities, software developers, hardware suppliers, and end-users.
* Documentation: All communications will be documented and stored in a central repository accessible to relevant stakeholders.

## Scope Management Plan

Objective: Define and control what is included and excluded in the project.

* Scope Definition: Deliver a functional intelligent recognition system that identifies defects in manhole covers using machine learning.
* Control Mechanisms: Use a Work Breakdown Structure (WBS) and regular scope reviews to monitor and control the project scope.
* Change Request Process: All requests for changes in scope must be submitted in writing, reviewed by the project management team, and approved by the steering committee.

## Quality Management Plan

Objective: Ensure the project outputs meet all quality standards and stakeholder requirements.

* Standards: Adherence to ISO 9001 standards for quality management.
* Quality Metrics: Accuracy of defect recognition, system reliability, and user satisfaction.
* Audits and Reviews: Scheduled quality audits and peer reviews throughout the project lifecycle to identify and correct non-conformances.

## Change Management Plan

Objective: Manage changes effectively to minimize project disruptions.

* Change Identification and Recording: All changes must be identified, described, and recorded in the change management log.
* Impact Analysis: Analyze potential impacts on the project scope, budget, and timeline.
* Approval and Implementation: Changes must be approved by authorized personnel before implementation; necessary adjustments are to be communicated to all impacted stakeholders.

## Human Resources Plan

Objective: Define roles, responsibilities, and processes to manage project team members.

* Team Structure: A project manager, data scientists, software developers, testing engineers, and support staff.
* Roles and Responsibilities: Clearly define the roles and responsibilities for each team member.
* Training and Development: Provide necessary training in machine learning techniques, project management tools, and system maintenance.

## Implementation and Project Closure Plan

Objective: Outline the steps for implementing the system and formal procedures for project closure.

* Implementation Steps: System deployment in a controlled environment, user training, system testing, and live deployment.
* Performance Tracking: Monitor system performance against project objectives during the pilot phase.
* Closure Criteria: Project will be considered closed when the system meets all functional requirements, all documentation is completed, and final acceptance is received from the customer.
* Post-Implementation Review: Conduct a review to evaluate project success, document lessons learned, and provide recommendations for future projects.