Environmental, Health and Safety Management for Industrial Parks
Designing Web-Based Solutions
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Cities Development Initiative for Asia
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Cities Development Initiative for Asia (CDIA) is a multi-donor trust fund managed by the Asian Development Bank (ADB). It works closely with secondary cities in Asia and the Pacific to address gaps in infrastructure development and financing. It uses a demand-driven approach to support infrastructure projects that emphasize poverty reduction, environmental improvement, climate change mitigation or adaptation, and good governance. To facilitate these initiatives at the city level, CDIA provides a range of international and domestic expertise that can include, among others, support for project preparation studies for high priority infrastructure investment projects.

CDIA is implemented by ADB and Agence Française de Développement (AFD). It receives funding support from Austria, France, Germany, Switzerland and the European Union. It was established in 2007 by the ADB and the German government with the intent of improving the lives of 1.6 billion people in Asia and the Pacific.
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CDIA helps secondary cities in Asia and the Pacific develop bankable infrastructure projects. It has been working in the People’s Republic of China since 2008 and has conducted project preparation studies (PPPs) in 18 cities. Out of the 20 PPPs conducted, 15 are now linked to project financing estimated at $6.4 billion, with about $2.4 billion or 37% linked to Asian Development Bank investment loans.

In 2019 CDIA provided technical assistance to the municipal government of Huangshan in China’s Anhui Province. The assistance involved carrying out four project preparation studies in support of the implementation of the Anhui Huangshan Xin’an River Ecological Protection and Green Development Project (hereafter the Huangshan Xin’an River Project or the Project) — for which loans of $100 million from the Asian Development Bank and €50 million from the KfW German Development Bank were provided to China. The project will primarily upgrade sewerage and stormwater drainage facilities in Huangshan city, and in urban areas of its four surrounding counties, to reduce pollution in the Xin’an River. It will also construct river embankments to provide better flood protection, encourage the use of organic fertilizer and biological pesticides, strengthen capacity for ecological system and project management, and pilot a green finance mechanism.

The project is part of the ADB-China Country Partnership – Yangtze River Economic Belt Programme. The Yangtze River Economic Belt (YREB) is an environmentally-focused economic development initiative covering nine Chinese provinces including Anhui. The YREB region is home to over 40% of China’s population, and contributes about 45% of the nation’s economic output. It is also home to freshwater bodies that provide drinking water for 400 million people. The Xin’an River, the major river in the southern part of Huangshan, drains south east towards the Xin’an River Basin, flowing into Qiantang Lake and on to the Qiantang River, which discharges into the Hangzhou Bay, south of Shanghai. Qiantao Lake and the Xin’an River are the main source of drinking water for 10 million residents downstream in Zhejiang Province, and protecting the river’s water quality is thus of critical importance.

Huangshan Municipality lies some 100 km south of the Yangtze River, in the south of Anhui Province. It is composed of three districts, Tunxi, Huangshan, and Huizhou, and four counties, She, Xiuning, Yi, and Qimen, with a total land area of 9,800 km², and a permanent population of 1.4 million (0.72 million urban and 0.68 million rural residents). Its UNESCO World Heritage Sites, including the mountain which gives the area its name, Huangshan (Mount Huang or Yellow Mountain), and the beautiful traditional villages of Xidi and Hongcun, draw more than 70 million tourists to the region every year. However, the rapid growth of tourism, along with economic development, urbanization and intensive agriculture, have increased environmental pressures across the Xin’an River Basin, and damaged water quality in the river. Huangshan Municipality is therefore in urgent need of strengthened water management and sustainable green development to maintain and improve water quality in the upstream reaches of the Xin’an River.

CDIA provided technical assistance to the Huangshan government on four core aspects of the Huangshan Xin’an River Project, all of which represent key areas for infrastructure investment in China. This has led to the introduction of innovative concepts, approaches and technologies for project design and implementation, making the city a pioneer in the relevant fields in China. CDIA technical experts took part in consultations and capacity-building events with local stakeholders to enhance understanding of the design, construction, operation and maintenance of the suggested innovations. These joint efforts contributed to the successful approval of the ADB loan for the Project in December 2019.

This series of four reports is intended to support the Huangshan government, design institutes, sub-project owners and project managers to implement and build on innovative elements in each of the four areas, with recommendations and technical roadmaps to guide them through project design and implementation. It can also be used as a reference for other cities in China and elsewhere in the Asia Pacific region. Highlights of the innovative elements of the interventions include:

1. First Flush Stormwater Pollution Management: Space saving and cost-effective solutions for stormwater pollution control in urban areas, including adapted design for a detention pond and concepts for integrated community development.

2. Environmental Health and Safety (EHS) management: Development of a web-based EHS management platform for industrial parks, to improve environmental safety monitoring and emergency responses, and upgrade enterprise management behavior.

3. Application of Informational Communication Technologies (ICT): Cost-effective ICT strategies for a range of environmental monitoring systems, with integration into ‘smart city’ data management platforms for better maintenance and operation.

4. Climate Change Adaptation and Mitigation: Recommendations: piloting the ARCCE (assessment, review, communication, collaboration, engagement) participatory approach to developing climate change measures and integrating them into project design.

Further details can be found in the individual reports.

Acknowledgements

CDIA would like to express its gratitude to the Huangshan Municipal Government, particularly Mr. Wang Weidong, Director, and Mr. Yin Quan, Deputy Director of the Huangshan ADB Project Management Office, who had the vision and courage to ensure that the Huangshan projects demonstrated innovations and best practices in various areas. We also owe thanks to Fan Mingyuan, Principal Water Resources Specialist from the Asian Development Bank, who led the preparation of the investment project, spearheaded the innovations, and provided much valuable feedback on the CDIA intervention areas.

This publication was prepared by Allen Zhang, with close collaboration from Zhang Yu, Senior Infrastructure Development Specialist from CDIA, who led this intervention. Their great efforts played a vital role in this project’s innovative approach, and in ensuring it would have a longer-term impact. The publication also benefited from valuable input from Analyn Rubeaneza, Communications and Outreach Specialist, and Chas Anne RoVo, Urban Development Specialist, from CDIA.

Many thanks also to Joey Shen, who supported many aspects of the report’s development, and for the excellent work done by the editing team from CONSTELLATIONS International.

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Preface

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Preface
This report details an innovative online approach to Environmental, Health and Safety (EHS) Management for industrial parks and the enterprises in them, based on research carried out in Huangshan Municipality, Anhui Province, People’s Republic of China, as part of a project preparation study (PPS) by the Cities Development Initiative for Asia (CDIA), ahead of implementation of the ADB-funded Anhui Huangshan Xin’an River Ecological Protection and Green Development Project (the Project). The report’s aim is to share experience gained during the study with the local Project Management Office, design institutes, executive/implementation agencies and local authorities in Huangshan, and facilitate implementation of CDIA’s recommendations in two pilot industrial parks. It is hoped the study will also provide a model for other industrial parks or cities that may wish to implement similar measures.

**Executive Summary**

**Background**

Because the Xin’an River is the main drinking water source for the population in Huangshan and the downstream cities, there is an urgent need for Huangshan City to strengthen environmental, health and safety (EHS) management of industrial facilities close to the river. Huangshan has two major provincial chemical industrial parks, in Huizhou District and She County, which produce epoxy resins and dyeing materials, and are located within 1-2 km of a tributary of the Xin’an River. Both parks are required as part of the Project to install state-of-the-art monitoring systems for environmental and safety management, and emergency response.

**Project Goals**

CDIA technical assistance (TA) was sought, in the form of a project preparation study, to introduce additional innovations and international best practices into the project design, in order to enhance EHS management in the two industrial parks.

**Methodology**

CDIA experts first carried out a review of the draft feasibility study reports on EHS management prepared by the industrial parks as part of the ADB project. They found that the EHS approach focused on environmental and safety monitoring, and alarm and emergency response systems, but did not outline ways of preventing environmental hazards or safety incidents from occurring in the first place. The experts also made site visits to key manufacturing enterprises in the two parks, conducting interviews and reviewing current EHS management practices. They discovered that some aspects of EHS management and safety monitoring were in need of improvement: not all enterprises had online safety monitoring systems reliably connected to the park’s emergency response center or administration office, or to government monitoring departments. Information technology had not been fully incorporated into daily management of EHS affairs by the parks or enterprises, hindering communications and administration. Thus, enterprises could not always access government data, or easily upload their own documents or monitoring data, and regulators and monitoring departments had only partial information about day-to-day environmental issues in the parks, and would not always be immediately informed in case of an emergency.

**Recommendations**

To remedy the lack of systematic EHS management, and mitigate environmental and safety risks in the parks, CDIA experts proposed the introduction of a comprehensive EHS management system, incorporating greater use of existing information management systems. They also proposed the development of a web-based EHS management system platform, known as “WeHS”, to be implemented in both parks to link enterprises, park administration and emergency response units digitally. Among other functions, it will enable continuous online monitoring of environmental parameters and industrial production safety, with alarms to mobilize emergency responses at various levels in the event of accidents or hazardous emissions.
Executive Summary

The system will be integrated into Huangshan Municipality’s ‘Smart City’ cloud platform, to allow easier sharing of data and information, including in emergencies, between the parks, enterprises and administrative and monitoring departments.

Implementation

Based on analysis of the technical and safety requirements of enterprises and utility providers in the industrial parks, CDIA experts produced an EHS Management Manual to guide the establishment of a comprehensive EHS management program for the parks and enterprises.

They also prepared Terms of Reference (TOR) for the hiring of EHS and ICT experts and consultants to develop the online WeHS management platform. Key requirements include: an EHS management software programming design; an online EHS operating platform; apps for users in enterprises and industrial parks; and one year’s software commissioning and debugging during trial applications, as well as user training.

CDIA experts also held two capacity building activities to explain the importance, technical framework and approach of the WeHS system to representatives from the industrial parks, and collected feedback from stakeholders to further improve the technical guidance.

Outputs

The development of the web-based EHS Management System (WeHS) is a pilot demonstration of how industrial parks and manufacturing enterprises can cooperate to jointly improve EHS compliance and emergency responses, by means of advanced information technology and data sharing.

WeHS will help to provide real-time linkages between government, industrial parks and manufacturing enterprises, thus facilitating prevention of environmental or safety incidents.

The WeHS software can also be used by the enterprises as an internal auditing tool and training platform. It is thus a capacity building tool to enable individual enterprises to implement national and international best management practices, despite their limited resources and expertise, and will contribute greatly to the improvement of EHS management in the parks.

Consolidation of WeHS into Huangshan’s Smart City platform will allow seamless connections between industrial parks, enterprises and government regulators, including local government emergency control centers. It will help to prevent information isolation, enabling the industrial parks and enterprises to directly access online data, and upload data and documents to the platforms of official regulators without extra investment. Integration into the Smart City platform may also encourage others in Huangshan to implement WeHS.

The development of WeHS will be a sub-project included in the ADB-funded Project, with its own investment budget in the procurement plan. Developing WeHS across the two industrial parks in Huangshan also halves the cost of building such a system separately and independently in each of the parks.

The EHS Management Manual and TOR will guide the development of the WeHS system and the delivery of trial applications in the two industrial parks. The EHS Management Manual also makes this approach readily replicable by other industrial parks and manufacturing facilities in Huangshan and elsewhere in China. It thus helps to establish a set of tailored management approaches that will enable similar industrial parks and enterprises – which may lack the resources, expertise or capacity to develop an EHS management system by themselves – to improve their environmental, health and safety management.

Practical experience in the use of the WeHS management system in the parks, and of its integration into the Smart City platform, can also be disseminated by the Huangshan Municipal Government across China, and can be adopted by other cities in the Asia-Pacific Region.
Introduction

1. Project Background

The growth of industrial parks has been one of the features of China’s economic development of the past decades. They can be found in cities across the country, often clustering dozens of enterprises in similar industries in purpose-built sites, which have been established to provide better service to these companies. The sheer number and scale of such sites, and the fact that many are home to industries that use potentially hazardous chemicals, or present other pollution risks, means that environmental health and safety (EHS) management for these facilities is of prime importance.

However, despite their modern appearance, EHS management in these industrial parks is often quite underdeveloped. And since there are relatively few comprehensively managed industrial zones of a similar scale, with a similar, government-run management structure, in other parts of the world, there is a lack of easily transferable international experience to help such parks improve their management. Developing a practical approach that can introduce best management practice into the EHS management of industrial parks and individual enterprises is therefore a pressing issue in China, especially as the country has committed in recent years to promoting greener economic development and mitigating environmental risks.

One area where eco-friendly development has been emphasized in recent years is in the Yangtze River Economic Belt, an environmentally-focused economic development initiative established by the Chinese government, which covers nine provinces and municipalities. The Asian Development Bank, as part of the ADB-China Country Partnership – Yangtze River Economic Belt Programme, in 2019 approved a loan of $100 million for the Anhui Huangshan Xin’an River Ecological Protection and Green Development Project (hereafter the Huangshan Xin’an River Project, or the Project), which focuses on preventing pollution of the Xin’an River, an important source of drinking water for...
One focus of the Project is the need to strengthen environmental, health and safety (EHS) management of industrial facilities close to the Xin’an River. This report describes the findings of CDIA’s project preparation study on EHS management at two of Huangshan’s key industrial parks, and its recommendations for improving this through a digitally-networked EHS management system that can be used by both the parks.

1.2 EHS Management Issues in China’s Industrial Parks

In China, the administrative body in charge of every industrial park is a quasi-regulatory government agency, headed by government staff. Each industrial park has an EHS management department, which is responsible for the establishment of an effective monitoring and emergency response mechanism park-wide, and for day-to-day supervision of the EHS management of individual enterprises in the park. It also helps the administration to decide on whether or not to accept new enterprises into the park, from an EHS perspective.

In many cases in China, the industrial park is also the land-owner, and the enterprises in the park hold a long lease for the land and buildings they use. The park administration also either provides shared utilities, such as heat supply and wastewater treatment, to the enterprises, or engages service companies to provide them. The park also sets pollution standards for the discharge of pretreated wastewater from individual enterprises to its wastewater treatment plant (WWTP).

The regulator ultimately responsible for supervising the environmental issues of individual enterprises in an industrial park is the local Ecology and Environment Bureau (EEB) at the municipal or county level. Safety issues relating to industrial parks as a whole are regulated by the local Emergency Management Bureau (EMB). Each park’s EHS department is under the supervision of both the EEB and EMB.

If an environmental or safety incident occurs and has an impact on local water bodies and communities, the industrial parks, under the supervision of the local EEB and EMB, have some liability, since they administer the land use for industrial development and own the wastewater treatment and sewer/storm water control utilities. This joint liability for incidents that might take place at individual enterprises is a driver for the development of an integrated monitoring/emergency response devices and the establishment of a unified EHS management in the parks.

Industrial parks that are home to large enterprises can often rely on the enterprises to operate their own comprehensive EHS management systems, and so the parks only need to focus on supervision and monitoring. However, in most of China’s industrial parks, particularly those in small and medium-sized cities, the enterprises have not institutionalized comprehensive EHS management systems, and are therefore at greater risk of experiencing EHS accidents. Thus, the industrial parks need to act at the park level to find solutions to reduce such risks.

1.3 Regulatory Requirements for EHS Management of Chemical Industrial Parks in China


Specific regulatory requirements for EHS management in chemical industrial parks include:

- Establishing a clearly defined entrance program for accepting enterprises into the chemical industrial park, including a list of prohibited types of industries, and also rules for site closure and decommissioning of enterprises.
- Controlling and supervising the risks involved in transportation of dangerous goods through real time monitoring of transportation routes in the industrial park.
- Establishing a security and monitoring system for key hazard sources.
- Developing information technology (IT) applications for management and supervision of hazardous waste management in the industrial park.
- Establishing an integrated production safety and emergency response system for enterprises.
- Establishing an information management system (IMS) for safety supervision and emergency response and rescue in the industrial park.

Local government departments have also established administrative websites at city and provincial levels. The Anhui provincial Ecology and Environment Bureau has established online platforms for the filing of environmental impact assessments, registration of pollutant discharge/emission sources, and hazardous waste disposal manifest and registration. The provincial Emergency Management Bureau has established online platforms for key safety hazard monitoring, accident alarm systems, and emergency response centers.
Huangshan has two major provincial chemical industrial parks, located in Huizhou District and She County, which produce epoxy resins and dyeing materials, and are considered to be key economic engines of the city. The two industrial parks lie 1-2 km south of the Fengle River, a tributary within the Xin'an River Basin. (See Figure 03.)

Being so close to such a sensitive water body receptor, the two industrial parks are required, as part of the Huangshan Xin'an River Project, to install a state-of-the-art monitoring system for environmental and safety management (including stormwater runoff, wastewater discharge, air emissions and spills of hazardous substances), and an associated emergency response system.

CDIA technical assistance was sought to provide a project preparation study (PPS) and introduce additional innovations and relevant international best practices into the Project design, in order to enhance EHS management in the two industrial parks.

As a first step of the study, technical experts from CDIA carried out site visits to the Huizhou District Industrial Park (HDIP) and the She County Industrial Park (SCIP) in June 2019 to survey the current situation and assess the need for EHS management, environmental monitoring and emergency response systems. Reconnaissance visits to typical manufacturing facilities were also conducted. The visits included a review of the current state of EHS management of key facilities with major environmental and safety risks, such as wastewater treatment plants, aboveground storage tanks, and tank farms for storing fuel and chemicals.

With its source in the mountains in the north of Huizhou District, the Fengle River flows east to join the Lian River in She County. The Lian River then converges into the main Xin'an River approximately 20 km from the industrial parks, upstream from Qiandao Lake. (See Preface for more information.) (See Figure 03.)
The parks are home to enterprises engaged in the production of polyester and epoxy resins, which use similar chemical manufacturing processes. The use of toxic and dangerous chemicals in these processes means both parks are potentially major sources of environmental hazards.

Both industrial parks operate their own separate wastewater treatment plants (WWTP). All wastewater generated from the enterprises in the industrial parks is collected and conveyed to the plants for pretreatment, to meet the Class III limits set out in China’s Integrated Wastewater Discharge Standard (GB8978-1996). Both parks’ wastewater treatment plants are supervised by the local Ecology and Environment Bureau, and have installed online monitoring devices for real-time analysis of chemical oxygen demand and ammonia-nitrogen in treated wastewater effluents. Pre-treated wastewater is then conveyed by the municipal sewer network to the Huizhou Municipal Wastewater Treatment Plant or the She County Wastewater Treatment Plant for secondary treatment, to meet the Class IA limits stipulated by the Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant (GB18918-2002). (This is China’s most stringent standard, since the whole of the Xian’an River basin is designated as a water protection zone.)

Both the industrial parks also have stormwater drainage outlets, which are connected to the municipal storm sewer system. These outlets have emergency control valves to cut off contaminated stormwater runoff in case of any accidental spill of wastewater, chemicals or toxic substances, and prevent it from being discharged into the municipal storm sewers outside the parks.

1.6 CDIA’s Recommendations

This report is designed to share experience gained during the CDIA Study, along with the recommendations made by CDIA’s experts, with the local design institutes, Project Management Office, executive/implementation agencies and local authorities in Huangshan, so that these can be implemented effectively in HDIP and SCIP.

The report outlines how CDIA, in collaboration with local stakeholders, assessed the EHS management needs of the two industrial parks, and made proposals for upgrading the management system. Chief among the recommendations is the development and introduction of a web-based EHS management system (to be known as “WeHS”), which can be implemented across both industrial parks in Huangshan. This joint system is not only cost-effective, but will also enable online monitoring of environmental parameters and set alarm triggers to mobilize emergency response actions at various levels in the event of accidents or hazardous emissions. It is also hoped that this online EHS system can be integrated with the ‘Smart City’ cloud platform of the Huangshan Municipal Government, to allow easier sharing of data and information between the parks, enterprises and local administrative departments.

The report also describes how the CDIA team prepared an EHS Management Manual to guide the establishment of the EHS management program in the industrial parks and enterprises, and Terms of Reference (TOR) for the hiring of EHS and ICT experts and consultants to develop the web-based WeHS management platform. It is intended that these can serve as a model for other industrial parks or cities that may wish to implement similar measures.
Recommended Innovations for EHS Management in the Two Industrial Parks

2.1 Gap Analysis of EHS Management in the Two Parks

In conjunction with the relevant implementation agencies, design institutes, park administration and local regulators, CDIA’s EHS specialists first analyzed the draft feasibility study, prepared as part of the proposals for the Xin’an River Project. The feasibility study proposed measures for improving the efficiency of EHS management in the two industrial parks, including the development of information management system-based environmental monitoring, safety supervision and an emergency response system. However, the CDIA specialists noted two key shortcomings in the feasibility study’s proposals:

i. It focused on the development of separate information management systems for the two industrial parks, and did not propose linking these with the regulatory departments of the Huangshan Municipal Government.

ii. It emphasized the procurement of hardware for building an environmental and safety monitoring/alarm and response system to report accidents, but did not address the prevention of accidents, nor shortcomings in EHS management (particularly relating to human resources) that increase the risk of accidents.

After conducting site visits to the two industrial parks and some of their key enterprises, and reviewing the current EHS management situation in the parks, the CDIA specialists identified several key issues that must be addressed to improve the parks’ environmental/safety monitoring and emergency response.
Need for an Effective EHS Management System

Neither Huizhou District Industrial Park nor She County Industrial Park have established or implemented an effective EHS management system. Their current focus, echoed in the Project feasibility study proposals, is on alarm systems to alert authorities to accidents, and on providing an early response to such accidents and monitoring their consequences. While these measures are important, such a management approach does not emphasize accident prevention, or the creation of an EHS culture. For example, contacts between the administrations of HDIP and SCIP and their respective enterprises have reportedly not been very efficient, particularly in areas such as updates on new regulations, implementation of corrective action plans for any problems identified, and follow-ups on these issues.

Under-use of Information Technology

Information technology has not been incorporated into the daily management of EHS affairs by the administrations of the parks or their enterprises. This hinders both communications and the filing of documents. For example, during CDIA’s site visits and research, relevant EHS documentation for production activities at key enterprises in the parks, including EHS approval and permits, was not always readily available, indicating management problems and the lack of an effective database.

Economic and Staffing Issues

Introducing a comprehensive EHS management system in the industrial parks is also made harder by the fact that Huangshan is not an economic hub, and so the parks and their enterprises have difficulty attracting and/or retaining highly skilled staff. Similarly the enterprises, which are not major companies, lack the resources to invest in EHS or pay good salaries to talented professionals.

Incomplete, Non-integrated Monitoring Systems

A number of problems were also found in the parks’ approaches to monitoring. SCIP, for example, has carried out several individual projects to connect the online monitoring systems of key enterprises with the park’s emergency response center office. These systems monitor wastewater discharge and stormwater drains, air emissions, storage tank safety and movement of hazardous chemicals. However, reviews found that the connections are not always reliable, while some enterprises in the parks are not connected at all. In HDIP, meanwhile, the online monitoring and emergency response systems installed in key enterprises are stand-alone systems, with no networked IT connection to the park’s administrative office. HDIP has thus had to invest significant sums in monitoring individual manufacturing enterprises’ wastewater discharge, for example, by conducting manual sampling and analysis. CDIA’s review also found that neither the stand-alone monitoring systems of the enterprises in HDIP, nor the emergency response center of the SCIP Commission, were reliably connected with government authorities such as the Ecology and Environment Bureau and the Emergency Management Bureau, or the city or county-level Emergency Response Centers.

2.2 Recommendations for Improving EHS Management in the Industrial Parks – Web-Based EHS

To enable coordinated management of environmental and safety issues, and strengthen the parks’ capacity, CDIA’s experts recommended the development of a comprehensive EHS management system, to ensure better utilization and analysis of monitoring data, and prevent environmental and safety accidents. They also recommended the application of Information Management System technologies to improve the efficiency of EHS management and of document filing and communication by enterprises in the parks, as part of a web-based EHS management system, based on an ICT application, which would strengthen communication between enterprises and the administrative offices of the industrial parks. Specifically:

i. Alongside the purchase of hardware equipment for monitoring and alarm systems, software development is required for the establishment of a comprehensive online EHS management system (to be known as WeHS).

ii. Development of a compatible information management system and smart EHS management system should provide links between all the monitoring terminals and control devices in the enterprises and the industrial park administration.

iii. The online EHS system should provide a document filing function to ensure that electronic copies of all relevant documents, such as EHS approval documents and permits, are kept in the database.

iv. Given the parks’ and enterprises’ difficulties in attracting and retaining skilled professionals capable of carrying out the improvement of EHS management mechanisms, it is important to develop a comprehensive WeHS Management Manual, as a template and policy guideline for individual enterprises in the parks. This will enable the consistent enforcement of park-wide policies and practices, and is particularly practicable since the manufacturing enterprises in the two parks are in the same area of industry.

v. It is also proposed that the smart information management system and online EHS management system should be integrated into Huangshan’s Smart City ICT cloud platform, which is being developed by the city’s Data Resource Administration Bureau, and aims to link all government administrative platforms, including those of the local EEB and EMB. This will allow more efficient collection, storage and analysis of information and data across the two parks, as well as the sharing of data with other relevant users, and easy access to other regulatory platforms.
Visits to the two industrial parks confirmed their suitability for using a common EHS management system. Not only do the two parks have similar utilities including wastewater treatment plants and logistics companies, the enterprises in the parks are also engaged in similar types of business, mainly resins manufacturing and processing. Thus, while the use of toxic and dangerous chemicals in these processes means both parks are major sources of potential hazards, the similarity of manufacturing processes in the two parks offers an opportunity to improve the EHS management of all the enterprises in a consistent and coordinated manner, within the constraints of the resources available. Interviews with Huangshan’s Data Resource Administration Bureau (DRAB), meanwhile, also revealed that EHS management was already under consideration for inclusion in an online environmental demonstration platform affiliated with the development of Huangshan’s Smart City program. In the DRAB’s view, an online EHS management system would not only serve Huangshan’s enterprises well, but would also enhance the efficiency of government monitoring work. During capacity development activities held in July and December 2019, the approach to the development of WeHSc for pilot use in the two industrial parks, including the proposed outlines of the EHS management manual and the TOR, was presented to the Huangshan Project Management Office, design institutes, representatives of the industrial parks and relevant stakeholders for further discussion and feedback.

The CDIA experts’ recommendations and proposed innovations, along with their analysis of the draft feasibility study proposals, are summarized on the next page.

Table 01: Analysis and Recommendations for Developing a Web-Based EHS Management System in HDIP and SCIP

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Preliminary Design in the Feasibility Study</th>
<th>CDIA Review and Recommendations</th>
<th>Innovations for Improving EHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>EHS Management Program</strong></td>
<td>The draft feasibility studies for HDIP and SCIP focused on the development of environmental and safety monitoring systems for the industrial parks, and procuring environmental and safety monitoring devices and equipment. However, the studies did not clearly specify either compatible operating system software or applications interfaces with users or customers in the manufacturing enterprises.</td>
<td>The installation of hardware monitoring devices and equipment can only guarantee raising the alarm when environmental, fire and safety accidents occur. It has little effect in preventing such accidents taking place in the first place. Establishment of comprehensive EHS management programs at the individual facility level in the two industrial parks is recommended.</td>
<td>Development of an EHS Management Manual to guide the system set-up in both industrial parks and individual manufacturing enterprises, in order to prevent accidents occurring in the first place.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Web-Based EHS Program and Applications</strong></td>
<td>The draft feasibility studies emphasized installation of hardware equipment for environmental and safety monitoring systems, for alarm purposes, in the two industrial parks. However, they did not consider including applications for software development in a user-friendly ICT platform, for smarter EHS management of manufacturing enterprises in the two parks.</td>
<td>The software system is an important part of the ICT system, for the smart management of industrial parks, especially in EHS management. Development of operating system software or user applications for smart EHS management of manufacturing enterprises in the industrial parks is recommended.</td>
<td>Developing a web-based EHS management system for manufacturing enterprises in the industrial parks. The software would both (i) integrate the park’s EHS management and emergency functions, and (ii) help individual enterprises in setting up a comprehensive EHS management system, which they might not otherwise have the capacity to do.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Integration/Connection with Huangshan Municipality Smart ICT Center</strong></td>
<td>The draft feasibility studies for HDIP and SCIP separately proposed monitoring and alarm management systems for environmental and emergency responses in the two parks. However these systems would likely have been operated separately, and their data would not have been linked to government regulatory departments, or compatible with Huangshan’s Smart City platform.</td>
<td>Embedding the EHS management systems of the two industrial parks in Huangshan’s Smart City ICT platform is recommended for more efficient collection, storage and analysis of information/data, instead of them being operated as two isolated systems.</td>
<td>Development of an online EHS system, and implanting it into Huangshan’s Smart City ICT platform, allowing data to be shared by other qualified users with similar needs. The integration also allows the online EHS management system to readily access other regulatory platforms.</td>
</tr>
</tbody>
</table>
2.3 Implementation and Innovations of WeHS

The web-based EHS Management System (“WeHS”) proposed by CDIA aims to remedy the lack of data access to the online monitoring and emergency response systems installed in key enterprises in the industrial parks. Under the WeHS system, the administrations of both HDIP and SCIP will be able to connect to all the enterprises with key potential hazards in their parks, and will have access to relevant information and data from these enterprises.

WeHS will offer a range of online services, facilitating administration of the industrial parks and the registration of enterprises, and enabling document filing, information/data sharing, linkages between various parties, updates on EHS law and regulations, compliance auditing, regular reporting, tracking of corrective actions, improvement follow-ups and performance evaluation.

If it is incorporated into the Huangshan Smart City cloud platform, WeHS will also connect enterprises’ independent monitoring systems – and the parks’ emergency response centers – with government departments including the EEB, EMB and ERC etc. The parks, the government departments, and any third-parties commissioned to perform EHS supervision will be able, via the unified online platform, to facilitate the monitoring and management of the enterprises.

Once it has been tested in the two industrial parks, and if integrated into the Huangshan Smart City platform, WeHS would be readily replicable by other industrial parks or manufacturing facilities in Huangshan. (The integration of WeHS into the Smart City platform is intended to help facilitate the introduction of WeHS in the two parks, and share relevant experience with others in Huangshan who may also wish to implement it.)

An EHS management manual, customized for the needs of HDIP, SCIP and their manufacturing enterprises will be prepared, and published in the WeHS, to support the implementation of the EHS management mechanism in the industrial parks.

Figure 06 shows how a well-designed WeHS system would function.

A Cloud-based System Can Provide Easy Access for a Range of Users
As discussed in Chapter 2, the CDIA study identified areas for improvement in EHS management in HDIP and SCIP, and recommended the designing, piloting and implementation of a comprehensive EHS management program, to be implemented via a smart ICT system known as WeHS.

Based on this evaluation, an EHS Management Manual should be drawn up to guide the establishment of comprehensive EHS management programs for the industrial parks and the manufacturing enterprises in the parks.

To design and pilot the WeHS system, the engagement of a professional IT software consultant, and/or a consortium of software and EHS consulting firms, is necessary. To guide the recruiting of these consultants, Terms of Reference (TOR) for WeHS Software Development should also be drawn up.

Both the EHS management manual and WeHS system should also be integrated into the Huangshan Smart City Platform, which links government administrative platforms. This will allow the parks and enterprises to access relevant official data and information, as well as allowing data sharing and facilitating monitoring of safety in the parks.

The successful development of the WeHS system and the manual, and their integration into the Smart City platform, require a number of key prerequisites to be in place: expert knowledge, efficient organization, adequate financing and appropriate institutional management. These are discussed in more detail on the next pages.
### 3.2 Expert Knowledge

**Successful delivery of the web-based EHS management system requires:**

1. An EHS management software programming design;
2. An online EHS operating platform;
3. Applications for users from enterprises and staff of the industrial parks; and
4. Software commissioning and debugging in trial applications, as well as user training.

The development of the web-based EHS management system firstly requires the recruitment of a professional software firm with qualified experience to create an online EHS management operating platform/system and IT applications. Secondly, the development team/consortium needs to include a practicing EHS consultant/consultancy with appropriate experience of EHS management in China and international EHS management practices, to help develop the content design. The EHS consultant will also be responsible for debugging the WeHS in the proposed one-year trial operation period, via information collection, database access, data inputs and analysis. The software firm must modify the online EHS management system until it operates smoothly to the satisfaction of all users. The consulting firm can also provide technical assistance and training in WeHS to users in the two industrial parks and manufacturing enterprises.

Figure 07 shows the types of experts and expertise required from the general contractor or consortium of software/EHS firms for the development of WeHS.

<table>
<thead>
<tr>
<th>General Contractor (Consortium)</th>
<th>EHS Consulting Firm</th>
<th>EHS Experts and Engineers</th>
<th>ICT Experts and Engineers</th>
<th>IT Software Firm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EHS Law &amp; Regulations Expertise in China Regulatory Framework</strong></td>
<td><strong>International and China EHS Management Experience</strong></td>
<td><strong>International and China EHS Compliance Auditing Experience</strong></td>
<td><strong>Competent for IT Knowledge and Software Development</strong></td>
<td><strong>Experience of ICT Application in Huangshan Smart City Cloud Platform</strong></td>
</tr>
<tr>
<td><strong>Industrial Parks’ EHS Management Experience</strong></td>
<td><strong>Chemical Manufacturing Enterprises’ EHS Management Experience</strong></td>
<td></td>
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<tr>
<td><strong>Chemical Manufacturing Enterprises’ EHS Management Experience</strong></td>
<td><strong>International and China EHS Compliance Auditing Experience</strong></td>
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<td></td>
<td><strong>Competent for IT Knowledge and Software Development</strong></td>
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</table>

Figure 07: Requirements of the General Contractor/Consortium for Development of WeHS System and Troubleshooting
3.3 Efficient Organization

Regulatory requirements have been introduced and will play a key role in the implementation of an integrated production safety and emergency response system, and the application of the relevant information management system, in the two chemical industrial parks. Both parks and their enterprises have been made aware of these requirements, and are willing to use the online EHS management system as an IT tool to streamline their EHS management, which will be beneficial given their limited staffing.

Integration of WeHS in Huangshan’s Smart City development will also give the parks and enterprises easy access to administrative platforms operated by various government departments, and facilitate data collection and sharing. Previously, assessments of the skills of staff of the Huangshan Municipal Government, the Project Management Office, and the executive agencies and design institutes in charge of the Project have focused on project management capability. CDIA’s assessments, however, have shown that their knowledge of web-based EHS management and integrated ICT management is limited. It is therefore recommended that the PMO should also engage its own EHS management consultant to supervise and assist in the system development and implementation of this subproject.

3.4 Financing

Development of the smart EHS management system has been included as a subproject of the Xin’an River Project, with its own budget for procurement of relevant equipment and services. Among the technical assistance specialists working on implementation of the overall Project, another EHS specialist should also be funded, to take responsibility for supervising the performance of the software firm and consultants in charge of the WeHS system development, commissioning and debugging, referred to in Section 3.2 (This is in addition to the PMO’s consultant referred to in 3.3).

3.5 Institutional Management and Capacity Development

The Project Management Office will take charge of the implementation of all the commitments in the investment project, including development and integration of the smart EHS management system in the Huangshan Smart City ICT platform, and eventually transfer management of this to the Huangshan DRAB.

The two industrial parks will use the online WeHS system for their EHS management and supervision of the enterprises within their respective jurisdiction.

The DRAB will link the databases of the local Ecology and Environment Bureau and Emergency Management Bureau to the Huangshan Smart City platform.

The WeHS system will be authorized by the DRAB for access to, or connection with, the online monitoring, alarm and emergency response facilities of key enterprises in the two pilot industrial parks.

Online access to the database by the enterprises of HDIP and SCIP will also be authorized by the DRAB as part of the multi-functional applications in the WeHS system.

Although successful implementation of the web-based EHS management system requires institutional support from multiple agencies and plants in the Huangshan Smart City platform, it should be emphasized that the industrial park remains the owner and administrator of the WeHS management platform. Data collected by the platform from individual enterprises and park-wide utilities should remain confidential and be securely held by the industrial park, which can authorize access to the data by qualified users.

When the WeHS system is brought online, the software can also be used by the enterprises as an internal auditing tool and training platform. It is thus also a capacity-building tool designed to help individual enterprises to implement national and international best management practices, despite their limited resources and expertise. The development of WeHS will contribute greatly to the improvement of EHS management in HDIP and SCIP.
As noted above, the development and introduction of an integrated EHS management system for Huizhou District Industrial Park and She County Industrial Park and the enterprises based within them requires the preparation of a common EHS Management Manual to improve the management of wastewater, solid waste and emissions. This manual can be included as a key part of the parks’ web-based EHS management system.

In order to ascertain what information should be included in the manual, CDIA’s consultant visited major manufacturing enterprises and utility providers in the two parks in June 2019, to review their production processes and EHS management, including environmental monitoring, emission control practices, wastewater treatment and emergency response practices.

Enterprises visited included Huangshan Shenjian New Materials Co., Ltd. and Huangshan Youyi Chemistry Technology Co., Ltd. which manufacture polyester resins, and Anhui Shanfu New Materials Technology Co., Ltd., which makes epoxy resins.

The consultant also visited the She County Recycling Economy Industrial Park (SCIP) Heat Supply Co., Ltd., a coal-fired heat supply plant, and two wastewater treatment plants, Huangshan Huizhou Shuangyi Environmental Engineering Co., Ltd. and She County Recycling Circular Economy Industrial Park (SCIP) Dingyuan Wastewater Treatment Co., Ltd., which serve the enterprises in their respective industrial parks.

Observations from Site Visits

Wastewater Treatment Management in Manufacturing Enterprises

HDIP and SCIP have conducted environmental and safety assessments across the parks, in line with regulatory requirements, and identified key enterprises or key utilities with safety concerns, including liquefied natural gas storage and storage tanks for solvents and toxic substances. However, while safety surveillance monitors and/or alarms have been installed and appear to be operational in these key enterprises, they are not connected to the industrial parks’ administrations, and so cannot be used by the parks for EHS supervision purposes. Online surveillance devices at major hazard sources in individual key enterprises have been, or are being, connected to the city-level emergency control center; and selected online monitors and sensors installed in key enterprises in SCIP are connected to the She County Emergency Response Center – but the park’s own EHS department has no direct access. The EHS manual should therefore specify regular inspections and supervision of key hazards at chemical tank farms, to avoid risks developing undetected.

Regular Inspection and Supervision of Key Hazards in Chemical Tank Farms

Pre-treated wastewater from the enterprises is transferred through the industrial parks’ sewers for secondary treatment in the parks’ wastewater treatment plants, prior to discharge to the municipal wastewater treatment plant of either Huizhou District or She County. Both parks’ WWTPs are equipped with their own emergency storage tanks for collection of any untreated wastewater. Online monitoring and control devices had also been installed at the outlets of both parks’ WWTPs. To ensure best practice, sewer management in industrial parks should also be included in the EHS Manual.

Sewer Management in the Industrial Parks

The review identified several key issues for inclusion in the EHS management manual:

- Regular Inspection and Supervision of Key Hazards in Chemical Tank Farms
- Wastewater Treatment Management in Manufacturing Enterprises
- Sewer Management in the Industrial Parks
A detailed depiction of the flow of wastewater treatment, wastewater discharge and emergency response management in HDIP and SCIP can be found in Appendix 1.

Stormwater drained from individual enterprises, meanwhile, is collected by the parks’ storm sewer networks and discharged to neighboring ditches or tributaries of the Fengle River. Emergency shut-off valves and/or sluicing devices are installed at the outfalls of the HDIP and SCIP stormwater drainage networks. The emergency storage tanks installed at the parks’ WWTPs can be used for temporary collection of contaminated storm water in case of accidental chemical release. Stormwater management should also be included in the manual. Details of the stormwater sewer and emergency storage system in HDIP and SCIP can be found in Appendix 2.

The site visit and review of enterprises also identified other areas for which programming procedures should be included in the EHS Management Manual. Key topics include:

- Air Emissions Management
- Wastewater Management
- Tanks Management
- Waste Management
- Energy and Natural Resources Management
- Hazard Communication (HazCom)
- Industrial Hygiene Surveillance (Exposure Assessment)
- Respiratory Protection Program (RPP)
- Fire Prevention and Protection
- Emergency Preparedness and Response
- Hazard Communication (HazCom) and Personal Protective Equipment (PPE), etc.
- Equipment Safety (Material Handling, Machine Guarding, Pressured Vessels and Powered Vehicles, etc.)

Figure 08 depicts an outline structure for the EHS Management Manual, highlighting key management procedures related to EHS in HDIP, SCIP and their manufacturing facilities.
SPECIAL FEATURE: Designing the Terms of Reference (TOR) for Development of WeHS

This TOR is developed to facilitate bidding for the contract to develop the WeHS software. The objective of the software development is to create a system for online EHS management that can be implemented in the two chemical industrial parks in Huangshan. Preparation of the TOR is necessary to guide the bidding process in selecting the IT software and EHS consulting firms, or any consortium with both IT and EHS skills and experience of web-based EHS management systems development, to carry out the task of developing the proposed system. (See Chapter 3.2)

Key contents of the TOR for the development of WeHS software should include:

- Drawing up a programming design for an online EHS management system, to meet the demands of a range of users in government administration and supervision departments, and the EHS management requirements of industrial parks and enterprises;

- Function design for the software and/or application, including web-server, computer and mobile access to assist the authorities, industrial parks and manufacturing enterprises to implement online EHS management; and

- A requirement to provide at least one year’s WeHS commissioning and debugging service, to ensure delivery of successful software. Modification and improvement of the WeHS system can be best achieved with a long software-debugging period, once the industrial parks and their manufacturing enterprises have begun to carry out EHS management activities using WeHS. Software debugging should focus on log-ins for multiple users, database access, data inputs and outputs, EHS functional programs, and linkage to the Huangshan Smart City platform. The consultant should also provide assistance and training to multiple users, who may include third-party agencies, and relevant government departments using the system for a variety of administrative purposes relating to EHS management in industrial parks.
Takeaway and Recommendations for Other Cities

The development of a **web-based EHS Management System (WeHS)** is a pioneering demonstration of how industrial parks and manufacturing enterprises can cooperate to jointly improve EHS compliance and emergency response by means of advanced information technology and “big data” sharing, with applications for users in enterprises and the staff of industrial parks.

WeHS will provide **real-time linkage** between the demands of provincial and city government departments on the one hand, and the management needs of industrial parks and their manufacturing enterprises on the other. The proposed EHS system will influence the behaviors of enterprises towards the prevention of environmental or safety incidents, and will contribute greatly to the **improvement of EHS management in HDIP and SCIP**.

In particular, WeHS will **connect the individual enterprises to the emergency control centers** of the industrial parks, enhancing safety monitoring and emergency responses.

Sharing the information communication technology (ICT) solution across the two industrial parks in Huangshan also **saves half the cost** that would be incurred if such a system had to be built independently in each of the industrial parks.

**Terms of Reference (TOR) for selecting the IT software and EHS consulting firms** to develop the WeHS system will help to guide the bidding process and ensure that WeHS is relevant to users’ needs, while making sure that any initial bugs in the system are fixed during its first year of trial operation.

Consolidation of the WeHS management applications into Huangshan’s **Smart City platform** (Chapter 2), meanwhile, will allow seamless connections between government administrations, industrial parks and enterprises, including **connecting enterprises to local government emergency control centers**. It will help to prevent information isolation, enabling the
Industrial parks and manufacturing enterprises can directly access online data and upload to the local EEB and EMB platforms, without extra investment. It will also help to publicize the system to others in Huangshan who may wish to implement the WeHS application.

What’s more, given the relatively specific structure and administration of industrial parks in China, the web-based EHS management system adopted in Huangshan will help to establish a set of tailored management approaches that will enable similar industrial parks elsewhere in China to improve their environmental, health and safety management.

Guidance provided in the form of a Web-Based EHS Management Manual means the approach will be readily replicable by other industrial parks or manufacturing facilities throughout Huangshan Municipality, and also offers a practical, customizable model for industrial parks and enterprises in other cities that lack the resources, expertise or capacity to develop an EHS management system by themselves.

Experience in the use of the WeHS management system in HDIP and SCIP, and its incorporation into the Smart City platform can also be promoted by Huangshan Municipal Government to other industrial parks and/or enterprises with similar EHS management needs in other cities in China and elsewhere in Asia.